Catalogue Data in Autumn Semester 2016

Agricultural Sciences Bachelor

Bachelor Studies (Programme Regulations 2016)

1. Semester

First Year Examinations

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
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</thead>
<tbody>
<tr>
<td>529-2001-02L</td>
<td>Chemistry I</td>
<td>O</td>
<td>4 credits</td>
<td>2V+2U</td>
<td>W. Uhlig, J. E. E. Buschmann, S. Canonica, P. Funck, E. C. Meister, R. Verel</td>
</tr>
</tbody>
</table>

Abstract
General Chemistry I: Chemical bond and molecular structure, chemical thermodynamics, chemical equilibrium.

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

Content
1. Stoichiometry
2. Atoms and Elements (Quantenmechanical Model of the Atom)
3. Chemical Bonding
4. Thermodynamics
5. Chemical Kinetics
6. Chemical Equilibrium (Acids and Bases, Solubility Equilibria)

Lecture notes
Online-Skript mit durchgerechneten Beispielen.

Literature
- Brown, LeMay, Bursten CHEMIE (deutsch)
- Housecroft and Constable, CHEMISTRY (englisch)
- Oxtoby, Gillis, Nachtrieb, MODERN CHEMISTRY (englisch)

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<tr>
<th>Number</th>
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<tr>
<td>401-0251-00L</td>
<td>Mathematics I</td>
<td>O</td>
<td>6 credits</td>
<td>4V+2U</td>
<td>A. Cannas da Silva</td>
</tr>
</tbody>
</table>

Abstract
This course covers mathematical concepts and techniques necessary to model, solve and discuss scientific problems - notably through ordinary differential equations.

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

The goal of Mathematics I and II is to provide the mathematical foundations relevant for this paradigm. Differential equations are by far the most important tool for modelling and are therefore a main focus of both of these courses.

Content
1. Single-Variable Calculus:
   - review of differentiation, linearisation, Taylor polynomials, maxima and minima, antiderivative, fundamental theorem of calculus, integration methods, improper integrals.
2. Linear Algebra and Complex Numbers:
   - systems of linear equations, Gauss-Jordan elimination, matrices, determinants, eigenvalues and eigenvectors, cartesian and polar forms for complex numbers, complex powers, complex roots, fundamental theorem of algebra.
3. Ordinary Differential Equations:
   - separable ordinary differential equations (ODEs), integration by substitution, 1st and 2nd order linear ODEs, homogeneous systems of linear ODEs with constant coefficients, introduction to 2-dimensional dynamical systems.

Literature
- Bretscher, O.: Linear Algebra with Applications (Pearson Prentice Hall).

Prerequisites / notice
- Prerequisites: familiarity with the basic notions from Calculus, in particular those of function and derivative.
- Mathe-Lab (Assistance):
  - Mondays 12-14, Tuesdays 17-19, Wednesdays 17-19, in Room HG E 41.

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<tr>
<td>551-0001-00L</td>
<td>General Biology</td>
<td>O</td>
<td>3 credits</td>
<td>3V</td>
<td>U. Sauer, O. Y. Martin, A. Widmer</td>
</tr>
</tbody>
</table>

Abstract
Organismic biology to teach the basic principles of classical and molecular genetics, evolutionary biology and phylogeny.

First in a series of two lectures given over two semesters for students of agricultural and food sciences, as well as of environmental sciences.

Objective
The understanding of some basic principles of biology (inheritance, evolution and phylogeny) and an overview of the diversity of life.
Week 1-7 by Alex Widmer, Chapters 12-25
12  Cell biology  Mitosis
13  Genetics  Sexual life cycles and meiosis
14  Genetics  Mendelian genetics
15  Genetics  Linkage and chromosomes
20  Genetics  Evolution of genomes
21  Evolution  How evolution works
22  Evolution  Phylogenetic reconstructions
23  Evolution  Microevolution
24  Evolution  Species and specialization
25  Evolution  Macroevolution

Week 8-14 by Oliver Martin, Chapters 26-34
26  Diversity of Life  Introduction to viruses
27  Diversity of Life  Prokaryotes
28  Diversity of Life  Origin & evolution of eukaryotes
29  Diversity of Life  Nonvascular&seedless vascular plants
30  Diversity of Life  Seed plants
31  Diversity of Life  Introduction to fungi
32  Diversity of Life  Overview of animal diversity
33  Diversity of Life  Introduction to invertebrates
34  Diversity of Life  Origin & evolution of vertebrates

Literature
- Bohle 1995. Limnische Systeme. Springer, ca. Fr. 50.-

Literature
- Bohle 1995. Limmische Systeme. Springer, ca. Fr. 50.-

Lecture notes
- Slides are provided by instructors and are accessible via moodle.
Knowledge about the World Food System will be provided, based on case studies along food value chains in countries with various development stages and dependent on multiple boundary conditions. This shall generate profound understanding of the associated global challenges especially food scarcity, suboptimal diet and nutrition, food quality and safety as well as effects on the environment.

Content
Case studies on certain foods of plant and animal origin serve to demonstrate the entire food value chain from the production of raw material to processed food and its consumer relevant property functions. In doing so, important corresponding aspects for developed, emerging and developing countries are demonstrated, by use of engineering as well as natural and social science approaches.

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

Abstract
This practical course provides an introduction to elementary laboratory techniques. The experiments cover a wide range of techniques, including analytical and synthetic techniques (e.g. investigation of soil and water samples or the preparation of simple compounds). Furthermore, the handling of gaseous substances is practised.

Objective
This course is intended to provide an overview of experimental chemical methods. The handling of chemicals and proper laboratory techniques represent the main learning targets. Furthermore, the description and recording of laboratory processes is an essential part of this course.

Content
The classification and analysis of natural and artificial compounds is a key subject of this course. It provides an introduction to elementary laboratory techniques, and the experiments cover a wide range of analytic and synthetic tasks:
- Selected samples (e.g. soil and water) will be analysed with various methods, such as titrations, spectroscopy or ion chromatography. The chemistry of aqueous solutions (acid-base equilibria and solvatation or precipitation processes) is studied.
- The synthesis of simple inorganic complexes or organic molecules is practised.
- Furthermore, the preparation and handling of environmentally relevant gaseous species like carbon dioxide or nitrogen oxides is a central subject of the Praktikum.

Lecture notes
The script will be published on the web. Details will be provided on the first day of the semester.

Literature
A thorough study of all script materials is requested before the course starts.
1. Modeling and simulations
2. Visualizing multidimensional data
3. Data management with lists and tables
4. Data management with a relational database
5. Introduction to macro programming
6. Introduction to programming with Python

All materials for the lecture are available at www.evim.ethz.ch

This course is based on application-oriented learning. The students spend most of their time working through projects with data from natural science and discussing their results with teaching assistants. To learn the computer science basics there are electronic tutorials available.

Bachelor Studies (Programme Regulations 2010)

3. Semester

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<tr>
<th>Number</th>
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<th>ECTS</th>
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<tbody>
<tr>
<td>402-0063-00L</td>
<td>Physics II</td>
<td>O</td>
<td>5</td>
<td>3V+1U</td>
<td>A. Vaterlaus</td>
</tr>
<tr>
<td>Abstract</td>
<td>Introduction to the &quot;way of thinking&quot; and the methodology in Physics, with the help of demonstration experiments. The Chapters treated are Electromagnetism, Refraction and Diffraction of Waves, Elements of Quantum Mechanics with applications to Spectroscopy, Thermodynamics, Phase Transitions, Transport Phenomena. Whenever possible, examples relevant to the students' main field of study are given.</td>
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<tr>
<td>Objective</td>
<td>Introduction to the scientific methodology. The student should develop his/her capability to turn physical observations into mathematical models, and to solve the latter.</td>
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<tr>
<td>Content</td>
<td>Elektromagnetismus, Elektromagnetische Wellen, Wellenoptik, Strahlenoptik, Quantenoptik, Quantenmechanik, Thermische Eigenschaften, Transportphänomene, Wärmestrahlung</td>
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<tr>
<td>Lecture notes</td>
<td>Skript wird verteilt.</td>
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<tr>
<td>Literature</td>
<td>Friedhelm Kuypers</td>
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<tr>
<td></td>
<td>Physik für Ingenieure und Naturwissenschaftler</td>
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<td>Band 2 Elektrizität, Optik, Wellen</td>
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<td>Wiley-VCH, 2012</td>
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<td>ISBN 3527411445, 9783527411443</td>
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<td></td>
<td>Douglas C. Giancoli</td>
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<td>Physik</td>
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<td>3. erweiterte Auflage</td>
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<td></td>
<td>Pearson Studium</td>
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<td></td>
<td>Hans J. Paus</td>
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<td></td>
<td>Physik in Experimenten und Beispielen</td>
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<td>Carl Hanser Verlag, München, 2002, 1068 S.</td>
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<td></td>
<td>Paul A. Tipler</td>
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<td>Physik</td>
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<td></td>
<td>Spektrum Akademischer Verlag, 1998, 1522 S., ca Fr. 120.-</td>
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<td></td>
<td>David Halliday</td>
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<td></td>
<td>Robert Resnick</td>
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<td></td>
<td>Jearl Walker</td>
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<td>Wiley-VCH, 2003, 1388 S., Fr. 87.- (bis 31.12.03)</td>
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<td>dazu gratis Online Ressourcen (z.B. Simulationen): <a href="http://www.halliday.de">www.halliday.de</a></td>
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<tr>
<td>701-0071-00L</td>
<td>Mathematics III: Systems Analysis</td>
<td>O</td>
<td>4</td>
<td>2V+1U</td>
<td>N. Gruber, D. Byrne</td>
</tr>
<tr>
<td>Abstract</td>
<td>The objective of the systems analysis course is to deepen and illustrate the mathematical concepts on the basis of a series of very concrete examples. Topics covered include: linear box models with one or several variables, non-linear box models with one or several variables, time-discrete models, and continuous models in time and space.</td>
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<tr>
<td>Objective</td>
<td>Learning and applying of concepts (models) and quantitative methods to address concrete problems of environmental relevance. Understanding and applying the systems-analytic approach, i.e., Recognizing the core of the problem - simplification - quantitative approach - prediction.</td>
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<tr>
<td>Content</td>
<td><a href="http://www.up.ethz.ch/education/systems-analysis.html">http://www.up.ethz.ch/education/systems-analysis.html</a></td>
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<td>Lecture notes</td>
<td>Overhead slides will be made available through Ilias.</td>
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<td>752-4001-00L</td>
<td>Microbiology</td>
<td>O</td>
<td>2</td>
<td>2V</td>
<td>M. Schuppler, S. Schlegel, J. Vorhoft-Zambelli</td>
</tr>
<tr>
<td>Abstract</td>
<td>Teaching of basic knowledge in microbiology with main focus on Microbial Cell Structure and Function, Molecular Genetics, Microbial Growth, Metabolic Diversity, Phylogeny and Taxonomy, Prokaryotic Diversity, Human-Microbe Interactions, Biotechnology.</td>
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<tr>
<td>Objective</td>
<td>Teaching of basic knowledge in microbiology.</td>
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<tr>
<td>Content</td>
<td>Der Schwerpunkt liegt auf den Themen: Bakterielle Zellbiologie, Molekulare Genetik, Wachstumsphysiologie, Biochemische Diversität, Phylogenie und Taxonomie, Prokaryotische Vielfalt, Interaktion zwischen Menschen und Mikroorganismen sowie Biotechnologie.</td>
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<tr>
<td>Lecture notes</td>
<td>Die Behandlung der Themen erfolgt auf der Basis des Lehrbuchs Brock, Biology of Microorganisms</td>
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<tr>
<td>701-0255-00L</td>
<td>Biochemistry</td>
<td>O</td>
<td>2</td>
<td>2V</td>
<td>H.P. Kohler</td>
</tr>
<tr>
<td>Abstract</td>
<td>Building on the biology courses in the 1st and 2nd semesters, this course covers basic biochemical knowledge in the areas of enzymology and metabolism. Those completing the course are able to describe and understand fundamental cellular metabolic processes.</td>
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<tr>
<td>Objective</td>
<td>Students are able to understand - the structure and function of biological macromolecules - the kinetic bases of enzyme reactions - thermodynamic and mechanistic basics of relevant metabolic processes Students are able to describe the relevant metabolic reactions in detail</td>
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</tbody>
</table>
Introduction, basics, composition of cells, biochemical units, repetition of relevant organic chemistry
Structure and function of proteins
Carbohydrates
Lipids an biological membranes
Enzymes and enzyme kinetics
Catalytic strategies
Metabolism: Basic concepts and design. Repetition of basic thermodynamics
Glycolysis, fermentation
The citric acid cycle
Oxidative phosphorylation
Fatty acid metabolism

Prerequisites / notice
Basic knowledge in biology and chemistry is a precondition.
Objective
Understanding of the basic issues and methods in resource and environmental economics; ability to solve typical problems in the field using the appropriate tools, which are concise verbal explanations, diagrams or mathematical expressions.

Topics are:
- Introduction to resource and environmental economics
- Importance of resource and environmental economics
- Main issues of resource and environmental economics
- Normative basis
- Utilitarianism
- Fairness according to Rawls
- Economic growth and environment
- Externalities in the environmental sphere
- Governmental internalisation of externalities
- Private internalisation of externalities: the Coase theorem
- Free rider problem and public goods
- Types of public policy
- Efficient level of pollution
- Tax vs. permits
- Command and Control Instruments
- Empirical data on non-renewable natural resources
- Optimal price development: the Hotelling-rule
- Effects of exploration and Backstop-technology
- Effects of different types of markets.
- Biological growth function
- Optimal depletion of renewable resources
- Social inefficiency as result of over-use of open-access resources
- Cost-benefit analysis and the environment
- Measuring environmental benefit
- Measuring costs
- Concept of sustainability
- Technological feasibility
- Conflicts sustainability / optimality
- Indicators of sustainability
- Problem of climate change
- Cost and benefit of climate change
- Climate change as an international ecological externality
- International climate policy: Kyoto protocol
- Implementation of the Kyoto protocol in Switzerland

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

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

Literature

751-6101-00L Anatomy and Physiology of Man and Animals I O 2 credits 2V M. C. Härdi-Landerer, S. E. Ulbrich

Objective
Imparts a basic understanding of physiology an anatomy in man and domestic animals, focusing on the interrelations between morphology and function of the organism, in particular of domestic animals. This is fostered by discussing all subjects from a functional point of view. The lecture consists of two consecutive parts.

751-3401-00L Plant Nutrition I W 2 credits 2V E. Frossard

Objective
The aim of these lecture is to present the processes controlling the uptake and transport of nutrients and water by the plant, the assimilation of nutrients in the plant, the effect of nutrients on crop yield and quality, the role of the soil as a source of nutrients for crops, and the basic principles of fertilization of different crop types using mineral and organic fertilizers.

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

Literature
Schubert S 2006 Pflanzenernährung Grundwissen Bachelor Ulmer UTB

Phytomedicine: Entomology W 1 credit 1V C. De Moraes

Objective
Does not take place this semester.

Abstract
Applied Entomology: key insect pests and their antagonists in crops, arthropods in storage and public health systems, insect ecology, and pest control strategies
At the end of this course in Applied Entomology, students will have (1) an overview on herbivore insects (pests) and their natural antagonists in agroecosystems, combined with an insight into ongoing research, and (2) an in-depth understanding of population dynamics and damage development based on selected examples from the areas of plant, animal and public health.

751-4501-01L Phytomedicine: Plant Pathology

**Abstract**
Plant Pathology topics: plant diseases in agroecosystems, categories of pathogens, pathogen life histories, pathogen attack and plant defense, gene-for-gene systems, and disease control strategies.

**Objective**
Gain an understanding of the causes and consequences of plant diseases in agroecosystems.

**Content**

**Lecture notes**
Lecture notes will be available for purchase at the cost of reproduction.

**Literature**

751-6301-00L Animal Breeding

**Abstract**
Introduction to basics of animal breeding. Importance of animal production. Species of livestock and their products, performance recording, functional traits, genetic diversity, breeding goals. Qualitative and quantitative traits. Basic knowledge of breeding methods: genetic and environmental variation, heritability, genetic correlation, estimation of breeding values, selection, mating systems.

**Objective**
Show the importance of animal production for Swiss and international agriculture. Name the livestock species, their products, systematic classification and breeding and production goals. Describe methods to measure animal performance (performance recording) and functional traits. Define the most important parameters and methods in animal breeding.

**Content**

**Lecture notes**
Transparencies and single chapters of textbook are made available on homepage.

**Literature**
Tierzucht (Willam/Simianer) UTB 3526 (2011)

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### Agricultural and Resource Economics

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

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

**Objective**
Goals:
The student gets an overview over Area Planning in Switzerland with legal aspects, instruments and the actual state of the art. Awareness rising for complex regional planning and developing questions. Introduction in regional development and politics, based on existing and future regulations and their effects on different political levels.

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

regional development:
- Basics for a successful regional development based on personal field experience
- Discussion of the different instruments
- Stake holders and their role in regional politics
- Case studies for developing strategies (small scale studies)

**Lecture notes**
no script will be delivered, mainly for technical reasons; all necessary stuff will be delivered as papers or via internet.

**Literature**
no literature

**Prerequisites / notice**
german spoken (with translation of french and italien technical terms)

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<tr>
<td>751-1311-00L</td>
<td>Introduction to Agricultural Management</td>
<td>W+</td>
<td>2</td>
<td>2V</td>
<td>R. Finger</td>
</tr>
</tbody>
</table>

**Abstract**
Vermittlung von betriebswirtschaftlichen Grundlagenwissen und Analyse- und Planungsinstrumenten mit Anwendung auf Unternehmen der Agrar- und Ernährungswirtschaft

**Objective**
Teilnehmer des Kurzes sollen am Ende der Vorlesung i) grundlegende Unterscheidungsmerkmale und analyseren können, ii) verschiedene Analyse- und Planungsinstrumente auf Fragestellungen der Produktionsplanung, Investition und Finanzierung an Beispielen anwenden zu können, iii) verschiedene Werkzeuge zur unternehmerischen Entscheidungsunterstützung anwenden können und iv) die Spezifika von Unternehmen in der Agrar- und Ernährungswirtschaft kennengelernt haben.

**Content**
Die Vorlesung geht auf folgende Inhalte, mit spezifischen Anwendungen im Agrar- und Ernährungssektor ein:

- Grundlagen und Ziele unternehmerischen Entscheidens
- Kosten und Leistungsrechnung
- Produktionsplanung
- Produktionsprogrammplanung
- Investitionsplanung und Finanzierung
- Entscheidungen unter Unsicherheit und Risikomanagement

**Lecture notes**
Vorlesungunterlagen werden im Laufe des Semesters zur Verfügung gestellt

**Literature**

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### 5. Semester

#### Focus Agricultural Natural Sciences

#### Focus Agricultural Natural Sciences
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<tr>
<th>Number</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>751-4001-00L</td>
<td>Forage Cropping</td>
<td>W+</td>
<td>2 credits</td>
<td>2G</td>
<td>N. Buchmann, A. Lüscher</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td>This course is an introduction into forage cropping and grassland sciences. Topics include: extensive/intensive use, grassland evaluation, grassland maintenance, management using fertilization, cutting, etc. Relationships between site, vegetation composition and management will be explored.</td>
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<td><strong>Objective</strong></td>
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<td>Die Studierenden werden wichtige Mischungen und Pflanzengemeinschaften mitteleuropäischer Graslandökosysteme kennen, klassische und aktuelle Arbeiten der Bestandesökophysiologie kennen, in der Lage sein, den Einfluss von Umweltfaktoren und Bewirtschaftung nicht nur auf Einzelpflanzen, sondern auf Pflanzenbestände und ihre Erträge abzuschätzen, und üben, ein wissenschaftliches Thema schriftlich prägnant zusammenzufassen.</td>
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<td><strong>Content</strong></td>
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<td>In diesem Kurs werden die verschiedenen Typen des Futterbaus und die wichtigsten Mischungen, aber auch natürliche Pflanzengemeinschaften in Mitteleuropa vorgestellt (Bestandesbeurteilung). Basierend auf der Ökophysiologie von Einzelzwecken wird die Ökophysiologie von Pflanzenbeständen erarbeitet. Es werden verschiedene Arten der Bewirtschaftung vorgestellt (z. B. Bestandeslenkung durch Düngung, Beweidung, Schnittterrine, etc.) und ihre Auswirkungen auf die Bestandeszusammensetzung und auf die Erträge diskutiert. Feedback-Mechanismen zwischen Umwelt und Futterbausystemen werden angesprochen.</td>
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<td><strong>Lecture notes</strong></td>
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<td>Handouts werden auf dem Netz zur Verfügung gestellt.</td>
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<td><strong>Literature</strong></td>
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<td></td>
<td>Wird in der Veranstaltung angesprochen.</td>
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<td><strong>Prerequisites / notice</strong></td>
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<td>Course will be given in German. Course builds on the Ertrags- und Ökophysiologie lecture and provides the basics for the Graslandsysteme.</td>
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<tr>
<td>751-4101-00L</td>
<td>Crops</td>
<td>W+</td>
<td>2 credits</td>
<td>2G</td>
<td>A. Walter, F. Liebisch, W. Richner</td>
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<td></td>
<td><strong>Abstract</strong></td>
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<td>Presentation of the central crops of our regions (cereals, oil and fibre plants, legumes, root and tuber plants) with respect to their biology, site requirements, reaction to environmental conditions and farming practice. A few crops of other regions will be discussed for these aspects as well.</td>
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<td>During this course, students acquire essential knowledge on agriculturally relevant aspects of crop biology, Via lectures and 'hands-on' teaching elements, differences between species as well as common aspects of different species will be experienced. Thereby, the foundation will be laid for a more intense examination of alternative crops, cropping systems and of procedures to characterize geno- and phenotype.</td>
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<td><strong>Content</strong></td>
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<td>The relevance of agriculture at the international level will be treated in the first block. During the semester in autumn (Horticultural Crops I), post harvest aspects in fruit production are discussed in 2 blocks of 4h. Following on this, viticulture (incl. some aspects of wine making) will be looked at in 3 blocks of 4h. During the spring semester (Horticultural Crops II), 3 blocks of 4h deal with vegetable production, and 2 blocks of 4h are addressing berry production.</td>
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<td><strong>Language and script:</strong></td>
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<td>German or French, maybe selected parts in English.</td>
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<tr>
<td>751-4201-00L</td>
<td>Horticulture I</td>
<td>W</td>
<td>2 credits</td>
<td>2V</td>
<td>L. Bertschinger, A. Bühlmann, J.L. Spring</td>
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<td><strong>Abstract</strong></td>
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<td></td>
<td>Overview on horticulture (international and national), insights into principles of practical fruit production (pre- and post-harvest), viticulture (incl. some hints on wine making), berry production and vegetable production in Switzerland.</td>
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<td>Insights into fruit production (world and Switzerland), particularly ...</td>
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<td>- Main production areas (international &amp; national)</td>
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<td>- Relevance (international &amp; national)</td>
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<td>- Key aspects of production (Switzerland), i.e. selected aspects referring to varieties, production techniques incl. physiology and plant protection, economics</td>
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<td>- Key challenges (Switzerland)</td>
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<td>- Selected, interesting research and development projects</td>
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<td></td>
<td><strong>Content</strong></td>
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<td>The relevance of horticulture at the international level will be treated in the first block. During the semester in autumn (Horticultural Crops I), post harvest aspects in fruit production are discussed in 2 blocks of 4h. Following on this, viticulture (incl. some aspects of wine making) will be looked at in 3 blocks of 4h. During the spring semester (Horticultural Crops II), 3 blocks of 4h deal with vegetable production, and 2 blocks of 4h are addressing berry production.</td>
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<td>Delivered during the lectures by the different teachers, ELBA upload.</td>
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<td><strong>Literature</strong></td>
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<td>751-4701-00L</td>
<td>Herbology</td>
<td>W+</td>
<td>2 credits</td>
<td>2G</td>
<td>B. Streit, N. Delabays, U. J. Haas</td>
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<td></td>
<td><strong>Abstract</strong></td>
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<td>The focus will be on the basic principles of biology and ecology of weeds, crop-weed interactions and basic knowledge of chemical, physical and biological weed control with their respective (dis-) advantages. Furthermore students will get an introduction on the mechanisms of weed management in different farming systems and crops.</td>
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<td>751-4801-00L</td>
<td>System-Oriented Management of Herbivore Insects I</td>
<td>W+</td>
<td>2 credits</td>
<td>2G</td>
<td>D. Mazzi</td>
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<td><strong>Abstract</strong></td>
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<td>The focus is on the potential to assess strategies and tactics of pest management, taking into account the demands from the economy, the environment and the society. Significant agricultural approaches will be explained using practical examples, including prevention using natural resources, surveillance and forecasting, resistance management, as well as product registration, incl. ecotoxicology.</td>
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<td><strong>Objective</strong></td>
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<td>The students gain a good understanding of fundamental aspects of pest management in agroecosystems. They will have the ability to assess options for action in view of requirements from the economy, the ecology and the society. Further, they will learn to perform searches on relevant issues in pest management, and to critically evaluate case studies.</td>
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<td></td>
<td><strong>Abstract</strong></td>
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<td>The basics of planning of feeding and formulation of diets incl. the implications on nutrient cycles and balances are taught. In the part dealing with ruminants, forage-based diets and the application of feed formulation programs are central and exercised on-farm. With pigs and poultry, the basics of energy and nutrient requirements are deepened through practical examples.</td>
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<td><strong>Objective</strong></td>
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<td>The students are able, based on the knowledge they obtain in this course, to deal with problems in the nutrition of ruminants, pigs and poultry on farm.</td>
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<td><strong>Content</strong></td>
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<td>- Programmteil Wiederkäuer: Einführung in die Winterfütterungsplanung für Milchkühe, Betriebsbesuch (Erfassung aller notwendigen Daten inkl. Futterprobenentnahme für eine konkrete Planung auf einem Praxisbetrieb), Besonderheiten der Milchvollfütterung (Laktationsverlauf, Jahreszeit, etc.); Einführung in den LBL-Fütterungsplan, Möglichkeiten der Futterbeurteilung und - bewertung mit praktischer Beurteilung der gesammelten Proben, Berechnungen und Besprechung Fütterungsplan, Aufstellung der Mineralstoffbilanz, Vorführung von PC-Software zur Fütterungsplanung Vorstellen und diskutieren des Fütterungsplanes auf dem Praxisbetrieb durch die Gruppe.</td>
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<td><strong>Lecture notes</strong></td>
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<td>Handsouts in German language will be provided by each lecturer when starting his part of the lecture.</td>
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<td></td>
<td><strong>Literature</strong></td>
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<td>Die Dozierenden geben in der Lehrveranstaltung die relevante Literatur bekannt.</td>
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<td><strong>Prerequisites / notice</strong></td>
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<td>Blockkurs in Halbtagesform; eingeschlossen sind Betriebsbesuche. Fach mit benoteter Semesterleistung.</td>
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<tr>
<td>751-7103-00L</td>
<td>Animal Feed and Feeding of Ruminant</td>
<td>W+</td>
<td>2 credits</td>
<td>2V</td>
<td>M. A. Boessinger</td>
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</table>

Data: 06.03.2019 12:57  Autumn Semester 2016  Page 8 of 1571
The knowledge of the nutrition of ruminants and of the feeds used is deepened. Particular emphasis is put on the variety of home-grown feeds, their production and conservation and their application in the nutrition of dairy cows, cattle and small ruminants. Finally, information on specific problems of animal nutrition is communicated.

Objective
Purchase of basic skills in agricultural livestock nutrition.

Content

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

Literature
Eine Literaturliste ist im Skript enthalten.

Prerequisites / notice
Fach mit benoteter Semesterendprüfung

751-6121-00L
Regulatory Physiology
W+ 2 credits 2V S. E. Ulbrich, M. C. Härder-Landerer

Abstract

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

751-4504-00L
Plant Pathology I
W 2 credits 2G B. McDonald

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

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

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

Lecture Topics and Tentative Schedule
Week 1 No Lecture: First day of autumn semester
Week 2 The nature of plant diseases, symbiosis, parasites, mutualism, biotrophs and necrotrophs, disease cycles and pathogen life cycles. Nematode attack strategies and types of damage.
Week 5 Symptoms and signs of fungal infection. Example fungal diseases: potato late blight, wheat stem rust, grape powdery mildew, wheat Septoria leaf blotch.
Week 6 Plant defense mechanisms, host range and non-host resistance. Passive structural and chemical defenses, preformed chemical defenses. Active structural defense, papillae, active chemical defense, hypersensitive response, pathogenesis-related (PR) proteins, phytoalexins and disease resistance.
Week 7 Pisatin and pisatin dimethylase. Local and systemic acquired resistance, signal molecules.
Week 8 Pathogen effects on food quality and safety.
Week 9 Epidemiology: historical epidemics, disease pyramid, environmental effects on epidemic development. Plant effects on development of epidemics, including resistance, physiology, density, uniformity.
Week 10 Disease assessment: incidence and severity measures, keys, diagrams, scales, measurement errors. Correlations between incidence and severity.
Week 11 Molecular detection and diagnosis of pathogens. Host indexing, serology, monoclonal and polyclonal antibodies. ELISA, PCR, rDNA and rep-PCR.
Week 12 Strategies for minimizing disease risks: principles of disease control and management.
Week 13 Disease control strategies: economic thresholds, physical control methods.
Week 14 Cultural control methods: avoidance, tillage practices, crop sanitation, fertilizers, crop rotation.

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

2 credits

2G

2V

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

Abstract

2V

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

Objective

2 credits

2V

Consumer Behaviour I

2 credits

2V

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

Lombriser Roman & Aplanalp Peter: Strategisches Management

Literature

752-2120-00L

Consumer Behaviour I

W

2 credits

2V

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

Lombriser Roman & Aplanalp Peter: Strategisches Management

Literature

751-8001-00L

Agricultural Engineering I

W

2 credits

2V

M. Schick, M. Sax

R. Huber

ECTS


Literature


Focus Agricultural and Resource Economics

Focus Agricultural and Resource Economics

Number | Title | Type | ECTS | Hours | Lecturers

751-0401-00L | Optimization of Agricultural Production Systems | W+ | 2 credits | 2G | R. Huber

Introduction in to optimization of agricultural production systems with linear and non-linear programming models.

Abstract

Students will be able to a) solve linear and non-linear optimization problems in the context of agricultural production; b) properly interpret the results; and c) critically discuss the economic implications.

Objective

Content

The course is an application of Operations Research (OR). First, the theory and application of linear programming (LP) is presented. Students will learn the underlying principles (Optimization, Duality, Simplex) and solve exercises in the context of agricultural production. In the second part of the course, the foundation of non-linear programming (NLP) is introduced (Lagrange, Kuhn-Tucker) and illustrated with various examples.

Lecture notes

Handed out during lecture

Literature


751-1307-00L | Managerial Economics Agri-Food Chain: Strategic Concepts | W+ | 2 credits | 2G | M. Weber, B. Hölttschi

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

Abstract

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

Objective

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

Content

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

Number | Title | Type | ECTS | Hours | Lecturers

751-0401-00L | Optimization of Agricultural Production Systems | W+ | 2 credits | 2G | R. Huber

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Number | Title | Type | ECTS | Hours | Lecturers

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Objective

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- Classic process of strategy process
- Selected alternative processes
- Case studies

Content

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

Number | Title | Type | ECTS | Hours | Lecturers

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Abstract

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Objective

Content

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Lecture notes

Handed out during lecture

Literature

Die Studierenden werden wichtige Mischungen und Pflanzengemeinschaften mitteleuropäischer Graslandökosysteme kennen, klassische

In dieser Vorlesung sollen Mikroökonomische Zusammenhänge am Fallbeispiel des Agrar- und Ernährungssektors vermittelt werden. Ziel

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

- Pindyck und Rubinfeld, Mikroökonomie, 7. Aufl., Pearson Studium.

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


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

Lecturers
- N. Buchmann, A. Lüscher

Prerequisites / notice
- Grundkenntnisse der Ökonomie/Agrarökonomie
- Vorlesung Einführung in die Mikroökonomie

P. S.: 06.03.2019 12:57

Autumn Semester 2016
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Type</th>
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<tr>
<td>751-4101-00L</td>
<td>Crops</td>
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<td>751-4201-00L</td>
<td>Horticulture I</td>
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<td>751-7101-00L</td>
<td>Applied Animal Nutrition</td>
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<td>751-4504-00L</td>
<td>Plant Pathology I</td>
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In this Kurs werden die verschiedenen Typen des Futterbaus und die wichtigsten Mischungen, aber auch natürliche Pflanzen mit einem breiten Spektrum von Pflanzenarten behandelt. Es werden verschiedene Arten der Bewirtschaftung vorgestellt (z. B. Bestandeslenkung durch Düngung, Beweidung, Schnitttermine, etc.) und ihre Auswirkungen auf die Bestandeszusammensetzung und auf die Erträge diskutiert. Feedback-Mechanismen zwischen Umwelt und Futterbausystemen werden angesprochen.

Handouts werden auf dem Netz zur Verfügung gestellt.

Plandaten werden auf dem Netz zur Verfügung gestellt.

Course will be given in German. Course builds on the Ertrags- und Ökophysiologie lecture and provides the basics for the Graslandsystems.

Students will understand: 1) how pathogens attack plants and; 2) how plants defend themselves against pathogens; 3) factors driving the development of epidemics in agroecosystems.

The focus is on the potential to assess strategies and tactics of pest management, taking into account the demands from the economy, the environment and the society. Significant agricultural approaches will be explained using practical examples, including prevention using natural resources, surveillance and forecasting, resistance management, as well as product registration, incl. ecotoxicology.

Handouts will be provided by each lecturer when starting his part of the lecture.

The students will be able to perform searches on relevant issues in pest management, and to critically evaluate case studies.

Language and script: German or French, maybe selected parts in English.

The basics of planning of feeding and formulation of diets incl. the implications on nutrient cycles and balances are taught. In the part dealing with ruminants, forage-based diets and the application of feed formulation programs are central and exercised on-farm. With pigs and poultry, the basics of energy and nutrient requirements are deepened through practical examples.

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This class is intended to convey methods of agroecological research through selected case studies from current research projects and hands-on exercises. Students will gain an overview on actors in the field of sustainable agricultural development.

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

Lecture Topics and Tentative Schedule

Week 1 No Lecture: First day of autumn semester

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


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

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

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

Week 8 Pathogen effects on food quality and safety.

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

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

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

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

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

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

Lecture notes

Detailed lecture notes (~160 pages) will be available for purchase at the cost of reproduction at the start of the semester.
Tentative Programme:
1. Introduction
2. Data acquisition, data organization, data storage, working with data
3. Graphical presentations I - Spreadsheets
5. Correct and problematic graphical data displays
6. Introduction to 'R'
7. Data import and graphical presentation
8. Statistical distribution and confidence intervals
9. Statistical tests - Repetition and hands-on applications
10. Linear regressions
11./12. Analysis of Variance
13. ANOVA - Discussion of results with Prof. E. Frossard

Last week of semester: examination (Leistungskontrolle)

Prerequisites / notice
Mainly German (with some English passages from text books)
Theoretical background in ensemble statistics from the mandatory course in the 4th semester; students should have cleared the examination of that fundamental course to be able to follow

Agricultural Science Practical

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<tr>
<th>Number</th>
<th>Title</th>
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<td>Farm Placement</td>
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Abstract
Das agrarwissenschaftliche Praktikum besteht aus dem Betriebsaufenthalt, der Betriebsaufnahme (Betriebsheft) und der agronomischen Fachaufgabe. Die Leistungskontrolle erfolgt über die Rückmeldung zu den einzelnen Bestandteilen des Praktikums.

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

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

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

Bachelor’s Thesis

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<td>Bachelor’s Thesis</td>
<td>O</td>
<td>14 credits</td>
<td>30D</td>
<td>Lecturers</td>
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Abstract
It completes the Bachelor program and consists of a scientific project carried out independently under the tutorship of a lecturer at the study program in Agricultural Science.

Objective
The independent writing of a scientific paper/thesis

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

Agricultural Sciences Bachelor - Key for Type

| O       | Compulsory             | E-   | Recommended, not eligible for credits |
| W+      | Eligible for credits and recommended | Z    | Courses outside the curriculum |
| W       | Eligible for credits   | Dr   | Suitable for doctorate |

Key for Hours

| V       | lecture                | P    | practical/laboratory course |
| G       | lecture with exercise  | A    | independent project |
| U       | exercise               | D    | diploma thesis |
| S       | seminar                | R    | revision course / private study |
| K       | colloquium             |      | |

ECTS
Special students and auditors need special permission from the lecturers.
In this seminar, students establish the scientific fundamentals of performance measurement and educational diagnostics and study them on human learning and relate them to the school.

**Abstract**

This course looks into scientific theories and also empirical studies on human learning and relate them to the school.

**Objective**

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

**Content**

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

**Lecture notes**

Folien werden zur Verfügung gestellt.

**Literature**


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

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**Educational Science (EW 1)**

This course looks into scientific theories and also empirical studies on human learning and relate them to the school.

**Objective**

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

**Content**

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

**Lecture notes**

Folien werden zur Verfügung gestellt.

**Literature**


This course is only apt for students who intend to enroll in the programs "Lehrdiplom" or "Didaktisches Zertifikat". It is about learning in childhood and adolescence.
Students apply the insights, abilities and skills they have acquired within the context of an educational institution. They observe 10 lessons further.

P. Edelsbrunner - Get to know cognitively activating instructions in MINT subjects

Lecturers

Coping with Psychosocial Demands of Teaching (EW4

Hours

Teaching Internship Including Examination Lessons

Agricultural Science

Only for students who enrolled from HS 2011 on into TC.

The teaching internship can just be visited if all other courses of TC are completed. Repetition of the teaching internship is excluded even if the examination lessons are to be repeated.

Abstract

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

Objective

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

Participants are exemplarily introduced to different research methods used in research on learning and instruction and learn to weigh advantages and disadvantages of these approaches.

1S

Students use their specialist-subject, educational-science and subject-didactics training to draw up concepts for teaching.

Objective

- Get to know intellectually activating instructions in MINT subjects

P. Edelsbrunner

Prerequisites / notice

Für eine reibungslose Semesterplanung wird um frühe Anmeldung und persönliches Erscheinen zum ersten Lehrveranstaltungstermin ersucht.

Abstract

This seminar focuses on teaching units in chemistry, physics and mathematics that have been developed at the MINT Learning Center of the ETH Zurich. In the first meeting, the mission of the MINT Learning Center will be communicated. Furthermore, in groups of two, the students will intensively work on, refine and optimize a teaching unit following a goal set in advance.

Objective

- Get knowledge about relevant research methods

E. Stern, P. Greutmann, B. Rütsche

851-0242-07L

Abstract

On successful completion of the course students will have knowledge of pedagogically relevant findings from the empirical educational sciences.

Objective

- Understanding of research methods used in the empirical human sciences

P. Edelsbrunner, B. Rütsche, E. Stern, E. Ziegler

851-0242-08L

Abstract

This course aims to get familiar with research methods in general and understand research methods used in the empirical educational sciences.

Objective

- Understanding research methods used in the empirical educational sciences

E. Stern, P. Greutmann, further lecturers

851-0240-16L

Abstract

This course unit can only be enrolled after successful participation in, or during enrollment in the course "Human Learning (EW 1)".

Objective

- Understanding research methods relevant for education

P. Edelsbrunner, B. Rütsche, E. Stern

851-0240-22L

Abstract

The successful participation in EW1 ("Human Learning") and EW2 ("Designing Learning Environments for School") is recommended, but not a mandatory prerequisite.

Objective

Students possess theoretical knowledge and practical competences to be able to cope with the psychosocial demands of teaching. (1) They know the basic rules of negotiation and conflict management (e.g., mediation) and can apply them in the school context (e.g., in conversations with parents).

Subject Didactics and Professional Training

Number

Title

Type

ECTS

Hours

Lecturers

751-9020-00L

Teaching Internship Including Examination Lessons

Agricultural Science

W

6 credits

13P

G. Kaufmann

Number of participants limited to 30.

This course can only be enrolled after successful participation in, or during enrollment in the course "Human Learning (EW 1)".

Abstract

This course aims to get familiar with research methods in general and understand research methods used in the empirical educational sciences.

Objective

- Understanding of research methods used in the empirical human sciences

P. Edelsbrunner, B. Rütsche, E. Stern

851-0242-07L

Abstract

This course aims to get familiar with research methods in general and understand research methods used in the empirical educational sciences.

Objective

- Understanding of research methods relevant for education

P. Edelsbrunner, B. Rütsche, E. Stern

851-0240-22L

Abstract

This course aims to get familiar with research methods in general and understand research methods used in the empirical educational sciences.

Objective

- Understanding research methods relevant for education

P. Edelsbrunner, B. Rütsche, E. Stern

851-0240-16L

Number of participants limited to 30.

This course can only be enrolled after successful participation in, or during enrollment in the course "Human Learning (EW 1)".

Abstract

This course aims to get familiar with research methods in general and understand research methods used in the empirical educational sciences.

Objective

- Understanding research methods relevant for education

P. Edelsbrunner, B. Rütsche, E. Stern

### Further Subject Didactics

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<td>Mentored Work Specialised Courses in the Respective O Subject with an Educational Focus Agricul. Sc A</td>
<td>2 credits</td>
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<td>G. Kaufmann, K. Koch, U. Lerch</td>
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</table>

**Abstract**

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

**Objective**

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

**Content**


Lernformen:

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

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

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

**Agricultural Sciences TC - Key for Type**

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<th></th>
<th>Compulsory</th>
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**Key for Hours**

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<th>colloquium</th>
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<th>independent project</th>
<th>diploma thesis</th>
<th>revision course / private study</th>
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**ECTS**
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
751-6501-00L | Ruminant Science (HS) | W+ | 4 credits | 4G | M. Kreuzer, M. C. Härdi-Landerer, E. Hillmann, U. Witschi

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

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

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

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

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

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

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

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

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

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

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

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

Content
Four main topics in Pig Science:
HS
- Behaviour and Husbandry of pigs: behavioral needs, husbandry related behavioral disorders, design and construction of housing systems in accordance with welfare requirements and legal regulations.
- Planning of reproductive cycle in practice
- welfare monitoring in practice
- pigs in organic farming
- Animal Health and Diseases: animal hygiene, immunology/vaccinations, metabolic diseases, diarrhoe, legisalation, thermoregulation, important infections, prophylaxis.
- poster, exam and evaluation

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

Lecture notes
Handouts/scripts are distributed by the the lecturers.

Literature
Specific literature is indicated by the lecturers.
Lecturers

Die Studierenden erlangen das grundlegende theoretische Verständnis und Fachwissen zur Endokrinologie der Reproduktion und zur The contact hour part of the course (16 h) is conceptually a block course which is subdivided into one day of lecture and one day of excursion.

Objective

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

Content

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

Lecture notes

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

Literature

Will be communicated at the start of the course.

Prerequisites / notice

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

Livestock Biology

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>751-7211-00L</td>
<td>Ruminal Digestion</td>
<td>W+</td>
<td>1</td>
<td>1G</td>
<td>A. Schwarm</td>
</tr>
<tr>
<td></td>
<td>This course broadens the knowledge in one of the most important aspects of ruminant nutrition: the microbial digestion in the rumen (and in the hindgut). For a comprehensive understanding of the rumen microbial ecosystem, the mechanisms of nutrient fermentation and the synthesis of microbial protein, thorough basics are provided. Apart from lectures, group and laboratory exercises are included. The course is a balanced mixture of blackboard exercise, laboratory exercise, group exercise, lecture and student seminar presentation. Credit point associated with grade of either a written report or an oral presentation in the final seminar (both on a self-chosen related topic).</td>
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<td>Objective: The course enables students to understand in detail how ruminal digestion works and how this knowledge can be applied to design optimal feeding diets using highly fibrous forages and a variety of other feeds. The students also are able to show how to modify the most important rumen microbes beneficially by nutritional means.</td>
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<td></td>
<td>Content: Structure of the contact hour part of the course (14 h): 2 h Introduction and blackboard exercise 8 h Basic topics in ruminal digestion, lectures and group exercises: - Systematics of the microbes involved in microbial digestion - Measurement of microbial digestion - Interactions of microbes and epithelium of the digestive tract - Differences between ruminal and hindgut microbial digestion - Microbial nutrient degradation and its modification - Efficiency of microbial protein synthesis - Manipulation of the ruminal digestion 2 h Laboratory exercise with a rumen fistulated cow and the Rumen Simulation Technique 2 h Final seminar</td>
<td></td>
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<tr>
<td></td>
<td>Lecture notes: Lecture notes are provided via Moodle.</td>
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<tr>
<td></td>
<td>Literature: Will be communicated at the start of the course.</td>
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<tr>
<td></td>
<td>Prerequisites / notice: The course is balanced mixture of blackboard exercise, laboratory exercise, group exercise, lecture and student seminar presentation.</td>
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</table>

Livestock Genetics

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>751-6243-00L</td>
<td>Conservation of Animal Genetic Resources</td>
<td>W+</td>
<td>1</td>
<td>1V</td>
<td>H. Signer-Hasler, C. Flury</td>
</tr>
<tr>
<td></td>
<td>Conservation of Animal Genetic Resources overviews the distribution, endangerment and conservation of farm animal genetic resources in Switzerland and abroad. The theory is illustrated with numerous examples and the knowledge is deepened in exercises.</td>
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</table>

Autumn Semester 2016
Objective
The students
- overview the distribution and endangerment of animal genetic resources on national and international level and they know, where to find the relevant information.
- can explain, what value can be assigned to biodiversity and name reasons, why biodiversity should be conserved.
- know the national and international efforts of the present and the past to conserve biodiversity in the livestock sector.
- can explain what is important concerning the management of small populations.
- can explain differences between species and breeds concerning biodiversity conservation.
- can describe different conservation activities, in particular in situ and ex situ conservation
- can describe current national and international conservation programmes for species and breeds.

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<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>751-6305-00L</td>
<td>Livestock Breeding and Genomics</td>
<td>W</td>
<td>3 credits</td>
<td>3G</td>
<td>P. von Rohr</td>
</tr>
</tbody>
</table>

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

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

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

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

Literature
To be announced in the lectures.

Methodology Competences

Methodology Competences
Methods for Scientific Research

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<thead>
<tr>
<th>Number</th>
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</tr>
</thead>
</table>
| 751-6241-00L | Laboratory Practical in Molecular Animal Genetics and Inherited Diseases | W+  | 3 credits | 3P | S. Neuenschwander, A. Bratus-
|          | Technologies of molecular animal-, immuno- and biochemical genetics will be shown and applied to selected domestic and farm animals. The students will perform laboratory tests for genome analysis (identification of gene loci, gene mapping), gene expression (mRNA, proteins), diagnostics (analysis of hereditary diseases) and verification of animals and animal products (parentage control, forensics). |      |      |                                          | Neuenschwander, C. Schelling |

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

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

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

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

Literature

Specific literature will be indicated individually by the lecturers.

<table>
<thead>
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</thead>
</table>

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

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

The tentative schedule contains the following topics:

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

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

### Content

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

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### Objective

The course will be divided in two parts:

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

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

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

### Project Management for Scientific Research

#### Number

<table>
<thead>
<tr>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forum: Livestock in the World Food System</td>
<td>W+</td>
<td>2</td>
<td>1S</td>
<td>M. Kreuzer, S. Bauersachs, E. Hillmann, S. Neuenschwander</td>
</tr>
</tbody>
</table>

#### Abstract

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

#### Objective

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

#### Content

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

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

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

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

#### Lecture notes

No scriptum

#### Prerequisites / notice

Requirements for allocation of the two credit points:
- Theatre presentation (with handout) at the forum
- Delivery of written documents of sufficient quality
- Active participation during the presentations by the other participants
The students will learn the conceptual and methodological basis of research in plant breeding. In addition to teaching the theoretical background, the major aim of the course is to integrate the students into the research groups (on job training) and, hence, to focus on the practical application of the knowledge.

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

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

**Lecture notes**
None

**Prerequisites / notice**
The number of training slots in the various groups is limited. It is therefore highly recommended to contact the group leaders early enough (first come first serve).

The full integration in a research group often means to work on weekends. The total time budget is equivalent to about 180 hours. Active participation in group meetings (discussion, presentation) and short written reports about the work conducted are required for the 6 credit points. There are no grades, it is only pass or fail.

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**Major in Plant Sciences**

**Disciplinary Competences**

**Agronomy and Plant Breeding**

<table>
<thead>
<tr>
<th>Number</th>
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</thead>
<tbody>
<tr>
<td>751-4104-00L</td>
<td>Alternative Crops</td>
<td>W+</td>
<td>2</td>
<td>2V</td>
<td>A. Walter, B. Büter, E. A. Pérez Torres</td>
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<tr>
<td></td>
<td>Abstract</td>
<td></td>
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<td>Few crops dominate the crop rotations worldwide. Following the goal of an increased agricultural biodiversity, species such as buckwheat but also medicinal plants might become more important in future. The biology, physiology, stress tolerance and central aspects of the value-added chain of the above-mentioned and of other alternative crops will be depicted.</td>
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<tr>
<td></td>
<td>Objective</td>
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<td>During this course, students learn to assess the potential of different minor or alternative crops compared to the dominant major crops based on their biological and agronomical features. Each student will assess and present a specific alternative crop of his or her choice based on information from scientific articles and Wikipedia. Wikipedia-entries will be generated.</td>
</tr>
<tr>
<td>751-4203-00L</td>
<td>Horticultural Science: Case Studies (HS)</td>
<td>W+</td>
<td>2</td>
<td>2G</td>
<td>L. Bertschinger, J. Röstl, V. J. U. Zufferey</td>
</tr>
<tr>
<td></td>
<td>Number of participants limited to 24.</td>
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<tr>
<td></td>
<td>Abstract</td>
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<td>Lectures address 2 horticultural cropping systems and value chains, each one in 4 2h-lecture blocks. Afterwards, the students split in 2 groups for addressing a case study focusing on one of the cropping systems treated before. An excursion to a research site might be included. In a final colloquium, each group presents a report on their case study and their conclusions.</td>
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<tr>
<td></td>
<td>Objective</td>
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<td>Achieve a deepened understanding of horticultural value chain challenges relating to ecological intensification, resource efficiency, climate change and healthy and safe food, and the problem solution strategies and scientific principles behind. Deliver in a team effort a report and a presentation providing a comprehensive insight into a problem of the horticultural value chain and its science-based solution strategy.</td>
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<tr>
<td></td>
<td>Content</td>
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<td>In the autumn semester, the two addressed cropping systems and value chains are fruit-production and viticulture. In the spring semester, the two addressed cropping systems and value chains are vegetable-production- and berry-production or glasshouse-horticulture. The selected topics address challenges with regard to ecological intensification, resource efficiency or climate change and branch into ongoing research and development projects.</td>
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<tr>
<td></td>
<td>Lecture notes</td>
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<td>Documents handed out during the case studies.</td>
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<tr>
<td></td>
<td>Literature</td>
<td></td>
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<td>As provided by the case study leaders.</td>
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<td></td>
<td>Prerequisites / notice</td>
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<td></td>
<td>The course builds on basic knowledge delivered in ‘Horticultural Crops I’ and ‘Horticultural Crops II’. If these courses have not been followed by interested participants, equivalent knowledge and experience will greatly support a successful and productive participation of the participating student. Language: spoken English, bilingual possible.</td>
</tr>
<tr>
<td>751-3603-00L</td>
<td>Current Challenges in Plant Breeding</td>
<td>W+</td>
<td>2</td>
<td>2G</td>
<td>B. Studer, A. Hund, University lecturers</td>
</tr>
<tr>
<td></td>
<td>Number of participants limited to 15.</td>
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<td></td>
<td>The seminar 'Current challenges in plant breeding' aims to bring together national and international experts in plant breeding to discuss current activities, latest achievements and future perspective of a selected topic/area in plant breeding. The topic this year will be: 'Genome editing: potential and challenges for plant breeding'.</td>
</tr>
</tbody>
</table>
Students will understand the consequences arising from the unintentional or deliberate introduction of alien organisms into agricultural, S. Bonhoeffer, R. R. Regös

Selected required readings (peer reviewed literature, selected book chapters). Optional recommended readings with additional information. Peer-reviewed research articles, selected according to the selected topic/area.

The course focuses on alien organisms in agriculture as well as the scientific assessment and regulatory management of their effects on the environment and agricultural production. Students of this course will learn about the nature of alien organisms such as invasive species, biocontrol organisms and genetically modified organisms. With a particular focus on arthropods, plants and their interactions we will look at the potential threats the novel organisms pose, the benefits they provide and how both of these effects can be scientifically assessed. Students will learn how the topic of alien organisms in agriculture is intrinsically tied to policy making and regulation and get to know current examples and future challenges in research. In the last part of the course students will be able to apply the acquired knowledge in a practical exercise (case study).

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

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

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

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

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

#### Crop Health

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<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
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</tr>
</thead>
<tbody>
<tr>
<td>751-5121-00L</td>
<td>Insect Ecology</td>
<td>W+</td>
<td>2</td>
<td>2V</td>
<td>R. R. Kariyat Ramachandran, C. De Moraes, M. Mescher</td>
</tr>
<tr>
<td>751-4811-00L</td>
<td>Alien Organisms in Agriculture</td>
<td>W+</td>
<td>2</td>
<td>2G</td>
<td>J. Collatz, M. Meissle</td>
</tr>
<tr>
<td>751-4506-00L</td>
<td>Plant Pathology III</td>
<td>W+</td>
<td>2</td>
<td>2G</td>
<td>U. Merz, M. Maurhofer Bringolf</td>
</tr>
</tbody>
</table>

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

### Objective
Establishing contacts and strengthening the network to national and international plant breeders and scientists for future collaboration. For full and active participation, a total of 2 credit/ECTS points will be provided.

### Lecture notes / notice
Material will be distributed during the course.

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

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

#### Number
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<td>W+</td>
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<tr>
<td>751-4506-00L</td>
<td>Plant Pathology III</td>
<td>W+</td>
<td>2</td>
<td>2G</td>
</tr>
</tbody>
</table>

#### Abstract
The course will partly be an e-learning exercise (with computers). A script will be used on annual and perennial crops and their most important diseases. It will be updated stepwise. The students will learn and train preparation skills for microscopy, acquire knowledge of selected diseases (identification, biology of pathogen, epidemiology) and understand the corresponding integrated control measures practiced in Swiss agriculture.

#### Objective
- Establishing contacts and strengthening the network to national and international plant breeders and scientists for future collaboration.
- Promotion of collaboration and Master thesis projects with practical plant breeders
- Establishing of a scientific presentation in an interdisciplinary team
- Establishing contacts and strengthening the network to national and international plant breeders and scientists

#### Literature
Selected required readings (peer reviewed literature, selected book chapters). Optional recommended readings with additional information.
At the end of this course the students are familiar with the principles on which radioisotope works are based and they have learned from
H. A. Gamper
Lecturers

Handouts will be available on the webpage of the course.

Radio-isotopes are extensively used at the soil/plant or ecosystem level to quantify the fluxes of elements (phosphorus (P), heavy metals,
T. I. McLaren
Biogeochemistry and Sustainable Management

ECTS
Hours
Lecturers

2G
N. Buchmann, L. Hörtnagl

Abstract

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

Objective

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

Content

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

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

Lecture notes

Handouts will be available on the webpage of the course.

Literature

Will be discussed in class.

Prerequisites / notice

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

Radio-Isotopes in Plant Nutrition

ECTS
Hours
Lecturers

3 credits
2G
E. Frossard

Abstract

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

Objective

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

Content

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

Lecture notes

Documents will be distributed during the lecture

Literature

Will be given during the lecture

Prerequisites / notice

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

Rhizosphere Ecology

ECTS
Hours
Lecturers

4 credits
4G
H. A. Gamper, T. I. McLaren

Number of participants limited to 18.

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

Abstract

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

Objective

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

Develop skills on the critical analysis of scientific papers.

Define explanatory hypotheses, identify knowledge gaps for further investigations.

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

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

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

Discuss and interpret data in the context of the literature.

Prepare a research report in the format of a scientific paper and a poster in the format of a conference paper, partially alone and partially
in small groups, using data obtained from the glasshouse experiment.
This course is designed to stimulate thinking and promote critical analysis of important processes that occur in the rhizosphere. As part of this course, the knowledge acquired will be used for analysing and interpreting experimental data, as well as, preparing a scientific report and conference-type poster.

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

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

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

For documentation, lecture slides and laboratory protocols will continuously be uploaded to the directory ‘751-5123-00L Rhizosphere Literature’ on the electronic document exchange platform ILIAS, LDA-ELBA: https://ilias-app2.let.ethz.ch/llias.php?ref_id=109651&cmd=viewer&cmdClass=lldbjourseq&cmdNode=et:tv&baseClass=iiRepositoryGUJ

Lecture notes

Literature


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

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

Popular science entries to the significance of processes in the rhizosphere:
http://www.the-scientist.com/?articles.view/articleNo/30950/title/The-Root-of-the-Problem/
http://nautil.us/issue/34/adaptation/junk-food-is-bad-for-plants-too

Ecological understanding (Second Edition)
Students will gain insight into the role of sensory cues and signals in mediating interactions within and between species. There will be a...
In this seminar students apply their knowledge on sustainable agriculture, tropical soils and land use to a case study related to a current research project from the Sustainable Agroecosystems group. The seminar offers interactions with researchers and extension specialists working in the context of agricultural development.

Objective

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

Prerequisites / notice

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

751-5115-00L

Current Aspects of Nutrient Cycle in Agro-Ecosystems

W+  2 credits  1S  E. Frossard, A. Oberson Dräyer

Abstract

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

Objective

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

751-4003-01L

Current Topics in Grassland Sciences (HS)

W+  2 credits  2S  N. Buchmann

Abstract

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

Objective

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

Content

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

Lecture notes

none

Prerequisites / notice

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

Design, Analysis and Communication of Science

Type | ECTS | Hours | Lecturers
---|---|---|---
Experimental Design and Applied Statistics in Agro-Ecosystem Science | O | 3 | G |
A. Hund, W. Eugster, C. Grieder, R. Kölliker

Introduction To Experimental Design and Applied Statistics

Introduction to R / Revival of R Skills

Designs of Field and Growth Chamber Experiments

Nonlinear Regression Fits

Multivariate Techniques: Principle Component Analysis, Canonical Correpondence Analysis (CCA), Cluster Analysis

ANOVA using linear and mixed effect models

Error Analysis, Error Propagation and Error Estimation

Introduction to autoregression and autocorrelations in temporal and spatial data and how to consider them in ANOVA-type analysis

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

This tentative schedule containst the following topics:

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

Lecture notes

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

Literature

Handouts will be available (in English)

Prerequisites / notice

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

Major in Agriculture Economics

Disciplinary Competences

Decision Making and Management

Type | ECTS | Hours | Lecturers
---|---|---|---
Introduction to Marketing | O | 3 | G |
F. von Wagenerheim

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

Data: 06.03.2019 12:57  Autumn Semester 2016  Page 27 of 1571
Objective
After taking the lecture, students should have knowledge on
1) The definition and role of marketing (marketing basics) 
2) Creating marketing insights - understanding customer behavior
- Theoretical concepts in customer behavior (customer behavior)
- Analytical means to extend knowledge on customer behavior (marketing research)
- Strategic tools to quantify customer behavior (CLV, CE)
3) Strategic marketing - translating marketing insights into into actionable marketing strategies
- Segmentation, Targeting, and Positioning
- Attracting customers (marketing mix, 4Ps)
- Maintaining profitable customer relations (CRM)

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

The lecture features a short tutorial that is held at irregularly spaced intervals throughout the semester (approximately every third week). The tutorial is embedded within the lecture and consists of short sessions of about 30 minutes. It serves to illustrate theoretical and methodological concepts from the lecture by walking students through the analysis of real-world data from the telecommunications industry.

The case data will be provided so that students practice and apply the concepts of the lecture on their own. The tutorial is held jointly by two Teaching Assistants (Zhiying Cui and Jana Gross) and the professor (Prof. F. v. Wangenheim).

Literature
Weekly readings, distributed in class (via Moodle)

751-2205-00L Advanced Management in the Agri-Food-Chain W+ 2 credits 2G M. Weber

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

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

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

Lecture notes
Reader with selected contents.

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

752-2122-00L Food and Consumer Behaviour W+ 2 credits 2V M. Siegrist, C. Hartmann

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

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

Resource Economics and Agricultural Policy

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

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

Objective
Focus: Policy Evaluation

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

Content
Unit: Subject

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

Lecture notes
Handouts (power point presentations)

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

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

701-1651-00L Environmental Governance W 3 credits 2G E. Lieberherr, G. de Buren, R. Schiesser

Abstract
The course addresses environmental policies, focusing on new steering approaches, which are generally summarized as environmental governance. The course also provides students with tools to analyze environmental policy processes and assesses the key features of environmental governance by examining various practical environmental policy examples.
The main part of this lecture will examine constellations where hierarchies, markets or cooperation have been observed and described in
Groups, identities and utility maximization - some conceptual foundations

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

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

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

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

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

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

851-0594-00L International Environmental Politics

Abstract

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

Objective

The objectives of this course are to (1) gain an overview of relevant questions in the area of international environmental politics from a
social sciences viewpoint; (2) learn how to identify interesting/innovative questions concerning this policy area and how to answer them in a
methodologically sophisticated way; (3) gain an overview of important global and regional environmental problems.

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

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<tbody>
<tr>
<td>751-2103-00L</td>
<td>Socioeconomics of Agriculture</td>
<td>W+</td>
<td>2</td>
<td>2V</td>
<td>S. Mann</td>
</tr>
<tr>
<td>Abstract</td>
<td>The main part of this lecture will examine constellations where hierarchies, markets or cooperation have been observed and described in the agricultural sector. On a more aggregated level, different agricultural systems will be evaluated in terms of main socioeconomic parameters like social capital or perceptions.</td>
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<tr>
<td>Objective</td>
<td>Students should be able to describe the dynamics of hierarchies, markets and cooperation in an agricultural context.</td>
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<tr>
<td>Content</td>
<td>Groups, identities and utility maximization - some conceptual foundations Micro-Socioeconomics: Hierarchy, cooperation and markets Macro-Socioeconomics: Varieties of Capitalism Agricultural Administration: Path dependencies and efficiency issues Causes and Impacts of farm succession Occupational Choice in the farming sector System Choice and segregation (organic, GMO etc.) The economics of rural areas Common Resource Management in Alpine Farming Agricultural Cooperatives Societal perceptions of agriculture Perceptions of farming from within Varieties of agricultural systems and policies</td>
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<tr>
<td>Prerequisites / notice</td>
<td>A detailed course schedule will be made available at the beginning of the semester.</td>
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<tr>
<td>851-0626-01L</td>
<td>International Aid and Development</td>
<td>W+</td>
<td>2</td>
<td>2V</td>
<td>I. Günther</td>
</tr>
<tr>
<td>Abstract</td>
<td>Does not take place this semester. Prerequisites: Basic knowledge of economics The course gives economic and empirical foundations for a sound understanding of the instruments, prospects and limitations of international development aid. Students are able to critically discuss the various aid instruments of bi-and multilateral donors and NGOs. Introduction to the Determinants of Underdevelopment: History of Aid; Aid and Development: Theories and Empirics; Political Economy of Aid; Experience and Impact of Aid; New Instruments of Aid; e.g. Micro-Finance, Budget-Support; Fail-Trade. Articles and book abstracts will be uploaded to a course website.</td>
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<tr>
<td>Objective</td>
<td>Students have a theoretically and empirically sound understanding of the prospects and limitations of international development aid. Students are able to critically discuss the various aid instruments of bi-and multilateral donors and NGOs. Introduction to the Determinants of Underdevelopment: History of Aid; Aid and Development: Theories and Empirics; Political Economy of Aid; Experience and Impact of Aid; New Instruments of Aid; e.g. Micro-Finance, Budget-Support; Fail-Trade. Articles and book abstracts will be uploaded to a course website.</td>
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<tr>
<td>Literature</td>
<td>Books: I. Günther: International Development and Aid, Second Edition (2012). - The objectives of this course are to (1) gain an overview of relevant questions in the area of international environmental politics from a social sciences viewpoint: (2) learn how to identify interesting/innovative questions concerning this policy area and how to answer them in a methodologically sophisticated way; (3) gain an overview of important global and regional environmental problems.</td>
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Content

This course deals with how and why international cooperation in environmental politics emerges, and under what circumstances such cooperation is effective and efficient. Based on theories of international political economy and theories of government regulation various examples of international environmental politics are discussed: the management of international water resources, the problem of unsafe nuclear power plants in eastern Europe, political responses to global warming, the protection of the stratospheric ozone layer, the reduction of long-range transboundary air pollution in Europe, the prevention of pollution of the oceans, etc.

The course is open to all ETH students. Participation does not require previous coursework in the social sciences.

After passing an end-of-semester test (requirement: grade 4.0 or higher) students will receive 3 ECTS credit points. The workload is around 90 hours (meetings, reading assignments, preparation of test).

Lecture notes

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

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

Literature

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

Prerequisites / notice

None

Methodology Competences

Methods in Agricultural Economics

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<tbody>
<tr>
<td>363-0305-00L</td>
<td>Empirical Methods in Management</td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>A. Scherer</td>
</tr>
<tr>
<td>Abstract</td>
<td>Evidence-based management requires valid empirical research. In this course, students will learn the basics of research design, fundamentals of data collection and statistical methods to analyze the data acquired in social science research. Students are expected to apply their knowledge in class discussions and out-of-class assignments.</td>
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| Objective   | - Ability to formulate research questions and designing an appropriate study  
- Ability to collect and analyze data using a variety of methods  
- Ability to critically assess the quality of empirical research in management  
- Applied knowledge of empirical methods through out-of-class assignments |
| Content     | 1) Introduction to empirical management research  
2) Research designs: exploratory, descriptive, experimental  
3) Measurement and scaling  
4) Data collection and sampling  
5) Data analysis methods  
6) Reporting and presenting empirical research |
| Prerequisites / notice | Assignments and projects: This course includes out-of-class assignments and projects to give students some hands-on experience in conducting empirical research in management. Projects will focus on one particular aspect of empirical research, like the formulation of a research question or the design of a study. Students will have at least one week to work on each assignment. Students are expected to work on these assignments individually. Duplicate answers will receive no credit and will be subject to a disciplinary review. Assignments will be graded and need to be turned-in on time. |

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

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<tr>
<td>363-0585-00L</td>
<td>Intermediate Econometrics</td>
<td>W+</td>
<td>3</td>
<td>2V</td>
<td>M. Kesina</td>
</tr>
<tr>
<td>Abstract</td>
<td>The idea of this course is to familiarize students with instrumental variables estimation of linear regression models and the estimation of models with limited dependent variables as well as of nonlinear regression models. While most of the material covered will pertain to cross-sectional data, we will also work on selected issues with panel data.</td>
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<tr>
<td>Objective</td>
<td>I will provide STATA programs and show the execution thereof. After having participated in this course, students will be able to carry out simple research projects and understand the basics of intermediate econometrics. In particular, they will be able to write simple programs in STATA and to qualify their own and others' regression output relating to problems covered.</td>
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<th>Hours</th>
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</tr>
</thead>
<tbody>
<tr>
<td>751-0423-00L</td>
<td>Risk Analysis and Risk Management in Agriculture</td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>R. Finger</td>
</tr>
<tr>
<td>Abstract</td>
<td>Agricultural production is exposed to various risks which are important for decisions taken by farmers and other actors in the agri-food sector. Moreover, risk management is indispensable for all actors. This course introduces modern concepts on decision making under risk and recent developments in risk management. The focus of this course is on agricultural applications.</td>
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</table>
| Objective   | - to develop a better understanding of decision making under uncertainty and risk;  
- to gain experience in different approaches to analyze risky decisions;  
- to develop an understanding for different sources of risk in agricultural production;  
- to understand the crucial role of subjective perceptions and preferences for risk management decisions;  
- to get an overview on risk management in the agricultural sector, with a particular focus on insurance solutions |
| Content     | - Quantification and measurement of risk  
- Risk preferences, expected utility theory and alternative models of risk behavior  
- Concepts on the decision making under risk  
- Production, investment and diversification decisions under risk  
- Risk management in agriculture |
| Lecture notes | Handouts will be distributed in the lecture and available on the moodle. knowledge of basic concepts of probability theory and microeconomics |

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</thead>
<tbody>
<tr>
<td>751-1573-00L</td>
<td>Dynamic Simulation in Agricultural and Regional Economics</td>
<td>W+</td>
<td>1</td>
<td>1V</td>
<td>B. Kopainsky</td>
</tr>
<tr>
<td>Abstract</td>
<td>Students in this class develop a dynamic simulation model that represents the basic mechanisms underlying food security in developing countries in a highly aggregated way. Students then proceed to extending the simulation model with one policy to improve food security and they analyze the dynamic impacts of this policy on production and environmental outcomes.</td>
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</tbody>
</table>
The lecture slides are provided as handouts - including notes and literature sources - to registered students only. All material is to be found

Topics covered in this course include:
- ECTS
- Professional Internship Part I: Preparation
- Systems Dynamics and Complexity

A successful participant of the course is able to:
- Finding solutions: what is complexity, problem solving cycle.
- Calculating project schedules according to the critical path method.
- Setup and run systems dynamics models by means of Vensim software.
- Identify feedback cycles and reasons for unintended system behavior.
- Analyse the stability of nonlinear dynamical systems and apply this to macroeconomic dynamics.

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

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

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

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

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

Lecture notes
Weekly self-study tasks are used to apply the concepts introduced in the lectures and to come to grips with the software program VENSIM. The lecture slides are provided as handouts - including notes and literature sources - to registered students only. All material is to be found on the Moodle platform. More details during the first lecture.

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

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

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

Information about relevant literature will be given in the lecture.
Thesis tasks are possible for students who did not already attend the course "Mathematical Optimization", which is a more advance lecture covering similar topics and more.

Professional Internship

Working on agricultural and regional projects, the students will apply their knowledge in the fields of economics, biology and technology. They will work on a project in one of the following areas:
- only for Agricultural Sciences MSc
- Agricultural Economics and Policy
- Sectoral Programming in Agricultural and Regional Economics

Agricultural Economics and Policy

Evaluation of Agricultural Policies

Data: 06.03.2019 12:57 Autumn Semester 2016 Page 31 of 1571
### Abstract
The course focuses on agricultural economic research with particular focus on policy evaluation. We impart insights in the issue of policy evaluation as part of agricultural economics research.

### Objective
**Focus: Policy Evaluation**

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

### Content
**Unit: Subject**

<table>
<thead>
<tr>
<th>Lecture notes</th>
<th>Literature</th>
<th>Prerequisites / notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reader with selected contents.</td>
<td>- Vorlesung “Managerial Economics Agri-Food Chain: Strategische Konzepte” in D-USYS</td>
<td>- Vorlesung “Management” in D-USYS</td>
</tr>
</tbody>
</table>

### Prerequisites / notice

<table>
<thead>
<tr>
<th>751-2205-00L</th>
<th>Advanced Management in the Agri-Food-Chain</th>
<th>W</th>
<th>2 credits</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>W 2G M. Weber</strong></td>
<td></td>
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</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>Advanced Management in the Agri-Food-Chain (Vorlesung wird in deutscher Sprache abgehalten.)</td>
<td></td>
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</tr>
</tbody>
</table>
| **Objective** | After the lecture the students …
- know the characteristics and consequences of complexity in the organizational world,
- know and can apply selected comprehensive models for managing in complex situations,
- know possible practical applications and examples of the treated contents to organizations in the Agri-Food Chain and
- are able to deepen the relevant topics in an autonomous way. |
| **Content** | In the lecture the following contents will be treated:
- State, reasons and effects of complexity in the organizational world.
- A basic framework for shaping and governing intelligent organizations.
- Selected contemporary models for managing in the complex organizational world.
- Transfer and adaption of the models to organizations in the Agri-Food Chain. |
| **Lecture notes** | Reader with selected contents. |
| **Prerequisites / notice** | - Vorlesung “Management” in D-USYS |

<table>
<thead>
<tr>
<th>752-2122-00L</th>
<th>Food and Consumer Behaviour</th>
<th>W</th>
<th>2 credits</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>W 2V M. Siegrist, C. Hartmann</strong></td>
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<tr>
<td><strong>Abstract</strong></td>
<td>This course focuses on food consumer behavior, consumer's decision-making processes and consumer's attitudes towards food products. The course provides an overview about the following topics: Factors influencing consumer's food choice, food and health, attitudes towards new foods and food technologies, labeling and food policy issues</td>
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<tr>
<td><strong>Objective</strong></td>
<td>The main part of the lecture will examine constellations where hierarchies, markets or cooperation have been observed and described in the agricultural sector. On a more aggregated level, different agricultural systems will be evaluated in terms of main socioeconomic parameters like social capital or perceptions.</td>
<td></td>
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</tbody>
</table>
| **Content** | Students should be able to describe the dynamics of hierarchies, markets and cooperation in an agricultural context. Groups, identities and utility maximization - some conceptual foundations
Micro-Socioeconomics: Hierarchy, cooperation and markets
Macro-Socioeconomics: Varieties of Capitalism
Agricultural Administration: Path dependencies and efficiency issues
Causes and Impacts of farm succession
Occupational Choice in the farming sector
System Choice and segregation (organic, GMO etc.)
The economics of rural areas
Common Resource Management in Alpine Farming
Agricultural Cooperatives
Societal perceptions of agriculture
Perceptions of farming from within
Varieties of agricultural systems and policies |
| **Lecture notes** | www.agroscope.admin.ch/agroscope/de/home/themen/wirtschaft-technik/soziooekonomie/socioeconomics-of-agriculture.html see script |
| **Prerequisites / notice** | Basic economic knowledge is expected. |

<table>
<thead>
<tr>
<th>751-2103-00L</th>
<th>Socioeconomics of Agriculture</th>
<th>W</th>
<th>2 credits</th>
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</thead>
<tbody>
<tr>
<td><strong>W 2V S. Mann</strong></td>
<td></td>
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| **Prerequisites / notice** | Basic economic knowledge is expected. |

<table>
<thead>
<tr>
<th>751-1573-00L</th>
<th>Dynamic Simulation in Agricultural and Regional Economics</th>
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<th>1 credit</th>
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<tr>
<td><strong>W 1V B. Kopainsky</strong></td>
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<td><strong>Abstract</strong></td>
<td>Students in this class develop a dynamic simulation model that represents the basic mechanisms underlying food security in developing countries in a highly aggregated way. Students then proceed to extending the simulation model with one policy to improve food security and they analyze the dynamic impacts of this policy on production and environmental outcomes.</td>
<td></td>
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</tbody>
</table>
Students will know and understand the complex and interacting processes of ecology, biogeochemistry and management of agro- and forest ecosystems. Moreover, risk management is indispensable for all actors. This course introduces modern concepts on decision making under risk and recent developments in risk management. The focus of this course is on agriculture applications.

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

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

Handouts will be distributed in the lecture and available on the Moodle.

knowledge of basic concepts of probability theory and microeconomics

Agriculture and Environment

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<tr>
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- to develop an understanding for different sources of risk in agricultural production;  
- to understand the crucial role of subjective perceptions and preferences for risk management decisions;  
- to get an overview on risk management in the agricultural sector, with a particular focus on insurance solutions. |
| Content    | - Quantification and measurement of risk  
- Risk preferences, expected utility theory and alternative models of risk behavior  
- Concepts on the decision making under risk  
- Production, investment and diversification decisions under risk  
- Risk management in agriculture |
| Lecture notes / Literature | slides will be provided during the class |
| Prerequisites / notice | |
| 363-0305-00L | Empirical Methods in Management | W    | 3    | 2G    | A. Scherer |
| Abstract   | Evidence-based management requires valid empirical research. In this course, students will learn the basics of research design, fundamentals of data collection and statistical methods to analyze the data acquired in social science research. Students are expected to apply their knowledge in class discussions and out-of-class assignments. |
| Objective  | - Ability to formulate research questions and designing an appropriate study  
- Ability to collect and analyze data using a variety of methods  
- Ability to critically assess the quality of empirical research in management  
- Applied knowledge of empirical methods through out-of-class assignments |
| Content    | 1) Introduction to empirical management research  
2) Research designs: exploratory, descriptive, experimental  
3) Measurement and scaling  
4) Data collection and sampling  
5) Data analysis methods  
6) Reporting and presenting empirical research |
| Prerequisites / notice | Assignments and projects: This course includes out-of-class assignments and projects to give students some hands-on experience in conducting empirical research in management. Projects will focus on one particular aspect of empirical research, like the formulation of a research question or the design of a study. Students will have at least one week to work on these assignments individually. Duplicate answers will receive no credit and will be subject to a disciplinary review. Assignments will be graded and need to be turned-in on time. |
| Class participation | Class participation is encouraged and can greatly improve students' learning in this class. In this spirit, students are expected to attend class regularly and come to class prepared. |

Data: 06.03.2019 12:57  Autumn Semester 2016  Page 33 of 1571
Radio-isotopes are extensively used at the soil/plant or ecosystem level to quantify the fluxes of elements (phosphorus (P), heavy metals, radionucleides) within a given system and to assess the importance of processes controlling these fluxes (e.g. exchange reactions between the soil solution and the soil solid phase, element turnover through the microbial biomass, organic matter mineralization etc.). The course will first present the principles, the basic assumptions and the theoretical framework that underlay the work with radioisotopes. It will present how the introduction of an isotope into a system can be done so as to get information on the structure of the system (e.g. number and size of compartments). Secondly, case studies on isotopic dilution and tracer work will be presented for instance on the isotopic exchange kinetics method to determine nutrients or pollutants availability. The case studies will be adapted to the ongoing research of the group of plant nutrition and will thus give an insight into our current research. In addition, published studies will be analyzed and presented by the students. Finally, the advantages and disadvantages of work with radioisotopes will be analyzed and discussed critically.

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

**Objective**

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

Develop skills on the critical analysis of scientific papers.

Define explanatory hypotheses, identify knowledge gaps for further investigations.

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

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

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

Discuss and interpret data in the context of the literature.

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

**Content**

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

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

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

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

**Lecture notes**

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

https://ilias-app2.etl.ethz.ch/ilias.php?ref_id=109651&cmd=view&cmdClass=ilobjcoursegui&cmdNode=el:fv&baseClass=ilRepositoryGUI
This course provides an overview about the applicability of stable isotopes (carbon $^{13}$C, nitrogen $^{15}$N, oxygen $^{18}$O and water $^{2}$H) to studies on plants, soils, water and trace gases, know how to interpret data, and how to integrate and assess the outcomes of their own research. Students will be familiar with basic and advanced applications of stable isotopes in studies on plants, soils, water and trace gases, know how to design, carry out and interpret a small IsoProject, practice to search and analyze data: 06.03.2019 12:57

**Abstract**

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

**Objective**

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

**Prerequisites / notice**

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

**Literature**


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


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

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


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

Ecological understanding (Second Edition)


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


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

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

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

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

Students of D-USYS will be reimbursed via bank transfer for train and bus tickets of the zones 121 and 122 (Please send all tickets with the bank details to Christiane Gujan (http://www.plantnutrition.ethz.ch/the-group/people-a-z/person-detail.html?persid=85593).
The analyses of stable isotopes often provide insights into ecophysiological and ecological processes that otherwise would not be available with classical methods only. Stable isotopes proved useful to determine origin of pools andfluxes in ecosystems, to partition composite fluxes and to integrate processes spatially and temporally.

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

Handouts will be available on the webpage of the course.

Will be discussed in class.

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

### Agronomy and Plant Breeding

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
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</tr>
</thead>
<tbody>
<tr>
<td>751-4104-00L</td>
<td>Alternative Crops</td>
<td>W</td>
<td>2 credits</td>
<td>2V</td>
<td>A. Walter, B. Büter, E. A. Pérez Torres</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>Few crops dominate the crop rotations worldwide. Following the goal of an increased agricultural biodiversity, species such as buckwheat but also medicinal plants might become more important in future. The biology, physiology, stress tolerance and central aspects of the value-added chain of the above-mentioned and of other alternative crops will be depicted.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>During this course, students learn to assess the potential of different minor or alternative crops compared to the dominant major crops based on their biological and agronomical features. Each student will assess and present a specific alternative crop of his or her choice based on information from scientific articles and Wikipedia. Wikipedia-entries will be generated.</td>
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<tr>
<td>751-4203-00L</td>
<td>Horticultural Science: Case Studies (HS)</td>
<td>W</td>
<td>2 credits</td>
<td>2G</td>
<td>L. Bertschinger, J. Rösti, V. J. U. Zufferey</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>Lectures address 2 horticultural cropping systems and value chains, each one in 4 2h-lecture blocks. Afterwards, the students split in 2 groups for addressing a case study focusing on one of the cropping systems treated. An excursion to a research site might be included. In a final colloquium, each group presents a report on their case study and their conclusions.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>Achieve a deepened understanding of horticultural value chain challenges relating to ecological intensification, resource efficiency, climate change and healthy and safe food, and the problem solution strategies and scientific principles behind. Deliver in a team effort a report and a presentation providing a comprehensive insight into a problem of the horticultural value chain and its science-based solution strategy.</td>
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<tr>
<td><strong>Content</strong></td>
<td>In the autumn semester, the two addressed cropping systems and value chains are fruit-production and viticulture. The selected topics address challenges with regard to ecological intensification, resource efficiency or climate change and branch into ongoing research and development projects.</td>
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<tr>
<td><strong>Lecture notes</strong></td>
<td>Documents handed out during the case studies.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Literature</td>
<td>As provided by the case study leaders.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Prerequisites / notice</strong></td>
<td>The course builds on basic knowledge delivered in ‘Horticultural Crops I’ and ‘Horticultural Crops II’. If these courses have not been followed by interested participants, equivalent knowledge and experience will greatly support a successful and productive participation of the participating student. Language: spoken E, G or F. Documents: Preferably English, G/F possible.</td>
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<tr>
<td>751-3603-00L</td>
<td>Current Challenges in Plant Breeding</td>
<td>W</td>
<td>2 credits</td>
<td>2G</td>
<td>B. Studer, A. Hund, University lecturers</td>
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<tr>
<td><strong>Abstract</strong></td>
<td>The seminar ‘Current challenges in plant breeding’ aims to bring together national and international experts in plant breeding to discuss current activities, latest achievements and future prospective of a selected topic/area in plant breeding. The topic this year will be: ‘Genome editing: potential and challenges for plant breeding’.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>The educational objectives cover both thematic competences and soft skills:</td>
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<td></td>
<td>- Deepening of scientific knowledge in plant breeding</td>
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<td>- Critical evaluation of current challenges and new concepts in plant breeding</td>
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<td>- Promotion of collaboration and Master thesis projects with practical plant breeders</td>
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<td>- Soft skills:</td>
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<td>- Independent literature research to get familiar with the selected topic</td>
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<td>- Critical evaluation and consolidation of the acquired knowledge in an interdisciplinary team</td>
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<td>- Establishment of a scientific presentation in an interdisciplinary team</td>
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<td>- Presentation and discussion of the teamwork outcome</td>
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<td>- Establishing contacts and strengthening the network to national and international plant breeders and scientist</td>
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<tr>
<td><strong>Content</strong></td>
<td>The topic 'Genome editing: potential and challenges for plant breeding' was selected. In the fall semester (November 29, 2016), the enrolled students will meet with the lecturers as well as four to six tutors, selected according to their expertise in the selected topic (one afternoon, for about three hours). After an input talk by the lecturers, four to six specific questions/aspects will be identified and phrased. The tutors and the enrolled students will be assigned to four to six different groups, to critically evaluate one question/aspect of the selected topic. The students, guided by tutors, will prepare a presentation of 15 minutes (plus 5 minutes discussion) covering their specific question/aspect. Participation on that afternoon will be mandatory.</td>
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<tr>
<td><strong>Lecture notes</strong></td>
<td>Seminar abstracts</td>
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<tr>
<td>Literature</td>
<td>Peer-reviewed research articles, selected according to the selected topic/area.</td>
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<tr>
<td><strong>Prerequisites / notice</strong></td>
<td>Participation in the BSc course ‘Pflanzenzüchtung’ is strongly recommended, a completed course in ‘Molecular Plant Breeding’ is highly advantageous.</td>
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### Crop Health

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<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td><strong>Abstract</strong></td>
<td>The course is designed for a maximum of 15 Master students and 10 PhD students (advertised and recruited via the Zurich-Based Plant Science Center). For full and active participation, a total of 2 credit/ECTS points will be provided.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>End of January (January 31, 2017), a one-day seminar on the selected topic will be organized. After one to two keynote speakers (international experts), four invited talks will link the selected topic to practical plant breeding. In the afternoon, the four to six students groups will present and discuss with the experts their specific questions on the selected topic/area. These presentations will be evaluated by the lecturers. The seminar will be public and serve as annual meeting of the SSA working group for plant breeding, bringing together the experts in plant breeding.</td>
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</table>
This is an introductory course in insect ecology. Students will learn about the ways in which insects interact with and adapt to their abiotic & biotic environments and their roles in diverse ecosystems. The course will entail lectures, outside readings, and critical analysis of contemporary literature.

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

Provided to students through ILIAS

Lectures and exercises:

Provided to students through ILIAS

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

### Functioning of Soil Systems

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>751-5001-00L</td>
<td>Agroecologists without Borders</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>C. Decock, A. Hofmann, J. Six</td>
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<td></td>
<td>In this seminar students apply their knowledge on sustainable agriculture, tropical soils and land use to a case study related to a current research project from the Sustainable Agroecosystems group. The seminar offers interactions with researchers and extension specialists working in the context of agricultural development.</td>
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</table>
|              | Objective                               |      |      |       | (1) Students analyze concrete examples of agricultural development projects in tropical agroecosystems.  
(2) Students broaden their understanding of environmental and socio-economic challenges of smallholder farmers.  
(3) Students articulate complexity and challenges in agricultural development interventions.  
(4) Students develop their science communication skills by producing science communication materials in the context of the given case study.  
(5) Students signing up for this class should have a strong interest in tropical agriculture and science communication. |
|              | Prerequisites / notice                  |      |      |       |                                                                             |
| 751-5201-00L | Tropical Soils and Land Use             | W    | 2    | 2G    | J. Six, A. Hofmann             |
|              | This course guides students in analyzing and comprehending tropical agroecosystems. Students gain practical knowledge of field methods, diagnostic tools and survey methods for tropical soils and agroecosystems. An integral part of the course is the two-week field project in Western Kenya, which is co-organized with University of Eldoret (Kenya) and KU Leuven (Belgium). |
|              | Objective                               |      |      |       | (1) Introduction to international soil classification with focus on tropical soils  
(2) Soil suitability (chemical, physical and biological fertility) for tropical crops  
(3) Soil conservation practices and stakeholder involvement  
(4) Approaches to analyzing tropical agroecosystems  
(5) Overview of the major land use systems in Western Kenya  
(6) Analysis of agricultural production systems  
(7) Hands-on training on the use of field methods, diagnostic tools and survey methods  
(8) Collaboration in international student teams (MSc students from Switzerland, Belgium and Kenya) |
|              | Prerequisites / notice                  |      |      |       |                                                                             |
Students will know and understand the complex and interacting processes of ecology, biogeochemistry and management of agro- and ecosystems. The course will present the principles underlying the use of radioisotopes in soil/plant systems. It will present how the introduction of an isotope into a system can be done so as to get some information on the structure of the system. Case studies will be presented to determine element availability. Finally, published studies from other groups will be analyzed and presented by the students. Radio-isotopes are extensively used at the soil/plant or ecosystem level to quantify the fluxes of elements (phosphorus (P), heavy metals, fertilisers, companion plants, and microbial symbionts, and other microbes on nutrient cycling and plant uptake are discussed. An "intercropping" experiment in the glasshouse is used as a model to check for rhizosphere effects on plant growth and mineral nutrition. Current Aspects of Nutrient Cycle in Agro-Ecosystems

The seminar concerns current aspects and research related to nutrient cycles in agro-ecosystems. It offers to deepen the knowledge on a specific theme related to nutrients. It is composed by presentations of national and international speakers and by an excursion. The students write a report where they compile the obtained information, relate it to their own knowledge and include literature. The course will present the principles underlying the use of radioisotopes in soil/plant systems. It will present how the introduction of an isolate into a system can be done to get some information on the structure of the system. Case studies will be presented to determine element availability. Finally, published studies from other groups will be analyzed and presented by the students. Radio-isotopes are extensively used at the soil/plant or ecosystem level to quantify the fluxes of elements (phosphorus (P), heavy metals, radionuclides) within a given system and to assess the importance of processes controlling these fluxes (e.g. exchange reactions between the soil solution and the soil solid phase, element turnover through the microbial biomass, organic matter mineralization etc.). The course will first present the principles, the basic assumptions and the theoretical framework that underlay the work with radioisotopes. It will present how the introduction of an isolate into a system can be done so as to get information on the structure of the system (e.g. number and size of compartments). Secondly, case studies on isotopic dilution and tracer work will be presented for instance on the isotopic exchange kinetics method to determine nutrients or pollutants availability. The case studies will be adapted to the ongoing research of the group of plant nutrition and will thus give an insight into our current research. In addition, published studies will be analyzed and presented by the students. Finally, and disadvantages of work with radioisotopes will be analyzed and discussed critically.

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Objective

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

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

Content

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

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

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

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

Lecture notes

For documentation, lecture slides and laboratory protocols will continuously be uploaded to the directory '751-5123-00L Rhizosphere Ecology' on the electronic document exchange platform ILIAS, LDA-ELBA: https://ilias-app2.let.ethz.ch/illias.php?ref_id=109651&cmd=view&cmdClass=ilobjcoursegui&cmdNode=et:fv&baseClass=ilRepositoryGUI
Students will be familiar with basic and advanced applications of stable isotopes in studies on plants, soils, water and trace gases, know how to combine classical and modern techniques to composite fluxes as well as to trace and integrate processes. In addition, students carry out a small project during lab sessions.

Data: 06.03.2019 12:57

Objective

This course provides an overview about the applicability of stable isotopes (carbon 13C, nitrogen 15N, oxygen 18O and water 2H) to solve ecophysiological or ecological problems, learn to design, carry out and interpret a small IsoProject, practice to search and analyze the relevant approaches, concepts and recent results in stable isotope ecology, know how to combine classical and modern techniques to solve ecological problems. Students will familiar be with basic and advanced applications of stable isotopes in studies on plants, soils, water and trace gases, know the relevant approaches, concepts and recent results in stable isotope ecology, know how to combine classical and modern techniques to solve ecological problems, learn to design, carry out and interpret a small IsoProject, practice to search and analyze literature as well as to give an oral presentation.

Literature


http://www.nature.com/scitable/knowledge/library/plant-soil-interactions-nutrient-uptake-105289112


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

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

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


Ecological understanding (Second Edition)


Prerequisites / notice

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

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

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

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

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

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

Abstract

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

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

Data: 06.03.2019 12:57

Autumn Semester 2016

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

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

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

Handouts will be available on the webpage of the course.

Important topics include the structure and properties of clays and oxides, the chemistry of the soil solution, gas equilibria, dissolution and precipitation of mineral phases, cation exchange, surface complexation, chemistry of soil organic matter, redox reactions in flooded soils, soil acidification and soil salinization.

Handouts in lectures.

Lectures notes: Classnotes on website: Vadose Zone Hydrology, by Or D., J.M. Wraith, and M. Tuller (available at the beginning of the semester)

http://www.step.ethz.ch/education/active-courses/vadose-zone-hydrology

Additional topics:

- Stable isotopes: Carbon (13C), Nitrogen (15N), Oxygen (18O), Hydrogen (2H) at natural isotope abundance and tracer levels.
- Stable isotope applications in ecology and environmental sciences.
- Stable isotope models and measurements.
- Stable isotope analyses in soil and water.
- Stable isotope ecology and environmental processes.
- Stable isotope applications in pedology and soil science.
### General Crop Science

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<thead>
<tr>
<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>751-4104-00L</td>
<td>Alternative Crops</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>A. Walter, B. Büter, E. A. Pérez Torres</td>
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<tr>
<td>751-4203-00L</td>
<td>Horticultural Science: Case Studies (HS)</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>L. Bertschinger, J. Rösti, V. J. U. Zufferey</td>
</tr>
<tr>
<td>751-3603-00L</td>
<td>Current Challenges in Plant Breeding</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>B. Studer, A. Hund, University lecturers</td>
</tr>
<tr>
<td>751-5121-00L</td>
<td>Insect Ecology</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>R. Kariyat Ramachandran, C. De Moraes, M. Mescher</td>
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<tr>
<td>751-4811-00L</td>
<td>Alien Organisms in Agriculture</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>J. Collatz, M. Meissle</td>
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</tbody>
</table>

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

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

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

#### Literature
- Documents handed out during the case studies.

#### Prerequisites / notice
- The course builds on basic knowledge delivered in 'Horticultural Crops I' and 'Horticultural Crops II'. If these courses have not been followed by interested participants, equivalent knowledge and experience will greatly support a successful and productive participation of the participating student.
- Language: spoken E, G or F, Documents: Preferably English, G/F possible.

#### Objective
- The educational objectives cover both thematic competences and soft skills:
  - Thematic competences:
    - Deepening of scientific knowledge in plant breeding
    - Critical evaluation of current challenges and new concepts in plant breeding
    - Promotion of collaboration and Master thesis projects with practical plant breeders
  - Soft skills:
    - Independent literature research to get familiar with the selected topic
    - Critical evaluation and consolidation of the acquired knowledge in an interdisciplinary team
    - Establishment of a scientific presentation in an interdisciplinary team
    - Presentation and discussion of the teamwork outcome
    - Establishing contacts and strengthening the network to national and international plant breeders and scientists

#### Content
- Interesting topics related to plant breeding will be selected in close collaboration with the working group for plant breeding of the Swiss Society of Agronomy (SSA). For this year, the topic 'Genome editing: potential and challenges for plant breeding' was selected.
- In the fall semester (November 29, 2016), the enrolled students will meet with the lecturers as well as four to six tutors, selected according to their expertise in the selected topic (one afternoon, for about three hours). After an input talk by the lecturers, four to six specific questions/aspects will be identified and phrased. The tutors and the enrolled students will be assigned to four to six different groups, to critically evaluate one question/aspect of the selected topic. The students, guided by tutors, will prepare a presentation of 15 minutes (plus 5 minutes discussion) covering their specific question/aspect. Participation on that afternoon will be mandatory.
- End of January (January 31, 2017), a one-day seminar on the selected topic will be organized. After one to two keynote speakers (international experts), four invited talks will link the selected topic to practical plant breeding. In the afternoon, the four to six students groups will present and discuss with the experts their specific questions on the selected topic/area. These presentations will be evaluated by the lecturers. The seminar will be public and serve as annual meeting of the SSA working group for plant breeding, bringing together the experts in plant breeding.
- The course is designed for a maximum of 15 Master students and 10 PhD students (advertised and recruited via the Zurich-Basel Plant Science Center). For full and active participation, a total of 2 credit/ECTS points will be provided.

#### Literature
- Seminar abstracts
- Peer-reviewed research articles, selected according to the selected topic/area.
- Participation in the BSc course 'Pflanzenzüchtung' is strongly recommended, a completed course in 'Molecular Plant Breeding' is highly advantageous.

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

#### Literature
- Provided to students through ILIAS.
- Selected required readings (-peer reviewed literature, selected book chapters). Optional recommended readings with additional information.
Abstract
The course focuses on alien organisms in agriculture as well as the scientific assessment and regulatory management of their effects on the environment and agricultural production.

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

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

Lecture notes
Material will be distributed during the course

701-0263-01L Seminar in Evolutionary Ecology of Infectious Diseases
W 3 credits 2G D. Croll, S. Bonhoeffer, R. R. Regös

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

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

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

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

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

751-5101-00L Biogeochemistry and Sustainable Management
W 2 credits 2G N. Buchmann, L. Hörtnagl

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

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

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

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

Literature
Will be discussed in class.

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

751-3405-00L Radio-Isotopes in Plant Nutrition
W 3 credits 2G E. Frossard

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

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

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

Lecture notes
Documents will be distributed during the lecture

Literature
Will be given during the lecture

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

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

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

Objective
Students will be familiar with basic and advanced applications of stable isotopes in studies on plants, soils, water and trace gases, know the relevant approaches, concepts and recent results in stable isotope ecology, know how to combine classical and modern techniques to solve ecophysiological or ecological problems, learn to design, carry out and interpret a small IsotopeProject, practice to search and analyze literature as well as to give an oral presentation.
Content
The analyses of stable isotopes often provide insights into ecophysiological and ecological processes that otherwise would not be available with classical methods only. Stable isotopes proved useful to determine origin of pools and fluxes in ecosystems, to partition composite fluxes and to integrate processes spatially and temporally.

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

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

Literature
Will be discussed in class.

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

**751-4805-00L** Recent Advances in Biocommunication

**Number of participants limited to 25**

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

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

**751-5001-00L** Agroecologists without Borders

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

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

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

**751-5115-00L** Current Aspects of Nutrient Cycle in Agro-Ecosystems

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

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

**751-4003-01L** Current Topics in Grassland Sciences (HS)

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

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

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

**Lecture notes**
none

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

**751-3801-00L** Experimental Design and Applied Statistics in Agroecosystem Science

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

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

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

The tentative schedule containst the following topics:

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

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

**Lecture notes**
Handouts will be available (in English)
Four main topics in Pig Science:

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

2. **Non-Ruminant Science**
   - can explain differences between species and breeds concerning biodiversity conservation.
   - can explain what is important concerning the management of small populations.
   - can describe different conservation activities, in particular in situ and ex situ conservation
   - can describe current national and international conservation programmes for species and breeds.
   - understand the complex interactions of nutrition, quality traits of products, breeding and reproduction, health management, behaviour and husbandry.
   - be trained to understand interdisciplinary and disciplinary research.
   - be able to critically analyze published research data.
   - be able to present precise scientific reports in oral and written form.

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

4. **Pig Science (HS)**
   - The overall goal of the course is to provide the essential scientific knowledge of the genetic, physiological and special nutritional aspects of pigs metabolism, animal health and behaviour, and of the implications for environment, product quality, housing and animal welfare, and breeding programs.
   - Students will understand the complex interactions of nutrition, quality traits of products, breeding and reproduction, health management, behaviour and husbandry.
   - be trained to understand interdisciplinary and disciplinary research.
   - be able to critically analyze published research data.
   - be able to present precise scientific reports in oral and written form.

**Prerequisites / notice**
- A selection of suggested additional literature, especially for German speaking students will be presented in the introductory lecture.
- This course is based on the course Mathematik IV: Statistik, passed in the 2nd year and the Bachelor's course "Wissenschaftliche Datenauswertung und Datenpräsentation" (751-0441-00L)

**Number** | **Title** | **Type** | **ECTS** | **Hours** | **Lecturers**
--- | --- | --- | --- | --- | ---
751-4506-00L | Plant Pathology III | W | 2 credits | 2G | U. Merz, M. Maurhofer Bringolf
751-6601-00L | Pig Science (HS) | W | 3 credits | 3V | E. Hillmann, M. C. Härdi-Landerer
751-6901-00L | Niches in Animal Production | W | 1 credit | 1G | M. Kreuzer, M. Buchmann
751-6243-00L | Conservation of Animal Genetic Resources | W | 1 credit | 1V | H. Signer-Hasler, C. Flury
751-6001-00L | Forum: Livestock in the World Food System | W | 2 credits | 1S | M. Kreuzer, S. Bauersachs,

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

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

**Lecture notes**
- Handouts/scripts are distributed by the lecturer.

**Literature**
- Specific literature is indicated by the lecturer.

**Prerequisites / notice**
- The lecture corresponds with the lecture "Ruminant Science" and knowledge in animal health, nutrition and breedin as wellas applied ethology and animal welfare are recommended.
- The lecture usually is in German (spec. nomenclature).
Abstract
This forum is a platform for the critical reflection of highly relevant topics of livestock in the frame of the world food system comprising issues from basic knowledge to acceptance in society. The exchange is operated by scientific writing and presentation.

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

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

- Preparation of the oral and written presentations takes place to a small part during the 2-h blocks and mainly outside of this time.
- Active participation during the presentations by the other participants.

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

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

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

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

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

Principles of Livestock Systems

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<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
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<tbody>
<tr>
<td>751-7703-00L</td>
<td>Tropical Animal Nutrition</td>
<td>W</td>
<td>1</td>
<td>1G</td>
<td>S. Marquardt</td>
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<tr>
<td>Abstract</td>
<td>Farm animals play an important role in most agro/eco - systems, but conditions for a successful management and nutrition in the tropics are diverse. In this course a wide range of aspects are examined.</td>
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<tr>
<td>Objective</td>
<td>The aim of this course is to know and understand animal production systems in the different zones of the tropics taking into consideration the local and social structure of the population. We will deal with different aspects of animal nutrition in the tropics.</td>
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<tr>
<td>Content</td>
<td>- Introduction to the tropics</td>
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<td>- Special problems and challenges in tropical regions</td>
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<td>- Importance of livestock in the tropics</td>
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<td>- Animal production and livestock production systems in the tropics</td>
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<td>- Special challenges for livestock in the tropics</td>
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<td>- Feeds available in the tropics</td>
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<td>- Tropical pasture systems and their characteristics</td>
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<td>- Quality of feeds in the tropics</td>
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<td>- Problems and challenges of animal nutrition in the tropics</td>
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<tr>
<td>751-6243-00L</td>
<td>Conservation of Animal Genetic Resources</td>
<td>W</td>
<td>1</td>
<td>1V</td>
<td>H. Signer-Hasler, C. Flury</td>
</tr>
<tr>
<td>Abstract</td>
<td>Conservation of Animal Genetic Resources overviews the distribution, endangerment and conservation of farm animal genetic resources in Switzerland and abroad. The theory is illustrated with numerous examples and the knowledge is deepened in exercises.</td>
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<td>Objective</td>
<td>The students learn to describe different conservation activities, in particular in situ and ex situ conservation.</td>
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<td>- can explain differences between species and breeds concerning biodiversity conservation.</td>
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<td>- can describe current national and international conservation programmes for species and breeds.</td>
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<td>- can explain current national and international conservation programmes for species and breeds.</td>
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<td>751-6125-00L</td>
<td>Practical Course in Molecular Physiology</td>
<td>W</td>
<td>3</td>
<td>3P</td>
<td>S. Bauersachs, S. E. Ulbrich</td>
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<tr>
<td>Abstract</td>
<td>This course is intended to intensify and broaden the knowledge of molecular biology gained during the bachelor lab practical course. It directly allows students to commence a master thesis with a detailed knowledge of pitfalls in experimental setup. It will also sensitize for the awareness of biological and technical variance in experimental research.</td>
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<tr>
<td>Objective</td>
<td>The course will be divided in two parts:</td>
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<td>Experimental part:</td>
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<td></td>
<td>- Isolation of leukocytes from blood and milk (cattle)</td>
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<td>- Culture of isolated cells and stimulation, e.g., with LPS</td>
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<td>- Extraction of RNA</td>
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<td></td>
<td>- Quantification and quality control of RNA (Nanodrop, Fluorometer, Bioanalyzer)</td>
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<td></td>
<td>- Analysis of gene expression by the use of quantitative real-time RT-PCR</td>
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<td>Theoretical part:</td>
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<td></td>
<td>- Principles of primary cell culture and transcriptional regulation, methods for analytical detection</td>
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<td></td>
<td>- Bioinformatics (scientific databases, sequence analysis, biostatistics)</td>
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<td></td>
<td>- Presentations by the students (e.g. techniques for analysis of physiological regulatory processes, application examples)</td>
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</table>
In this practical course the students will achieve a comprehensive understanding of molecular physiology in livestock research. A cell culture experiment using blood and milk leukocytes under pathogen-associated treatment will be performed and the analysis of differential gene expression undertaken. The primary cell culture study will give insights into the laboratory work undertaken in animal physiology research. It will include the general discussion of strategies for an appropriate experimental setup in livestock research and possible methods and tools for the analysis. Hands-on cell culture and harvesting, preanalytical sample preparation and measurement implementation as well as the analysis of differential gene expression, data analysis and statistical evaluation using bioinformatics will be performed. In addition, the students will present talks based on state-of-the-art primary literature about related topics to prepare for the course and to complement the provided information. The course will enable the students to design, perform and evaluate laboratory in vitro investigations of physiological regulatory processes on a cellular level.

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<tr>
<td>751-6127-00L</td>
<td>Practical course in Microscopy of Functional Histology</td>
<td>W</td>
<td>3</td>
<td>6P</td>
<td>S. E. Ulbrich</td>
</tr>
<tr>
<td>751-6129-00L</td>
<td>Practical course Epigenetics</td>
<td>W</td>
<td>3</td>
<td>6P</td>
<td>S. E. Ulbrich</td>
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### Ruminant Science

**Abstract**

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

**Objective**

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

**Content**

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

In summary

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

**Lecture notes**

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

**Prerequisites / notice**

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

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

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

The control of performance will consist of:

- an own lecture
- a final oral examination with focus on comprehension of the fundamental linkages rather than of specific details

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<td>751-7211-00L</td>
<td>Ruminal Digestion</td>
<td>W</td>
<td>1</td>
<td>1G</td>
<td>A. Schwarm</td>
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</table>

**Abstract**

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

**Objective**

The course enables students to understand in detail how ruminal digestion works and how this knowledge can be applied to design optimal feeding diets using highly fibrous forages and a variety of other feeds. The students also are able to show how to modify the most important rumen microbes beneficially by nutritional means.
In the Forum "Livestock in the World Food System", a topic of significance for livestock agriculture is selected by the students and this forum is a platform for the critical reflection of highly relevant topics of livestock in the frame of the world food system comprising issues from basic knowledge to acceptance in society. The exchange is operated by scientific writing and presentation.

The non-contact hour part is to comprehend the information given and to prepare either the written report or the oral presentation (cf. "Besonderes"). The preparation of the oral and written presentations takes place to a small part during the 2-h blocks and mainly outside of this time.

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

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

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

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

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

2 h Introduction and blackboard exercise

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

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

2 h Final seminar

Lecture notes
The lecture notes are provided via Moodle.

Literature
Will be communicated at the start of the course.

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

Credit point associated with grade of either a written report or an oral presentation in the final seminar (both on a self-chosen related topic)
Achieve a deepened understanding of horticultural value chain challenges relating to ecological intensification, resource efficiency, climate change and healthy and safe food, and the problem solution strategies and scientific principles behind. Deliver in a team effort a report and a presentation providing a comprehensive insight into a problem of the horticultural value chain and its science-based solution strategy.

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

As provided by the case study leaders.

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

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

**752-2122-00L**  
**Food and Consumer Behaviour**  
**W**  
**2 credits**  
**2V**  
**M. Siegrist, C. Hartmann**

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

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

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**752-5111-00L**  
**Gene Technology in Foods**  
**W**  
**3 credits**  
**2V**  
**L. Meile**

**Abstract**  
This course will increase basic knowledge on biotechnological constructs and application of genetically modified organisms (GMO) which are used worldwide in food production systems. The course discusses health issues, the legislation frame and food safety aspects of GMO applications in agriculture, food production and consumption in Switzerland and EU-countries.

**Objective**  
This course will provide knowledge and biological background on genetically modified organisms (GMO) and food produced with the help of GMO, especially on the molecular basis of GMO constructions with emphasis on genetically modified food in Switzerland and the EU. Criteria of rational food safety and health assessment in agriculture and food consumption will be elaborated.

**Content**  
Overview on application in gene technology, the gene transfer potential of bacteria, plants and other organisms and the mostly used transgenes in food as well as on GMO used for food production and their detection technologies in food; food safety assessment of GMO food; information on the legislation in Switzerland and EU-countries.

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

**Literature**  
Actual publications from literature will be provided.

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

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**752-2307-00L**  
**Nutritional Aspects of Food Composition and Processing**  
**W**  
**3 credits**  
**2V**  
**B. E. Baumer, J. M. Sych**

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

**Objective**  
Students should be able to:
- describe and compare the major concepts /criteria used for the evaluation of the nutritional quality of food
- apply these criteria when assessing the effects of selected processing technologies on nutritional quality.
- evaluate recent formulation strategies aimed to achieve additional physiological benefits for targeted population groups (i.e. functional foods).

**Content**  
The course gives inputs on compositional changes in food due to processing (with focus on thermal/chilling, enzymatic, chemical, emerging technologies) or new formulation strategies. Possible evaluation methods for these changes (e.g. nutritional profile) will be addressed.

**Lecture notes**  
Some contents will be provided by registered students who will individually or as a group present an actual publication.

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**751-0021-00L**  
**World Food System Summer School**

**Number of participants limited to 25.**

**Abstract**  
It is necessary to apply and be selected in order to participate in this course. This also applies to ETH Zurich applicants, they will go through a competitive selection process and are not guaranteed a place simply by signing up for the course.

Further information available:
http://www.worldfoodsystem.ethz.ch/education/summer-schools/upcoming.html

**Objective**  
Provide the opportunity for young scientists and practitioners to understand the challenges and opportunities of sustainable agriculture and organic production systems and to connect these to the broader context of the world food system. During the two week summer school at the Gut Rheinau, one of Switzerland’s largest organic farms, participants will engage in lectures, workshops, group work, case studies, hands-on work, and field trips.

**Content**  
The content framework includes the following modules: world food system overview; agricultural production; Global change drivers; smallholder livelihoods and rural development; Agroforest systems; labelling; International policy and trade; Processing, distribution, and retail; Nutrition and health; National policy and state interventions. The course will conclude with a group work on food system challenges.

**Literature**  
Documents handed out during the case studies.

**Prerequisites / notice**  
No prerequisites. Program is open to Masters, PhD and upper level Bachelor students.

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### Transdisciplinarity for Sustainable Development

**Number**  
701-1543-00L

**Title**  
Transdisciplinary Methods and Applications

**Type**  
W

**ECTS**  
3

**Hours**  
2G

**Lecturers**  
P. Krütli, M. Stauffacher

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Data: 06.03.2019 12:57
Autumn Semester 2016
Page 49 of 1571
Abstract
The course deals with transdisciplinary (td) methods, concepts and their applications in the context of case studies and other problem-oriented research projects. Td methods are used in research at the science-society interface and when collaborating across scientific disciplines. Students learn to apply methods within a functional framework. The format of the course is seminar-like, interactive.

Objective
At the end of the course students should:

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

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

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

Be prepared for:
- Transdisciplinary Case Study 2017

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

Lecture notes
Handouts are provided by the lecturers

Literature
Selected scientific articles and book-chapters

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

701-1551-00L Sustainability Assessment

Abstract
The course deals with the concepts and methodologies for the analysis and assessment of sustainable development. A special focus is given to the social dimension and to social justice as a guiding principle of sustainability as well as to trade-offs between the three dimensions of sustainability.

Objective
At the end of the course students should

Know:
- core concepts of sustainable development, and;
- the concept of social justice - normatively and empirically - as a core element of social sustainability;
- important empirical methods for the analysis and assessment of local / regional sustainability issues.

Understand and reflect on:
- the challenges of trade-offs between the different goals of sustainable development;
- and the respective impacts on individual and societal decision-making.

Content
The course is structured as follows:
- Overview of rationale, objectives, concepts and origins of sustainable development;
- Importance and application of sustainability in science, politics, society, and economy;
- Sustainable (local / regional) development in different national / international contexts;
- Analysis and evaluation methods of sustainable development with a focus on social justice;
- Trade-offs in selected examples.

Lecture notes
Handouts.

Literature
Selected scientific articles & book chapters

Master Studies (Programme Regulations 2011)

Majors

Major in Animal Science

Disciplinary Competences

Ruminant Science

Number  Title                      Type  ECTS  Hours  Lecturers
751-6501-00L Ruminant Science (HS) W+   4 credits  4G   M. Kreuzer, M. C. Härdi-Landerer, E. Hillmann, U. Witschi

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

Objective
At the end of the course the students are able to apply, by a comprehensive understanding of the underlying mechanisms, their knowledge in various fields of ruminant science. They will be able to develop and recommend best strategies for breeding programs, feed formulation, improving forage quality, increasing animal health and welfare etc. They will be trained to carry out interdisciplinary and disciplinary research at the highest level. The course Ruminant Science (FS) offered in spring has a similar structure but is complementary to this course.
Content
Fields (contact hours)
- Introduction: 2 h
- Special topics: 12 h
  - Lameness
  - Fertility in Cows
  - Food Intake of Ruminants
- Disciplinary topics: 36 h
  - Ruminant Husbandry: 16 h
  - Ruminant Nutrition Physiology: 10 h
  - Reproduction in Ruminants: 8 h
- Lectures held by the students: 4 h

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

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

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

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

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

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

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

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

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

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

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

2 h Introduction and blackboard exercise

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

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

2 h Final seminar

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

Non-Ruminant Science

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<th>Number</th>
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<tr>
<td>751-6601-00L</td>
<td>Pig Science (HS)</td>
<td>W+</td>
<td>3</td>
<td>3V</td>
<td>E. Hillmann, M. C. Härdi-Landerer</td>
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</table>

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

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

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<tr>
<th>Number</th>
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<tbody>
<tr>
<td>751-6001-00L</td>
<td>Forum: Livestock in the World Food System</td>
<td>W+</td>
<td>2</td>
<td>1S</td>
<td>M. Kreuzer, S. Bauersachs, E. Hillmann, S. Neuenschwander</td>
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<tr>
<td></td>
<td>Abstract</td>
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<td></td>
<td>This forum is a platform for the critical reflection of highly relevant topics of livestock in the frame of the world food system comprising issues from basic knowledge to acceptance in society. The exchange is operated by scientific writing and presentation.</td>
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<td>In the Forum &quot;Livestock in the World Food System&quot;, a topic of significance for livestock agriculture is selected by the students and subsequently dealt with from various angles (from scientific basis to production systems, environmental aspects and to the acceptance by society). The students learn to present a scientific subject in writing and orally to an audience and to defend the presentation in a discussion.</td>
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<td>Content</td>
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<td>The Forum &quot;Livestock in the World Food System&quot; will take place in blocks of 2 hours each. Once the general topic has been selected, it comprises two elements:</td>
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<td>Element 1. Oral Presentation: The students form small groups and are lecturers. There are chair persons (moderators) from outside of these small groups and they also head the discussion. The remaining students and lecturers are the audience.</td>
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<td>Element 2. Scientific writing: Option 1: preparation of a short scientific type of paper from a result table offered by the lecturers; Option 2: preparation of an abstract with limited word count from a scientific paper; Option 3: writing of a critical review of a paper. The students have to select 2 of the three options each. There will be a discussion in small groups at two dates.</td>
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<td>Introductions to both forms of presentation will be offered by lecturers.</td>
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<td>The preparation of the oral and written presentations takes place to a small part during the 2-h blocks and mainly outside of this time.</td>
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### Tropical Animal Nutrition

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<tbody>
<tr>
<td>751-7703-00L</td>
<td>Tropical Animal Nutrition</td>
<td>W+</td>
<td>1</td>
<td>1G</td>
<td>S. Marquardt</td>
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<tr>
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<td>Abstract</td>
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<td>Farm animals play an important role in most agro/eco - systems, but conditions for a successful management and nutrition in the tropics are diverse. In this course a wide range of aspects are examined.</td>
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<td>The aim of this course is to know and understand animal production systems in the different zones of the tropics taking into consideration the local and social structure of the population. We will deal with different aspects of animal nutrition in the tropics.</td>
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<td>- Introduction to the tropics</td>
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<td>- Special problems and challenges in tropical regions</td>
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<td>- Importance of livestock in the tropics</td>
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<td>- Animal production and livestock production systems in the tropics</td>
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<td>- Special challenges for livestock in the tropics</td>
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<td>- Feeds available in the tropics</td>
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<td>- Tropical pasture systems and their characteristics</td>
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<td>- Quality of feeds in the tropics</td>
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<td>- Problems and challenges of animal nutrition in the tropics</td>
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### Niches in Animal Production

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<tr>
<td>751-6901-00L</td>
<td>Niches in Animal Production</td>
<td>W+</td>
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<td>M. Kreuzer, M. Buchmann</td>
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<td>Abstract</td>
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<td>This course deals with unconventional animals or production forms and specific aspects of for keeping them in Europe or, more specifically, in Switzerland. This includes e.g. rare breeds, wild cattle, deer, camels, ostrich and fish. Particular emphasis will be given to the regulations and the problems occurring with import, housing and marketing of the products.</td>
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<td>At the end of the course the students are able to describe the conditions of keeping unconventional livestock and to develop recommendations for farmers intending to include niche production into the farm enterprise.</td>
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<td>The contact hour part of the course (16 h) is conceptually a block course which is subdivided into one day of lecture and one day of excursion.</td>
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### Animal Health and Genetics

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<tr>
<td></td>
<td>Animal Health and Genetics</td>
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The students are able to set up design matrices, the relationship matrix and its inverse as well as the Mixed Model equations to estimate BLUP breeding values for smaller examples.

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

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

Literature
To be announced in the lectures.

751-6243-00L Conservation of Animal Genetic Resources Abstract The students
- overview the distribution and endangerment of animal genetic resources on national and international level and they know, where to find the relevant information.
- can explain, what value can be assigned to biodiversity and name reasons, why biodiversity should be conserved.
- know the national and international efforts of the present and the past to conserve biodiversity in the livestock sector.
- can explain what is important concerning the management of small populations.
- can explain differences between species and breeds concerning biodiversity conservation.
- can describe different conservation activities, in particular in situ and ex situ conservation
- can describe current national and international conservation programmes for species and breeds.

751-6113-00L Endocrinology and Biology of Reproduction Abstract Die Studierenden erlangen das grundlegende theoretische Verständnis und Fachwissen zur Endokrinologie der Reproduktion und zur weiblichen und männlichen Reproduktionsbiologie. Sie können darüber hinaus pathologische Situationen (Fortpflanzungsstörungen) und deren vielfältige Ursachen in den physiologischen Kontext einordnen.

Methodology Competences

Methods in Animal Science

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

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

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

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

Literature

Specific literature will be indicated individually by the lecturers.

751-6003-00L Training Course in Research Groups (Large) Abstract The students will learn the conceptual and methodological background of research in the animal science groups of the Institute of Plant, Animal and Agroecosystem Science. In addition to teaching the theoretical background, the major aim of the course is to integrate the students into the research groups (on job training) and, hence, to focus on the practical application of the knowledge.

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

Content
The students will be integrated into the research groups day-to-day work and will thus deal with all aspects of scientific work. This comprises the planning (conceptually and logistically), execution (data collection, laboratory analyses) and evaluation (statistics, data presentation) of experiments as well as the basics of scientific writing (aim: later publication, Master thesis). The research topics and the range of methodologies vary between the animal science research groups in the Institute of Plant, Animal and Agroecosystem Sciences.
This course is intended to intensify and broaden the knowledge of molecular biology gained during the bachelor lab practical course. It
The students will be integrated into the research groups day-to-day work and will thus deal with all aspects of scientific work. This
The course program uses a learning-by-doing approach ("hands-on minds-on"). New topics are introduced in the lecture hall, but most of
The students will be integrated into the research groups day-to-day work and will thus deal with all aspects of scientific work. This
The course will be divided in two parts:

### 751-6003-01L Training Course in Research Groups (Small)  
**W+ 3 credits 6P**

**M. Kreuzer, E. Hillmann, S. E. Ulbrich**

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

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

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

### 751-3801-00L Experimental Design and Applied Statistics in Agroecosystem Science  
**W+ 3 credits 2G**

**A. Hund, W. Eugster, C. Grieder, R. Kölliker**

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

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

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

The tentative schedule containst the following topics:

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

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

**Lecture notes**  
Handouts will be available (in English)

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

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

### 751-6129-00L Practical course Epigenetics  
**W 3 credits 6P**

**S. E. Ulbrich**

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

**Objective**  
The course will be divided in two parts:
- Experimental part:
  - Isolation of leukocytes from blood and milk (cattle)
  - Culture of isolated cells and stimulation, e.g., with LPS
  - Extraction of RNA
  - Quantification and quality control of RNA (Nanodrop, Fluorometer, Bioanalyzer)
  - Analysis of gene expression by the use of quantitative real-time RT-PCR
- Theoretical part:
  - Principles of primary cell culture and transcriptional regulation, methods for analytical detection
  - Bioinformatics (scientific databases, sequence analysis, biostatistics)
  - Presentations by the students (e.g. techniques for analysis of physiological regulatory processes, application examples)

**Lecture notes**  
Specific readings after enlisting in a particular research group.

**Literature**  
Specific readings after enlisting in a particular research group.

**Prerequisites / notice**  
The number of training slots in the various groups is limited. It is therefore highly recommended to contact the group leaders early enough (first come first serve).

**Content**  
The full integration in a research group often means to work on weekends.

The full integration in a research group often means to work on weekends.

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

### 751-6127-00L Practical course in Microscopy of Functional Histology  
**W 3 credits 6P**

**S. E. Ulbrich**

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

**Objective**  
The course will be divided in two parts:
- Experimental part:
  - Isolation of leukocytes from blood and milk (cattle)
  - Culture of isolated cells and stimulation, e.g., with LPS
  - Extraction of RNA
  - Quantification and quality control of RNA (Nanodrop, Fluorometer, Bioanalyzer)
  - Analysis of gene expression by the use of quantitative real-time RT-PCR
- Theoretical part:
  - Principles of primary cell culture and transcriptional regulation, methods for analytical detection
  - Bioinformatics (scientific databases, sequence analysis, biostatistics)
  - Presentations by the students (e.g. techniques for analysis of physiological regulatory processes, application examples)

**Lecture notes**  
Specific readings after enlisting in a particular research group.

**Literature**  
Specific readings after enlisting in a particular research group.

**Prerequisites / notice**  
The number of training slots in the various groups is limited. It is therefore highly recommended to contact the group leaders early enough (first come first serve).

**Content**  
The full integration in a research group often means to work on weekends.

The full integration in a research group often means to work on weekends.

The total time budget is equivalent to about 180 hours. Active participation in group meetings (discussion, presentation) and short written reports about the work conducted are required for the 6 credit points. There are no grades, it is only pass or fail.

### 751-6125-00L Training Course in Molecular Physiology  
**W 3 credits 3P**

**S. Bauersachs, S. E. Ulbrich**

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

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

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

The tentative schedule contains the following topics:

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

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

**Lecture notes**  
Handouts will be available (in English)

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

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

**Data:** 06.03.2019 12:57  
**Autumn Semester 2016**  
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Content

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

Major in Crop Science
Disciplinary Competences
Cropping Systems

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

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

Objective
Achieve a deepened understanding of horticultural value chain challenges relating to ecological intensification, resource efficiency, climate change and healthy and safe food, and the problem solution strategies and scientific principles behind.

Deliver in a team effort a report and a presentation providing a comprehensive insight into a problem of the horticultural value chain and its science-based solution strategy.

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

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

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

Lecture notes
Documents handed out during the case studies.

Literature
As provided by the case study leaders.

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

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

751-4104-00L Alternative Crops W+ 2 credits 2V A. Walter, B. Büter, E. A. Pérez Torres

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

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

751-3603-00L Current Challenges in Plant Breeding W 2 credits 2G B. Studer, A. Hund, University lecturers

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

The topic this year will be: ‘Genome editing: potential and challenges for plant breeding’.

Objective
The educational objectives cover both thematic competences and soft skills:

- Thematic competences: Deepening of scientific knowledge in plant breeding
- Critical evaluation of current challenges and new concepts in plant breeding
- Promotion of collaboration and Master thesis projects with practical plant breeders

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

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

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

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

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

Lecture notes
Seminar abstracts

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

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

ECTS

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

Objective

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

Lecture notes

Provided to students through ILIAS

Literature

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

701-2063-01L

Seminar in Evolutionary Ecology of Infectious Diseases

W+ 3 credits 2G D. Croll, S. Bonhoeffer, R. R. Regős

Abstract

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

Objective

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

Content

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

Lecture notes

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

Literature

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

701-4811-00L

Alien Organisms in Agriculture

W 2 credits 2G J. Collatz, M. Meissle

Abstract

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

Objective

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

Content

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

Lecture notes

Material will be distributed during the course.

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Agriculture and Environment

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751-5101-00L

Biogeochemistry and Sustainable Management

W+ 2 credits 2G N. Buchmann, L. Hörtnagl

Abstract

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

Objective

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

Content

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

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

Lecture notes

Handouts will be available on the webpage of the course.

Literature

Will be discussed in class.

Prerequisites / notice

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

751-5115-00L

Current Aspects of Nutrient Cycle in Agro-Ecosystems

W+ 2 credits 1S E. Frossard, A. Oberson Dräyer

Abstract

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

Objective

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

751-4003-01L

Current Topics in Grassland Sciences (HS)

W+ 2 credits 2S N. Buchmann

Abstract

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


### 751-5001-00L Agroecologists without Borders

**Abstract**

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

**Objective**

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

**Prerequisites / notice**

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

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

**Abstract**

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

**Objective**

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

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

**Literature**


**Prerequisites / notice**

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

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### Methodology Competences

#### Methods in Agricultural Sciences

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>751-4506-00L</td>
<td>Plant Pathology III</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>U. Merz, M. Maurhofer Bringolf</td>
</tr>
<tr>
<td>Abstract</td>
<td>Identification based on host, symptoms and micro-morphology, completed with life cycles and related control measures of the most important fungal diseases and their causal pathogens of annual and perennial crops with agricultural significance.</td>
<td></td>
<td></td>
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<tr>
<td>Objective</td>
<td>The students will learn and train preparation skills for microscopy, acquire knowledge of selected diseases (identification, biology of pathogen, epidemiology) and understand the corresponding integrated control measures practiced in Swiss agriculture.</td>
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<tr>
<td>Content</td>
<td>The course will partly be an e-learning exercise (with computers).</td>
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<tr>
<td>Lecture notes</td>
<td>A script will be used on annual and perennial crops and their most important diseases. It will be updated stepwise.</td>
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<td></td>
</tr>
<tr>
<td>Prerequisites / notice</td>
<td>The course will be in German (spec. nomenclature).</td>
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</tbody>
</table>

| 751-4805-00L | Recent Advances in Biocommunication | W+   | 2    | 2G    | C. De Moraes                     |
| Abstract | Number of participants limited to 25 |      |      |       |                                |
| Objective | Students will gain insight into the role of sensory cues and signals in mediating interactions within and between species. There will be a primary, but not exclusive, focus on chemical signaling in interactions among plants, insects and microbes. The course will focus on the discussion of current literature addressing key conceptual questions and state-of-the-art research techniques and methods. |      |      |       |                                |
| Content  | Students will gain insight into the role of sensory cues and signals in mediating interactions within and between species. There will be a primary, but not exclusive, focus on chemical signaling in interactions among plants, insects and microbes. The course will focus on the discussion of current literature addressing key conceptual questions and state-of-the-art research techniques and methods. Students will engage in discussion and critical analyses of relevant papers and present their evaluations in a seminar setting. |      |      |       |                                |

| 751-3405-00L | Radio-Isotopes in Plant Nutrition | W+   | 3    | 2G    | E. Frossard                     |
| Abstract | The course will present the principles underlying the use of radioisotopes in soil/plant systems. It will present how the introduction of an isotope into a system can be done to get some information on the structure of the system. Case studies will be presented to determine element availability. Finally, published studies from other groups will be analyzed and presented by the students. |      |      |       |                                |
| Objective | At the end of the course the students are familiar with the principles on which radioisotope works are based and they have learned from case studies how radioisotopes can be used to obtain meaningful data. They are aware of the advantages of using radioisotopes in element cycling studies, but also of the risks and open questions related to isotope work. |      |      |       |                                |
Radio-isotopes are extensively used at the soil/plant or ecosystem level to quantify the fluxes of elements (phosphorus (P), heavy metals, radionuclides) within a given system and to assess the importance of processes controlling these fluxes (e.g. exchange reactions between the soil solution and the soil solid phase, element turnover through the microbial biomass, organic matter mineralization etc.). The course will first present the principles, the basic assumptions and the theoretical framework that underlay the work with radioisotopes. It will present how the introduction of an isotope into a system can be done so as to get information on the structure of the system (e.g. number and size of compartments). Secondly, case studies on isotopic dilution and tracer work will be presented for instance on the isotopic exchange kinetics method to determine nutrients or pollutants availability. The case studies will be adapted to the ongoing research of the group of plant nutrition and will thus give an insight into our current research. In addition, published studies will be analyzed and presented by the students. Finally, the advantages and disadvantages of work with radioisotopes will be analyzed and discussed critically.

**Content**

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

**Lecture notes**

Documents will be distributed during the lecture

**Literature**

Will be given during the lecture

**Prerequisites / notice**

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

**751-5123-00L Rhizosphere Ecology**

**W+ 4 credits 4G**

H. A. Gamper, T. I. McLaren

**Number of participants limited to 18.**

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

**Abstract**

This course is about the physical, chemical, and biological processes in the rhizosphere and their effect on plant growth. Effects of fertilisers, companion plants, and microbial symbionts, and other microbes on nutrient cycling and plant uptake are discussed. An "intercropping" experiment in the glasshouse is used as a model to check for rhizosphere effects on plant growth and mineral nutrition. In short, the processes dealt with in this course occur on a small-scale and are generally (bio)chemical and microbiological in nature.

**Objective**

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

**Content**

This course is designed to stimulate thinking and promote critical analysis of important processes that occur in the rhizosphere. As part of this course, the knowledge acquired will be used for analysing and interpreting experimental data, as well as, preparing a scientific report and conference-type poster. Practical experience will be gained with setting up a glasshouse experiment, soil and root sampling, basic soil and plant analyses, isolation of rhizobia, determination of the number of colony forming units (CFU), assays to screen for phosphorus and zinc solubilizing bacteria, DNA extraction, PCR amplification, and restriction fragment length polymorphism analysis (RFLP) of host range determining symbiosis-specific genes.

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

**Lecture notes**

For documentation, lecture slides and laboratory protocols will continuously be uploaded to the directory '751-5123-00L Rhizosphere Ecology' on the electronic document exchange platform ILIAS, LDA-ELBA: https://ilias-app2.let.ethz.ch/ilias.php?ref_id=109651&cmd=view&cmdClass=ilobjcoursegui&cmdNode=ef:tv&baseClass=ilRepositoryGUI
Students will be familiar with basic and advanced applications of stable isotopes in studies on plants, soils, water and trace gases, know


<table>
<thead>
<tr>
<th>Prequisites / notice</th>
<th>Prerequisites / notice</th>
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</thead>
<tbody>
<tr>
<td>How microbes can feed the world (American Academy of Microbiology) <a href="http://academy.asm.org/index.php/browse-all-reports/800-how-microbes-can-help-feed-the-world">http://academy.asm.org/index.php/browse-all-reports/800-how-microbes-can-help-feed-the-world</a></td>
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</tr>
<tr>
<td>Can microbes feed the world? (Society for general microbiology) <a href="http://www.sgm.ac.uk/en/publications/microbiology-today/past-issues.cfm/publication/can-microbes-feed-the-world">http://www.sgm.ac.uk/en/publications/microbiology-today/past-issues.cfm/publication/can-microbes-feed-the-world</a></td>
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</table>

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

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

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

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

Students of D-USYS will be reimbursed via bank transfer for train and bus tickets of the zones 121 and 122 (Please send all tickets with the bank details to Christiane Gujan (http://www.plantnutrition.ethz.ch/the-group/people-a-z/person-detail.html?persid=85593).
The analyses of stable isotopes often provide insights into ecophysiological and ecological processes that otherwise would not be available with classical methods only. Stable isotopes proved useful to determine origin of pools and fluxes in ecosystems, to partition composite fluxes and to integrate processes spatially and temporally.

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

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

Literature: Will be discussed in class.

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

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<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
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</table>

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

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

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

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

Lecture notes: Handouts will be available (in English).

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

Prerequisites / notice: This course is based on the course Mathematik IV: Statistik, passed in the 2nd year and the Bachelor's course "Wissenschaftliche Datenanalyse und Datenpräsentation" (751-0441-00L). This course does not provide the mathematical background that students are expected to bring along when signing up to this course. Alternatively, students can consider some aspects of this course as a first exposure to solutions in experimental design and applied statistics and then deepen their understanding in follow-up statistical courses.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>751-0203-00L</td>
<td>Professional Internship Part I: Preparation</td>
<td>W</td>
<td>2</td>
<td>4G</td>
<td>B. Dorn, E. Buff Keller</td>
</tr>
</tbody>
</table>

Objective: Die Studierenden
- kennen die Aufgaben und Termine des Berufspraktikums
- können wissenschaftliche Poster gestalten und wirkungsvoll präsentieren
- sind sich im Hinblick auf ihre Praktikumsbewerbung ihrer fachlichen und überfachlichen Kompetenzen bewusst und kommunizieren diese in Bewerbungsunterlagen und Vorstellungsgesprächen
- können konstruktives Feedback zur Postergestaltung und -präsentation sowie zu den Bewerbungsunterlagen geben und annehmen

Lecture notes: Arbeitsunterlagen werden in der Vorlesung abgegeben.

### Major in Food and Resource Use Economics

#### Disciplinary Competences

#### Decision Making in Food Value Chains

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<tr>
<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>751-1555-00L</td>
<td>Applied Food Industrial Organisation</td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>to be announced</td>
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</tbody>
</table>
- Introduction IO
  o Relevant topics for the food sector
  - high competition and market saturation
  - low R&D intensity
  - bargaining power of retailers
  - Private label introduction

- Theoretical Approaches
  o Structure Conduct Performance
  o Market Based View
  o Porters Five Forces
  o Resource Based View
  o Knowledge Based View

- Empirical Issues (Based on published research papers)
  o Competition / Concentration
  o Profitability
  o Impact of Innovation / R&D
  o Efficiency
  o Market power
  o Econometric Approaches

Literature
Several theoretical and empirical IO related research papers

752-2122-00L Food and Consumer Behaviour

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

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

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

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

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

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

Lecture notes
Reader with selected contents,

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

363-0403-00L Introduction to Marketing

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

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

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

The lecture features a short tutorial that is held at irregularly spaced intervals throughout the semester (approximately every third week). The tutorial is embedded within the lecture and consists of short sessions of about 30 minutes. It serves to illustrate theoretical and methodological concepts from the lecture by walking students through the analysis of real-world data from the telecommunications industry.

The case data will be provided so that students practice and apply the concepts of the lecture on their own. The tutorial is held jointly by two Teaching Assistants (Zhiying Cui and Jana Gross) and the professor (Prof. F. von Wangenheim).

Literature
Weekly readings, distributed in class (via Moodle)

Environmental and Resource Use Economics

Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
701-1651-00L | Environmental Governance | W+ | 3 credits | 2G | E. Lieberherr, G. de Buren, R. Schweizer

Abstract
The course addresses environmental policies, focusing on new steering approaches, which are generally summarized as environmental governance. The course also provides students with tools to analyze environmental policy processes and assesses the key features of environmental governance by examining various practical environmental policy examples.
The main part of this lecture will examine constellations where hierarchies, markets or cooperation have been observed and described in international environmental politics and to critically discuss them with reference to various practical policy examples. To be able to identify the main challenges and opportunities for environmental governance and to critically discuss them with reference to various practical policy examples.

Improvements in environmental quality and sustainable management of natural resources cannot be achieved through technical solutions alone. The quality of the environment and the achievement of sustainable development strongly depend on human behavior and specifically the human use of nature. To influence human behavior, we rely on public policies and other societal rules, which aim to steer the use of diverse tools such as emission standards or financial incentives to steer actors' behavior and can occur at the local, regional, national or international level.

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

The objectives of this course are to (1) gain an overview of relevant questions in the area of international environmental politics from a social sciences viewpoint; (2) learn how to identify interesting/innovative questions concerning this policy area and how to answer them in a methodologically sophisticated way; (3) gain an overview of important global and regional environmental problems.

This course deals with how and why international cooperation in environmental politics emerges, and under what circumstances such cooperation and the respective public policies are effective and/or efficient. Based on theories of international political economy and theories of government regulation various examples of international environmental politics are discussed: the management of international water resources, the problem of unsafe nuclear power plants in eastern Europe, political responses to global warming, the protection of the stratospheric ozone layer, the reduction of long-range transboundary air pollution in Europe, the prevention of pollution of the oceans, etc.

The objectives of this course are to (1) gain an overview of relevant questions in the area of international environmental politics from a social sciences viewpoint; (2) learn how to identify interesting/innovative questions concerning this policy area and how to answer them in a methodologically sophisticated way; (3) gain an overview of important global and regional environmental problems.

Socioeconomics of Agriculture

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

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

Socioeconomics of Agriculture

International Environmental Politics

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

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

The course deals with how and why international cooperation in environmental politics emerges, and under what circumstances such cooperation is effective and efficient. Based on theories of international political economy and theories of government regulation various examples of international environmental politics are discussed: the management of international water resources, the problem of unsafe nuclear power plants in eastern Europe, political responses to global warming, the protection of the stratospheric ozone layer, the reduction of long-range transboundary air pollution in Europe, the prevention of pollution of the oceans, etc.

The course is open to all ETH students. Participation does not require previous coursework in the social sciences.

After passing an end-of-semester test (requirement: grade 4.0 or higher) students will receive 3 ECTS credit points. The workload is around 90 hours (meetings, reading assignments, preparation of test).

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

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

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

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>751-2903-00L</td>
<td>Evaluation of Agricultural Policies</td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>M. Stolze, S. Mann</td>
</tr>
</tbody>
</table>

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

**Objective**
Focus: Policy Evaluation

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

**Content**

<table>
<thead>
<tr>
<th>Unit</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Introduction in the issue of policy evaluation</td>
</tr>
<tr>
<td>02</td>
<td>The normative frame for policy evaluation</td>
</tr>
<tr>
<td>03</td>
<td>Evaluation of policies</td>
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<tr>
<td>04</td>
<td>Context and use of evaluations</td>
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<tr>
<td>05</td>
<td>Quantitative policy evaluation</td>
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<tr>
<td>06</td>
<td>Qualitative policy evaluation</td>
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<tr>
<td>07</td>
<td>Group work</td>
</tr>
<tr>
<td>08</td>
<td>Agricultural Economics Research at ART</td>
</tr>
<tr>
<td>09</td>
<td>Agricultural Economics Research at FiBL</td>
</tr>
<tr>
<td>10</td>
<td>Examination, Feedback</td>
</tr>
</tbody>
</table>

**Lecture notes**

Handouts (power point presentations)

**Literature**

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


**Prerequisites / notice**

Unit 07: Group work

Unit 08: 1 day course at Agroscope in Tänikon, 8356 Ettenhausen, www.agroscope.admin.ch

Unit 09: 1 day course at FiBL in 5070 Frick, www.fibl.org

### International Aid and Development

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0626-01L</td>
<td>International Aid and Development</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>I. Günther</td>
</tr>
</tbody>
</table>

**Abstract**
The course gives economic and empirical foundations for a sound understanding of the instruments, prospects and limitations of international development aid.

**Objective**

Students have a theoretically and empirically sound understanding of the prospects and limitations of international development aid. Students are able to critically discuss the various aid instruments of bi- and multilateral donors and NGOs.

**Content**

Introduction to the Determinants of Underdevelopment; History of Aid; Aid and Development: Theories and Empirics; Political Economy of Aid; Experience and Impact of Aid; New Instruments of Aid: e.g. Micro-Finance, Budget-Support; Fair-Trade.

**Literature**

Articles and book abstracts will be uploaded to a course website.

### Methodology Competences

### Methods in Food and Resource Use Economics

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<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
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**Abstract**

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

**Objective**

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

**Content**

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

The tentative schedule contains the following topics:

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

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

**Lecture notes**

Handouts will be available (in English)

**Literature**

A selection of suggested additional literature, especially for German speaking students will be presented in the introductory lecture.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Type</th>
<th>Instructors</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-0541-00L</td>
<td>Systems Dynamics and Complexity</td>
<td>W+</td>
<td>3</td>
<td>G. Casiraghi,</td>
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<td>V. Nanumyan</td>
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<tr>
<td></td>
<td>Abstract</td>
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<tr>
<td></td>
<td>Finding solutions: what is complexity, problem</td>
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<td></td>
<td>solving cycle.</td>
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<td></td>
<td>Implementing solutions: project management,</td>
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<td></td>
<td>critical path method, quality control feedback</td>
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<td></td>
<td>loop.</td>
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<td>Controlling solutions: Vensim software, feedback</td>
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<td>cycles, control parameters, instabilities,</td>
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<td>chaos, oscillations and cycles, supply and</td>
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<td>demand, production functions, investment and</td>
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<td></td>
<td>consumption.</td>
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<td>Objective</td>
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<td>A successful participant of the course is able to:</td>
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<tr>
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<td>- understand why most real problems are not</td>
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<td>simple, but require solution methods that go</td>
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<tr>
<td></td>
<td>beyond algorithmic and mathematical approaches.</td>
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<td>- apply the problem solving cycle as a systematic</td>
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<td>approach to identify problems and their solutions</td>
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<td>- calculate project schedules according to the</td>
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<td>critical path method.</td>
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<td>- setup and run systems dynamics models by means</td>
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<td>of the Vensim software</td>
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<td>- identify feedback cycles and reasons for</td>
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<td>unintended systems behavior</td>
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<td>- analyse the stability of nonlinear dynamical</td>
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<td>systems and apply this to macroeconomic dynamics</td>
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<td>Why are problems not simple? Why do some systems</td>
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<td>behave in an unintended way? How can we model</td>
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<td>and control their dynamics? The course provides</td>
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<td>answers to these questions by using a broad</td>
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<td>range of methods encompassing systems oriented</td>
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<td>management, classical systems dynamics, nonlinear</td>
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<td>dynamics and macroeconomic modeling.</td>
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<td>The course is structured along three main tasks:</td>
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<td>1. Finding solutions</td>
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<td>2. Implementing solutions</td>
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<td>3. Controlling solutions</td>
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<td>PART 1 introduces complexity as a system</td>
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<td>immanent property that cannot be simplified. It</td>
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<td>introduces the problem solving cycle, used in</td>
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<td>systems oriented management, as an approach to</td>
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<td>structure problems and to find solutions.</td>
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<td>PART 2 discusses selected problems of project</td>
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<td>management when implementing solutions. Methods</td>
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<td>for identifying the critical path of subtasks</td>
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<td>in a project and for calculating the allocation</td>
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<td>of resources are provided. The role of quality</td>
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<td>control as an additional feedback loop and</td>
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<td>the consequences of small changes are discussed.</td>
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<td>PART 3, by far the largest part of the course,</td>
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<td>provides more insight into the dynamics of</td>
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<td>existing systems. Examples come from biology</td>
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<td>(population dynamics), management (inventory</td>
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<td>modeling, technology adoption, production</td>
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<td>systems) and economics (supply and demand,</td>
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<td>investment and consumption). For systems</td>
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<td>dynamics models, the software program VENSIM</td>
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<td>is used to evaluate the dynamics. For economic</td>
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<td>models analytical approaches, also used in</td>
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<td>nonlinear dynamics and control theory, are applied. These together provide a</td>
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<td>systematic understanding of the role of feedback</td>
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<td>loops and instabilities in the dynamics of systems.</td>
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<td>Emphasis is on oscillating phenomena, such as</td>
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<td>business cycles and other life cycles.</td>
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<td>Weekly self-study tasks are used to apply the</td>
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<td>concepts introduced in the lectures and to come</td>
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<td>to grips with the software program VENSIM.</td>
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<td>Lecture notes</td>
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<td>The lecture slides are provided as handouts -</td>
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<td>including notes and literature sources - to</td>
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<td>registered students only. All material is to be</td>
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<td>found on the Moodle platform. More details during</td>
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<td>Prerequisites / notice</td>
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<td>Self-study tasks (discussion exercises, Vensim</td>
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<td>exercises) are provided as home work. Weekly</td>
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<td>exercise sessions (45 min) are used to discuss</td>
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<td>selected solutions. Regular participation in the</td>
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<td>exercises is an efficient way to understand the</td>
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<td>concepts relevant for the final exam.</td>
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<tr>
<td>401-0647-00L</td>
<td>Introduction to Mathematical Optimization</td>
<td>W+</td>
<td>5</td>
<td>D. Adjaashvili</td>
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<td>Abstract</td>
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<td>Introduction to basic techniques and problems</td>
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<td>in mathematical optimization, and their</td>
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<td>applications to problems in engineering.</td>
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<td>The goal of the course is to obtain a</td>
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<td>good understanding of some of the most</td>
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<td>fundamental mathematical optimization techniques</td>
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<td>used to solve linear programs and basic</td>
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<td>combinatorial optimization problems. The students</td>
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<td>will also practice applying the learned models</td>
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<td>to problems in engineering.</td>
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<td>Information about relevant literature will be</td>
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<td>This course is meant for students who did not</td>
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<td>already attend the course &quot;Mathematical</td>
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<td>Optimization&quot;, which is a more advance lecture</td>
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<td>covering similar topics and more.</td>
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<td>751-0423-00L</td>
<td>Agricultural Production and Operations</td>
<td>W+</td>
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<td>R. Finger</td>
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<td>Agricultural production is exposed to various</td>
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<td>risks which are important for decisions taken</td>
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<td>by farmers and other actors in the agri-food</td>
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<td>sector. Moreover, risk management is</td>
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<td>indispensable for all actors. This course</td>
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<td>introduces modern concepts on decision</td>
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<td>making under risk and recent developments in</td>
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<td>risk management. The focus of this course is on</td>
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<td>the agricultural applications.</td>
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<td>Objective</td>
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<td>- to develop a better understanding of</td>
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<td>decision making under uncertainty and risk;</td>
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<td>- to gain experience in different approaches</td>
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<td>to analyze risky decisions;</td>
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<td>- to develop an understanding for</td>
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<td>different sources of risk in agricultural</td>
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<td>production;</td>
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<td>- to understand the crucial role of</td>
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<td>subjective perceptions and preferences for</td>
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<td>risk management decisions;</td>
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<td>- to get an overview on risk management in the</td>
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<td>agricultural sector, with a particular focus on</td>
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<td>insurance solutions</td>
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<td>- Quantification and measurement of risk</td>
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<td>- Risk preferences, expected utility theory</td>
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<td>and alternative models of risk behavior</td>
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<td>- Concepts on the decision making under risk</td>
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<td>- Production, investment and</td>
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<td>diversification decisions under risk</td>
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<td>- Risk management in agriculture</td>
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<td>Lecture notes</td>
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<td>lecture and available on the moodle.</td>
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<td>knowledge of basic concepts of probability</td>
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<td>theory and microeconomics</td>
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<td>751-1573-00L</td>
<td>Dynamic Simulation in Agricultural and Regional</td>
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<td>B. Kopainsky</td>
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<td>Economics</td>
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<td></td>
<td>Students in this class develop a dynamic</td>
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<td>simulation model that represents the basic</td>
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<td>mechanisms underlying food security in</td>
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<td>developing countries in a highly aggregated way.</td>
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<td>Students then proceed to extending the</td>
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<td>simulation model with one policy to improve food</td>
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<td>security and they analyze the dynamic impacts</td>
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<td>of this policy on production and</td>
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<td>environmental outcomes.</td>
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The goal is to gain experience in scientific project work and improve presentation, discussion, and writing skills. Hours articles and papers (will be provided during the class)

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

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

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<thead>
<tr>
<th>Number</th>
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<tbody>
<tr>
<td>363-0305-00L</td>
<td>Empirical Methods in Management</td>
<td>W+</td>
<td>3 credits</td>
<td>2G</td>
<td>A. Scherer</td>
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<tr>
<td>Abstract</td>
<td>Evidence-based management requires valid empirical research. In this course, students will learn the basics of research design, fundamentals of data collection and statistical methods to analyze the data acquired in social science research. Students are expected to apply their knowledge in class discussions and out-of-class assignments.</td>
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| Objective    | - Ability to formulate research questions and design an appropriate study  
- Ability to collect and analyze data using a variety of methods  
- Ability to critically assess the quality of empirical research in management  
- Applied knowledge of empirical methods through out-of-class assignments |
| Content      | 1) Introduction to empirical management research  
2) Research designs: exploratory, descriptive, experimental  
3) Measurement and scaling  
4) Data collection and sampling  
5) Data analysis methods  
6) Reporting and presenting empirical research |
| Prerequisites / notice | Assignments and projects: This course includes out-of-class assignments and projects to give students some hands-on experience in conducting empirical research in management. Projects will focus on one particular aspect of empirical research, like the formulation of a research question or the design of a study. Students will have at least one week to work on each assignment. Students are expected to work on these assignments individually. Duplicate answers will receive no credit and will be subject to a disciplinary review. Assignments will be graded and need to be turned in on time. |

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

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

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>351-2901-00L</td>
<td>Research Project in FRE</td>
<td>W+</td>
<td>2 credits</td>
<td>4A</td>
<td>R. Finger</td>
</tr>
<tr>
<td>Abstract</td>
<td>Students will summarize literature and concepts in a particular field of agricultural economics and policy. The task is to compose a short term paper and presentation at the end of the semester.</td>
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<tr>
<td>Objective</td>
<td>The goal is gain experience is scientific project work, and improve presentation, discussion and writing skills.</td>
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<tr>
<td>Content</td>
<td>Topics in the field of agricultural economics and policy will be distributed in the beginning of the course</td>
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Minors

Agricultural- Food- and Environmental Economics

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-1651-00L</td>
<td>Environmental Governance</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>E. Lieberherr, G. de Buren, R. Schweizer</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course addresses environmental policies, focusing on new steering approaches, which are generally summarized as environmental governance. The course also provides students with tools to analyze environmental policy processes and assesses the key features of environmental governance by examining various practical environmental policy examples.</td>
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<tr>
<td>Objective</td>
<td>To understand how an environmental problem may (not) become a policy and explain political processes, using basic concepts and techniques from political science.</td>
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<tr>
<td>Content</td>
<td>To analyze the evolution as well as the key elements of environmental governance.</td>
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</table>

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

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

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

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

Lecture notes Lecture slides and additional course material will be provided throughout the semester.
<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Type</th>
<th>Credits</th>
<th>Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>752-2122-00L</td>
<td>Food and Consumer Behaviour</td>
<td>W</td>
<td>2</td>
<td>2V</td>
</tr>
<tr>
<td>751-2903-00L</td>
<td>Evaluation of Agricultural Policies</td>
<td>W</td>
<td>3</td>
<td>2G</td>
</tr>
<tr>
<td>751-2205-00L</td>
<td>Advanced Management in the Agri-Food-Chain</td>
<td>W</td>
<td>2</td>
<td>2G</td>
</tr>
<tr>
<td>751-5001-00L</td>
<td>Agroecologists without Borders</td>
<td>W</td>
<td>2</td>
<td>2S</td>
</tr>
<tr>
<td>851-0594-00L</td>
<td>International Environmental Politics</td>
<td>W</td>
<td>3</td>
<td>2V</td>
</tr>
</tbody>
</table>

**Prerequisites / notice**

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

**Literature**

We will mostly work with readings from the following books:


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

**Objective**

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

**Objective**

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

**Content**

- be capable to conduct evaluations and critically reflect evaluation results

**Literature**

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


**Prerequisites / notice**

Unit 08: 1 day course at Agroscope in Tänikon, 8356 Ettenhausen, www.agroscope.admin.ch

Unit 09: 1 day course at FiBL in 5070 Frick, www.fibl.org

**Objective**

After the lecture the students ...

... know the characteristics and consequences of complexity in the organizational world,

... know and can apply selected comprehensive models for managing in complex situations,

... know possible practical applications and examples of the treated contents to organizations in the Agri-Food Chain and

... are able to deepen the relevant topics in an autonomous way.

**Content**

In the lecture the following contents will be treated:

- State, reasons and effects of complexity in the organizational world.
- A basic framework for shaping and governing intelligent organizations.
- Selected contemporary models for managing in the complex organizational world.
- Transfer and adaption of the models to organizations in the Agri-Food Chain.

**Literature**

Handouts (power point presentations)


**Objective**

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

**Prerequisites / notice**

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

**Objective**

The objectives of this course are to (1) gain an overview of relevant issues in the area of international environmental politics from a social sciences viewpoint; (2) learn how to identify interesting/innovative questions concerning this policy area and how to answer them in a methodologically sophisticated way; (3) gain an overview of important global and regional environmental problems.
Content
This course deals with how and why international cooperation in environmental politics emerges, and under what circumstances such cooperation is effective and efficient. Based on theories of international political economy and theories of government regulation various examples of international environmental politics are discussed: the management of international water resources, the problem of unsafe nuclear power plants in eastern Europe, political responses to global warming, the protection of the stratospheric ozone layer, the reduction of long-range transboundary air pollution in Europe, the prevention of pollution of the oceans, etc.

The course is open to all ETH students. Participation does not require previous coursework in the social sciences.

After passing an end-of-semester test (requirement: grade 4.0 or higher) students will receive 3 ECTS credit points. The workload is around 90 hours (meetings, reading assignments, preparation of test).

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

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

Prerequisites / notice
None

Crop Health Management

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>751-4506-00L</td>
<td>Plant Pathology III</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>U. Merz, M. Maurhofer Bringolf</td>
</tr>
<tr>
<td>Abstract</td>
<td>Identification based on host, symptoms and micro-morphology, completed with life cycles and related control measures of the most important fungal diseases and their causal pathogens of annual and perennial crops with agricultural significance.</td>
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<tr>
<td>Objective</td>
<td>The students will learn and train preparation skills for microscopy, acquire knowledge of selected diseases (identification, biology of pathogen, epidemiology) and understand the corresponding integrated control measures practiced in Swiss agriculture.</td>
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<tr>
<td>Content</td>
<td>The course will partly be an e-learning exercise (with computers).</td>
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<tr>
<td>Lecture notes</td>
<td>A script will be used on annual and perennial crops and their most important diseases. It will be updated stepwise</td>
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<tr>
<td>Prerequisites/notice</td>
<td>The course will be in German (spec. nomenclature)</td>
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<tr>
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<th>Hours</th>
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<tbody>
<tr>
<td>751-4805-00L</td>
<td>Recent Advances in Biocommunication</td>
<td>W+</td>
<td>2</td>
<td>2S</td>
<td>C. De Moraes</td>
</tr>
<tr>
<td>Number of participants limited to 25</td>
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<tr>
<td>Abstract</td>
<td>Students will gain insight into the role of sensory cues and signals in mediating interactions within and between species. There will be a primary, but not exclusive, focus on chemical signaling in interactions among plants, insects, and microbes. The course will focus on the discussion of current literature addressing key conceptual questions and state-of-the-art research techniques and methods.</td>
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<tr>
<td>Objective</td>
<td>Students will gain insight into the role of sensory cues and signals in mediating interactions within and between species. There will be a primary, but not exclusive, focus on chemical signaling in interactions among plants, insects, and microbes. The course will focus on the discussion of current literature addressing key conceptual questions and state-of-the-art research techniques and methods.</td>
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<tr>
<td>Content</td>
<td>The course will partly be an e-learning exercise (with computers).</td>
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<tr>
<td>Lecture notes</td>
<td>A script will be used on annual and perennial crops and their most important diseases. It will be updated stepwise</td>
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<tr>
<td>Prerequisites/notice</td>
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</thead>
<tbody>
<tr>
<td>751-5121-00L</td>
<td>Insect Ecology</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>R. R. Kariyat Ramachandran, C. De Moraes, M. Mescher</td>
</tr>
<tr>
<td>Abstract</td>
<td>This is an introductory course in insect ecology. Students will learn about the ways in which insects interact with and adapt to their abiotic &amp; biotic environments and their roles in diverse ecosystems. The course will entail lectures, outside readings, and critical analysis of contemporary literature.</td>
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<tr>
<td>Objective</td>
<td>Students completing this course should become familiar with the application of ecological principles to the study of insects, as well as major areas of inquiry in this field. Highlighted topics will include insect behavior, chemical and sensory ecology, physiological responses to biotic and abiotic stressors, plant-insect interactions, community and food-web dynamics, and disease ecology. The course will emphasize insect evolution and adaptation in the context of specific interactions with other organisms and the abiotic environment. Examples from the literature incorporated into lectures will highlight the methods used to study insect ecology.</td>
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<tr>
<td>Lecture notes</td>
<td>Provided to students through ILAS</td>
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<tr>
<td>Literature</td>
<td>Selected required readings (peer reviewed literature, selected book chapters). Optional recommended readings with additional information.</td>
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<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>701-0263-01L</td>
<td>Seminar in Evolutionary Ecology of Infectious Diseases</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>D. Croll, S. Bonhoeffer, R. R. Regös</td>
</tr>
<tr>
<td>Abstract</td>
<td>Students of this course will discuss current topics from the field of infectious disease biology. From a list of publications, each student chooses some themes that he/she is going to explain and discuss with all other participants and under supervision. The actual topics will change from year to year corresponding to the progress and new results occurring in the field.</td>
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<tr>
<td>Objective</td>
<td>This is an advanced course that will require significant student participation. Students will learn how to evaluate and present scientific literature and trace the development of ideas related to understanding the ecology and evolutionary biology of infectious diseases.</td>
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<tr>
<td>Content</td>
<td>A core set of ~10 classic publications encompassing unifying themes in infectious disease ecology and evolution, such as virulence, resistance, metapopulations, networks, and competition will be presented and discussed. Pathogens will include bacteria, viruses and fungi. Hosts will include animals, plants and humans.</td>
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<tr>
<td>Lecture notes</td>
<td>Provided to students through ILAS</td>
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<tr>
<td>Literature</td>
<td>Publications and class notes can be downloaded from a web page announced during the lecture. Papers will be assigned and downloaded from a web page announced during the lecture.</td>
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<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>751-4811-00L</td>
<td>Alien Organisms in Agriculture</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>J. Collatz, M. Meissle</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course focuses on alien organisms in agriculture as well as the scientific assessment and regulatory management of their effects on the environment and agricultural production.</td>
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<tr>
<td>Objective</td>
<td>Students will understand the consequences arising from the unintentional or deliberate introduction of alien organisms into agricultural systems. They will be able to understand the concept of environmental risk assessment and be able to evaluate risk management options.</td>
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</table>
Alien organisms in agriculture is a topic that receives an increasing awareness among farmers, agricultural scientists, regulators and the general public. Students of this course will learn about the nature of alien organisms such as invasive species, biocontrol organisms and genetically modified organisms. With a particular focus on arthropods, plants and their interactions we will look at the potential threats the novel organisms pose, the benefits they provide and how both of these effects can be scientifically assessed. Students will learn how the topic of alien organisms in agriculture is intrinsically tied to policy making and regulation and get to know current examples and future challenges in research. In the last part of the course students will be able to apply the acquired knowledge in a practical exercise (case study).

### Environmental Crop Physiology

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>751-3405-00L</td>
<td>Radio-Isotopes in Plant Nutrition</td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>E. Frossard</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course will present the principles underlying the use of radioisotopes in soil/plant systems. It will present how the introduction of an isotope into a system can be done to get some information on the structure of the system. Case studies will be presented to determine element availability. Finally, published studies from other groups will be analyzed and presented by the students.</td>
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<tr>
<td>Objective</td>
<td>At the end of this course the students will be familiar with the principles on which radioisotope works are based and have learned from case studies how radioisotopes can be used to obtain meaningful data. They will be aware of the advantages of using radioisotopes in element cycling studies, but also of the risks and open questions related to isotope work.</td>
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<tr>
<td>Content</td>
<td>Radio-isotopes are extensively used at the soil/plant or ecosystem level to quantify the fluxes of elements (phosphorus (P), heavy metals, radionuclides) within a given system and to assess the importance of processes controlling the fluxes (e.g. exchange reactions between the soil solution and the soil solid phase, element turnover through the microbial biomass, organic matter mineralization etc.). The course will present the principles, the basic assumptions and the theoretical framework that underlay the work with radioisotopes. It will present how the introduction of an isotope into a system can be done so as to get information on the structure of the system (e.g. number and size of compartments). Secondly, case studies on isotopic dilution and tracer work will be presented for instance on the isotopic exchange kinetics method to determine nutrients or pollutants availability. The case studies will be adapted to the ongoing research of the group of plant nutrition and will thus give an insight into our current research. In addition, published studies will be analyzed and presented by the students. Finally, the advantages and disadvantages of work with radioisotopes will be analyzed and discussed critically.</td>
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<tr>
<td>Literature</td>
<td>Documents will be distributed during the lecture</td>
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<tr>
<td>Prerequisites / notice</td>
<td>The lecture will take place at the ETH experimental station in Eschikon Lindau. See the location of the station at: <a href="http://www.pe.ipw.agrl.ethz.ch/about/reach">http://www.pe.ipw.agrl.ethz.ch/about/reach</a></td>
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<thead>
<tr>
<th>Number</th>
<th>Current Topics in Grassland Sciences (HS)</th>
<th>W+</th>
<th>2</th>
<th>2S</th>
<th>N. Buchmann</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>Research results in agro- and forest ecosystem sciences will be presented by experienced researchers as well as Ph.D. and graduate students. Citation classics as well as recent research results will be discussed. Topics will range from plant ecophysiology, biodiversity and biogeochemistry to management aspects in agro- and forest ecosystems.</td>
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<tr>
<td>Objective</td>
<td>Students will be able to understand and evaluate experimental design and data interpretation of on-going studies, be able to critically analyze published research results, practice to present and discuss results in the public, and gain a broad knowledge of recent research and current topics in agro- and forest ecosystem sciences.</td>
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<tr>
<td>Content</td>
<td>Research results in agro- and forest ecosystem sciences will be presented by experienced researchers as well as Ph.D. and graduate students. Citation classics as well as recent research results will be discussed. Topics will range from plant ecophysiology, biodiversity and biogeochemistry to management aspects in agro- and forest ecosystems.</td>
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<tr>
<td>Lecture notes</td>
<td>none</td>
<td></td>
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<tr>
<td>Literature</td>
<td>The lecture will take place at the ETH experimental station in Eschikon Lindau. See the location of the station at: <a href="http://www.pe.ipw.agrl.ethz.ch/about/reach">http://www.pe.ipw.agrl.ethz.ch/about/reach</a></td>
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<tr>
<td>Prerequisites / notice</td>
<td>Prerequisites: Basic knowledge of plant ecophysiology, terrestrial ecology and management of agro- and forest ecosystems. Course will be taught in English.</td>
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<table>
<thead>
<tr>
<th>Number</th>
<th>Alternative Crops</th>
<th>W</th>
<th>2</th>
<th>2V</th>
<th>A. Walter, B. Büter, E. A. Pérez Torres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>Few crops dominate the crop rotations worldwide. Following the goal of an increased agricultural biodiversity, species such as buckwheat but also medicinal plants might become more important in future. The biology, physiology, stress tolerance and central aspects of the value-added chain of the above-mentioned and of other alternative crops will be depicted.</td>
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<tr>
<td>Objective</td>
<td>During this course, students learn to assess the potential of different minor or alternative crops compared to the dominant major crops based on their biological and agronomical features. Each student will assess and present a specific alternative crop of his or her choice based on information from scientific articles and Wikipedia. Wikipedia-entries will be generated.</td>
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<tr>
<td>Lecture notes</td>
<td>Documents handed out during the case studies.</td>
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<tr>
<td>Literature</td>
<td>As provided by the case study leaders.</td>
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<tr>
<th>Number</th>
<th>Horticultural Science: Case Studies (HS)</th>
<th>W</th>
<th>2</th>
<th>2G</th>
<th>L. Bertschinger, J. Röstl, V. J. U. Zufferey</th>
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</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>Lectures address 2 horticultural cropping systems and value chains, each one in 4 2h-lecture blocks. Afterwards, the students split in 2 groups for addressing a case study focusing on one of the cropping systems treated before. An excursion to a research site might be included. In a final colloquium, each group presents a report on their case study and their conclusions.</td>
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<td>Objective</td>
<td>Achieve a deepened understanding of horticultural value chain challenges relating to ecological intensification, resource efficiency, climate change and healthy and safe food, and the problem solution strategies and scientific principles behind.</td>
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<tr>
<td>Content</td>
<td>In the autumn semester, the two addressed cropping systems and value chains are fruit-production and viticulture. In the spring semester, the two addressed cropping systems and value chains are vegetable-production- and berry-production or greenhouse-horticulture. The selected topics address challenges with regard to ecological intensification, resource efficiency or climate change and branch into ongoing research and development projects.</td>
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<tr>
<td>Lecture notes</td>
<td>Documents handed out during the case studies.</td>
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<tr>
<td>Literature</td>
<td>As provided by the case study leaders.</td>
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</table>
Agroecosystems and forest ecosystems play a major role in all landscapes, either for production purposes, ecological areas or for recreation. The human impact of any management on the environment is mainly driven by effects on biogeochemical cycles and thus ecosystem functioning, but also about feedback mechanisms of terrestrial ecosystems.

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

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

Handouts will be available on the webpage of the course. For documentation, lecture slides and laboratory protocols will continuously be uploaded to the directory ‘751-5123-00L Rhizosphere Ecology’ on the electronic document exchange platform ILIAS, LDA-ELBA: https://ilias-app2.let.ethz.ch/ilias.php?ref_id=109651&cmd=view&cmdClass=lobcoursegui&cmdNode=et-f&kbaseClass=ilRepositoryGUI
This course provides an overview about the applicability of stable isotopes (carbon 13C, nitrogen 15N, oxygen 18O and water 2H) to

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

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

Remark: The course is designed to be complementary to those on Radioisotopes in Plant Nutrition (751-3405-00L), and Nutrient Fluxes in Soil-Plant Systems (751-3404-00L), although some thematic overlaps cannot be avoided. Special emphasis is given to plant-microbe-soil interactions and an appreciation of whole plant functioning in the ecological context. You will familiarize yourself with bacterial isolation, fundamental aspects of microbial ecology, and the role of microorganisms in various biogeochemical processes. This course provides an overview about the applicability of stable isotopes (carbon 13C, nitrogen 15N, oxygen 18O and water 2H) to process-oriented ecological research. Topics focus on stable isotopes as indicators for the origin of pools and fluxes, partitioning of composite fluxes as well as to trace and integrate processes. In addition, students carry out a small project during lab sessions.

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


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

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

### Functioning of Soil Systems

#### 701-0535-00L Environmental Soil Physics/Vadose Zone Hydrology

**W 3 credits 2G**

**Lecturers**

D. Or

#### Abstract

The course provides theoretical and practical foundations for understanding and characterizing physical and transport properties of soils/near-surface earth materials, and quantifying hydrological processes and fluxes of mass and energy at multiple scales. Emphasis is given to land-atmosphere interactions, the role of plants on hydrological cycles, and biophysical processes in soils.

#### Prerequisites / notice

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

Students are able to
- characterize quantitative knowledge needed to measure and parameterize structural, flow and transport properties of partially-saturated porous media,
- quantify driving forces and resulting fluxes of water, solute, and heat in soils.
- apply modern measurement methods and analytical tools for hydrological data collection
- conduct and interpret a limited number of experimental studies
- explain links between physical processes in the vadose-zone and major societal and environmental challenges

Content

Weeks 1 to 3: Physical Properties of Soils and Other Porous Media
 Units and dimensions, definitions and basic mass-volume relationships between the solid, liquid and gaseous phases; soil texture; particle size distributions; surface area; soil structure. Soil colloids and clay behavior

Soil Water Content and its Measurement - Definitions; measurement methods - gravimetric, neutron scattering, gamma attenuation; and time domain reflectometry; soil water storage and water balance.

Weeks 4 to 5: Soil Water Retention and Potential (Hydrostatics) - The energy state of soil water; total water potential and its components; properties of water (molecular, surface tension, and capillary rise); modern aspects of capillarity in porous media; units and calculations and measurement of equilibrium soil water potential components; soil water characteristic curves definitions and measurements; parametric models; hysteresis. Modern aspects of capillarity

Demo-Lab: Laboratory methods for determination of soil water characteristic curve (SWC), sensor pairing

Weeks 6 to 9: Water Flow in Soil - Hydrodynamics:
Part 1 - Laminar flow in tubes (Poiseuille's Law); Darcy's Law, conditions and states of flow; saturated flow; hydraulic conductivity and its measurement.

Lab #1: Measurement of saturated hydraulic conductivity in uniform and layered soil columns using the constant head method.

Part 2 - Unsaturated steady state flow; unsaturated hydraulic conductivity models and applications; non-steady flow and Richards Eq.; approximate solutions to infiltration (Green-Ampt, Philip); field methods for estimating soil hydraulic properties.

Midterm exam

Lab #2: Measurement of vertical infiltration into dry soil column - Green-Ampt, and Philip's approximations; infiltration rates and wetting front propagation.

Part 3 - Use of Hydrus model for simulation of unsaturated flow

Week 10 to 11: Energy Balance and Land Atmosphere Interactions - Radiation and energy balance; evapotranspiration definitions and estimation; transpiration, plant development and transpiration coefficients small and large scale influences on hydrological cycle; surface evaporation.

Week 12 to 13: Solute Transport in Soils
 Transport mechanisms of solutes in porous media; breakthrough curves; convection-dispersion eq.; solutions for pulse and step solute application; parameter estimation; salt balance.

Lab #3: Miscible displacement and breakthrough curves for a conservative tracer through a column; data analysis and transport parameter estimation.

Additional topics:
Temperature and Heat Flow in Porous Media - Soil thermal properties; steady state heat flow; nonsteady heat flow; estimation of thermal properties; engineering applications.

Biological Processes in the Vadose Zone
An overview of below-ground biological activity (plant roots, microbial, etc.); interplay between physical and biological processes. Focus on soil-atmosphere gaseous exchange; exchange and challenges for bio- and phytoremediation.

Lecture notes
Classnotes on website: Vadose Zone Hydrology, by Or D., J.M. Wraith, and M. Tuller (available at the beginning of the semester)
http://www.step.ethz.ch/education/active-courses/vadose-zone-hydrology

Literature
Supplemental textbook (not mandatory) - Environmental Soil Physics, by: D. Hillel

751-5101-00L Biogeochemistry and Sustainable Management W+ 2 credits 2G N. Buchmann, L. Hörling

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

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

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

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

Lecture notes
Will be discussed in class.

Prerequisites / notice
Prerequisites: Attendance of introductory courses in plant ecophysiology, ecology, and grassland or forest sciences. Course will be taught in English.
Abstract
The seminar concerns current aspects and research related to nutrient cycles in agro-ecosystems. It offers to deepen the knowledge on a specific theme related to nutrients. It is composed by presentations of national and international speakers and by an excursion. The students write a report where they compile the obtained information, relate it to their own knowledge and include literature.

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

Rhizosphere Ecology

Number of participants limited to 18.

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

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

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

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

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

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

Lecture notes
For documentation, lecture slides and laboratory protocols will continuously be uploaded to the directory ’751-5123-00L Rhizosphere Ecology’ on the electronic document exchange platform ILIAS, LDA-ELBA:
https://ilias-app2.let.ethz.ch/ilias.php?ref_id=109651&cmd=view&cmdClass=ilobjcoursegui&cmdNode=el:fv&baseClass=ilRepositoryGUI
This course provides an overview about the applicability of stable isotopes (carbon 13C, nitrogen 15N, oxygen 18O and water 2H) to process-oriented ecological research. Topics focus on stable isotopes as indicators for the origin of pools and fluxes, partitioning of composite fluxes as well as to trace and integrate processes. In addition, students carry out a small project during lab sessions. Marking will consider the efforts and outcome of work by the individual participant as well as results of work in small groups. Activities for the course will result in posters and reports in the format of a conference and scientific paper. Reports will be due on Friday January 6, 2017.

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

### Literature

Will be discussed in class.

### Prerequisites / notice

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

#### 751-5001-00L

**Agroecologists without Borders**

- **W 2 credits**
- **2S**
- **C. Decock, A. Hofmann, J. Six**

**Abstract**

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

**Objective**

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

**Prerequisites / notice**

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

#### 751-5201-00L

**Tropical Soils and Land Use**

- **W 2 credits**
- **2G**
- **J. Six, A. Hofmann**

**Abstract**

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

**Objective**

Lectures and exercises:

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

**Field project:**

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

**Literature**


http://www.fao.org/3/a-i3794e.pdf

FAO (2006) Guidelines for soil description. PDF for Download:

http://www.fao.org/3/a-a0541e.pdf


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

#### 751-3405-00L

**Radio-isotopes in Plant Nutrition**

- **W 3 credits**
- **2G**
- **E. Frossard**

**Abstract**

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

**Objective**

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

**Content**

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

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

**Lecture notes**

Documents will be distributed during the lecture

**Literature**

Will be given during the lecture

**Prerequisites / notice**

The lecture will take place at the ETH experimental station in Eschikon Lindau. See the location of the station at:

http://www.pe.ipw.agri.ethz.ch/about/reach

### General Crop Science

#### Number Title

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<th>Number</th>
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<tr>
<td>751-4203-00L</td>
<td>Horticultural Science: Case Studies (HS)</td>
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**Abstract**

Lectures address 2 horticultural cropping systems and value chains, each one in 4 2h-lecture blocks. Afterwards, the students split in 2 groups for addressing a case study focusing on one of the cropping systems treated before. An excursion to a research site might be included. In a final colloquium, each group presents a report on their case study and their conclusions.
Objective: Achieve a deepened understanding of horticultural value chain challenges relating to ecological intensification, resource efficiency, climate change and healthy and safe food, and the problem solution strategies and scientific principles behind.

Deliver in a team effort a report and a presentation providing a comprehensive insight into a problem of the horticultural value chain and its science-based solution strategy.

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<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>Forum: Livestock in the World Food System</td>
<td>W</td>
<td>2 credits</td>
<td>1S</td>
<td>M. Kreuzer, S. Bauersachs, E. Hillmann, S. Neuenschwander</td>
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Abstract: This platform is for the critical reflection of highly relevant topics of livestock in the frame of the world food system comprising issues from basic knowledge to acceptance in society. The exchange is operated by scientific writing and presentation.

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

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

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

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

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

The preparation of the oral and written presentations takes place to a small part during the 2-h blocks and mainly outside of this time.
The aim of this course is to know and understand animal production systems in the different zones of the tropics taking into consideration BLUP breeding values for smaller examples.

**Lecturers**

S. E. Ulbrich

**Endocrinology and Biology of Reproduction**

Lecture notes

Copies of the slides are available on the net.

**Prerequisites / notice**

Specific literature is indicated by the lecturers.

**Literature**

Handouts/scripts are distributed by the lecturers.

**Prerequisites / notice**

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

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

**Content**

Four main topics in Pig Science:

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

**Lecture notes**

No scriptum

**Prerequisites / notice**

Requirements for allocation of the two credit points:

- Theatre presentation (with handout) at the forum
- Delivery of written documents of sufficient quality
- Active participation during the presentations by the other participants

**Abstract**

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

**Objective**

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

**Content**

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

**Lecture notes**

To be announced in the lectures.

**Literature**

To be announced in the lectures.

**Prerequisites / notice**

- Be able to critically analyze published research data.
- Be able to present precise scientific reports in oral and written form.

**Abstract**

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

**Objective**

Students will

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

**Content**

Four main topics in Pig Science:

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

**Literature**

Specific literature is indicated by the lecturers.

**Prerequisites / notice**

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

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

**Abstract**

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

**Objective**

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

**Content**

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

**Abstract**

Endokrinologie und Reproduktionsbiologie der Säugetiere und des Menschen (Anatomie, Morphologie, Physiologie, Regelmechanismen)

Die Systematik der Reproduktionshormone und der Hormonrezeptoren wird erläutert, die Wirkungsmechanismen (Bildung; orale Bioverfügbarkeit; Elimination) erklärt. Mit diesen Grundlagen wird das Verständnis der Regulation der Fortpflanzung umfassend erörtert.

**Objective**

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

### Ruminant Science

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<tr>
<th>Number</th>
<th>Title</th>
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<tr>
<td>751-7703-00L</td>
<td>Tropical Animal Nutrition</td>
<td>W</td>
<td>1</td>
<td>1G</td>
<td>S. Marquardt</td>
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<tr>
<td>751-613-00L</td>
<td>Endocrinology and Biology of Reproduction</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>S. E. Ulbrich</td>
</tr>
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#### 751-6001-00L

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

**Abstract**

This forum is a platform for the critical reflection of highly relevant topics of livestock in the frame of the world food system comprising issues from basic knowledge to acceptance in society. The exchange is operated by scientific writing and presentation.
Objective
In the Forum "Livestock in the World Food System", a topic of significance for livestock agriculture is selected by the students and subsequently dealt with from various angles (from scientific basis to production systems, environmental aspects and to the acceptance by society). The students learn to present a scientific subject in writing and orally to an audience and to defend the presentation in a discussion.

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

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

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

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

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

Lecture notes
no scriptum

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

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

Abstract
Methods for analysing livestock data, in particular for the estimation of breeding values: principles of selection index, introduction to BLUP, application of common models used, relationship matrix, methods for the estimation of variance components, basics of breeding programs.

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

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

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

Literature
To be announced in the lectures.

751-6501-00L Ruminant Science (HS) W+ 4 credits 4G M. Kreuzer, M. C. Härdi-Landerer, E. Hillmann, U. Witschi

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

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

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

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

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

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

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

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

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

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

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

Abstract
This course broadens the knowledge in one of the most important aspects of ruminant nutrition: the microbial digestion in the rumen (and in the hindgut). For a comprehensive understanding of the rumen microbial ecosystem, the mechanisms of nutrient fermentation and the synthesis of microbial protein, thorough basics are provided. Apart from lectures, group and laboratory exercises are included.
Objective
The course enables students to understand in detail how ruminal digestion works and how this knowledge can be applied to design optimal
feeding diets using highly fibrous forages and a variety of other feeds. The students also are able to show how to modify the most important
rumen microbes beneficially by nutritional means.

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

2 h Introduction and blackboard exercise

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

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

2 h Final seminar

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

Lecture notes
Lecture notes are provided via Moodle.

Literature
Will be communicated at the start of the course.

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

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

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

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

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

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

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

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

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

751-1555-00L Applied Food Industrial Organisation  
W+ 3 credits 2G to be announced

Abstract
Concepts of microeconomics and Industrial Organization and their application to the European food sector. Aspects include industry
structure as well as strategic actions and performance of food sector firms.

Objective
Understanding and application of theoretical concepts along the Structure-Conduct-Performance paradigm. Ability to apply theory to
empirical settings; understand and critically evaluate empirical industrial organization research and to replicate the results of such research
using econometric methods

Content
- Introduction IO
  o Relevant topics for the food sector
  - high competition and market saturation
  - low R&D intensity
  - bargaining power of retailers
  - Private label introduction

- Theoretical Approaches
  o Structure Conduct Performance
  o Market Based View
  o Porters Five Forces
  o Resource Based View
  o Knowledge Based View
    - Empirical Issues (Based on published research papers)
      o Competition / Concentration
      o Profitability
      o Impact of Innovation / R&D
      o Efficiency
      o Market power
      o Econometric Approaches

Literature
Several theoretical and empirical IO related research papers

752-2122-00L Food and Consumer Behaviour  
W 2 credits 2V M. Siegrist, C. Hartmann
752-2307-00L Horticultural Science: Case Studies (HS)

Abstract
This course focuses on food consumer behavior, consumer's decision-making processes and consumer's attitudes towards food products. The course provides an overview about the following topics: Factors influencing consumer's food choice, food and health, attitudes towards new foods and food technologies, labeling and food policy issues.

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

Content
The course gives inputs on compositional changes in food due to processing (with focus on thermal/chilling, enzymatic, chemical, emerging technologies) or new formulation strategies. Possible evaluation methods for these changes (e.g., nutritional profile) will be addressed.

Lecture notes
There is no script. Powerpoint presentations and relevant scientific articles will be available on-line for students. A selection of recommended readings will be given at the beginning of the course.

Prerequisites / notice
The course is open to Master and MAS students in food and science and nutrition or related. Basic knowledge of food chemistry and nutrition is expected, as well as an understanding of food processing.

751-4203-00L Nutritional Aspects of Food Composition and Processing

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

Objective
Students should be able to:
- describe and compare the major concepts /criteria used for the evaluation of the nutritional quality of food
- evaluate recent formulation strategies aimed to achieve additional physiological benefits for targeted population groups (i.e. functional foods).

Content
The course gives inputs on compositional changes in food due to processing (with focus on thermal/chilling, enzymatic, chemical, emerging technologies) or new formulation strategies. Possible evaluation methods for these changes (e.g., nutritional profile) will be addressed.

Literature
Documents handed out during the case studies.

Prerequisites / notice
Good knowledge in biology, especially in microbiology and molecular biology are prerequisites.

751-6001-00L Forum: Livestock in the World Food System

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

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

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

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

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

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

752-5111-00L Gene Technology in Foods

Abstract
This course will increase basic knowledge on biotechnological constructions and application of genetically modified organisms (GMO) which are used worldwide in food production systems. The course discusses health issues, the legislation frame and food safety aspects of GMO applications in agriculture, food production and consumption in Switzerland and EU-countries.

Objective
This course will provide knowledge and biological background on genetically modified organisms (GMO) and food produced with the help of GMO, especially on the molecular basis of GMO constructions with emphasis on genetically modified food in Switzerland and the EU. Criteria of rationale food safety and health assessment in agriculture and food consumption will be elaborated.

Content
Overview on application in gene technology, the gene transfer potential of bacteria, plants and other organisms and the mostly used transgenes in food as well as on GMO used for food production and their detection technologies in food; food safety assessment of GMO food; information on the legislation in Switzerland and EU-countries.

Lecture notes
Copies of slides from lectures will be provided

Literature
Actual publications from literature will be provided

Prerequisites / notice
Good knowledge in biology, especially in microbiology and molecular biology are prerequisites.

751-0021-00L World Food System Summer School

Abstract
Does not take place this semester.

Number of participants limited to 25.
It is necessary to apply and be selected in order to participate in this course. This also applies to ETH Zurich applicants, they will go through a competitive selection process and are not guaranteed a place simply by signing up for the course.

Further information available: http://www.worldfoodsystem.ethz.ch/education/summer-schools/upcoming.html

Abstract

Provide the opportunity for young scientists and practitioners to understand the challenges and opportunities of sustainable agriculture and organic production systems and to connect these to the broader context of the world food system. During the two week summer school at the Gut Rheinau, one of Switzerland's largest organic farms, participants will engage in lectures, workshops, group work, case studies, and field trips. Participants will work with scientists, practitioners, and farmers to develop an understanding of the complex systems that make up the world food system.

Objective

Understand the science, relationships, interactions and trade-offs in food systems; the role and potential of organic production systems; potential interventions; the cultural, socio-political, economic and environmental factors to be incorporated into solutions. Build skills in systems thinking, multi-cultural and multi-disciplinary collaboration, participatory processes. Connect to a network of expert faculty/scientists/practitioners.

Content

The content framework includes the following modules: world food system overview; agricultural production; Global change drivers; smallholder livelihoods and rural development; Agroforest systems; labelling; International policy and trade; Processing, distribution, and retail; Nutrition and health; National policy and state interventions. The course will conclude with a group work on food system challenges.

Literature

Participants will receive pre-reading material before the course commences.

Prerequisites / notice

No prerequisites. Program is open to Masters, PhD and upper level Bachelor students.

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<tr>
<td>701-1543-00L</td>
<td>Transdisciplinary Methods and Applications</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>P. Krüti, M. Stauffacher</td>
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<tr>
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<td>Sustainability Assessment</td>
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to begin with their master thesis:
a. successful completion of the bachelor programme;
b. fulfilling of any additional requirements necessary to
gain admission to the master programme.

Abstract
The Master thesis is an independent scientific work. Normally the subject is selected among the topics of the core subject. It is written under the guidance of an agricultural science professor.

Objective
The independent writing of a scientific paper/thesis

### Agroecosystem Sciences Master - Key for Type

<table>
<thead>
<tr>
<th>Code</th>
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<th>Key for Credits</th>
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<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
<td>E-</td>
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<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
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<tr>
<td>V</td>
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<tr>
<td>G</td>
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<td>U</td>
<td>exercise</td>
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<td>R</td>
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ECTS  European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
**Applied Geophysics Master**

*Courses at ETH Zurich only take place in Spring Semester.*

### Applied Geophysics Master - Key for Type

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<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
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<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
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ECTS European Credit Transfer and Accumulation System

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## Architecture Bachelor

### First Year Basic Courses

### First Year Examinations

### Examination Block 1

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<tr>
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<tr>
<td>051-0111-00L</td>
<td>Architecture I</td>
<td>O</td>
<td>1</td>
<td>2V</td>
<td>C. Kerez, H. Frei</td>
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</tbody>
</table>

**Abstract**

In a series of lectures aspects of the architectonical space will be exemplified and put into a theoretical context.

**Objective**

Training of a conscious perception and a conceptual understanding of the architectural space as well as techniques for its representation.

**Content**

In a series of lectures aspects of the architectonical space will be exemplified and put into a theoretical context.

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<tr>
<td>051-0151-00L</td>
<td>Architectural Technology I</td>
<td>O</td>
<td>1</td>
<td>2V</td>
<td>A. Spiro, D. Fiederling</td>
</tr>
</tbody>
</table>

**Abstract**


**Objective**

Knowledge of construction principles and its history. Cognition of correlation between concept, buildings structure, material and form.

**Content**

In the triad of typology, topology and tectonics, the latter is the primary focus of the theoretical discourse. The series of lectures identifies the most disparate tectonic principles which transcend time and geography, and elucidates the reciprocally generative parameters of construction, technology and form. The lectures theme convey fundamental concrete constructional and practical knowledge and concentrate on the guidance of the basic exercises (Architectural Technology I + II).

<table>
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<tbody>
<tr>
<td>051-0211-01L</td>
<td>Architecture and Art I</td>
<td>O</td>
<td>1</td>
<td>2V</td>
<td>K. Sander</td>
</tr>
</tbody>
</table>

**Abstract**

Theory and practice in the visual arts: Artistic thinking and practice.

**Objective**

Independent artistic thinking. Acquisition of artistic criteria.

**Content**

Reflection of visual contents and phenomena. Examination of current positions in art.

### Examination Block 2

<table>
<thead>
<tr>
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<td>051-0411-00L</td>
<td>Structural Design I</td>
<td>O</td>
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<td>4G</td>
<td>P. Block, J. Schwartz</td>
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</table>

**Abstract**

The course is an introduction to structural design using graphical methods and structural models, with a focus on a creative approach rather than repetitive calculations. Cable and membrane structures, arch and shell structures and combined arch and cable systems will be used to demonstrate these methods.

**Objective**


**Content**

After a general introduction of basic concepts, structural systems such as cable and arch structures will be analyzed with the help of graphic statics. The students will learn to understand the flow of forces in a structural system in relation to the system’s form. They will be able to modify this force flow and give dimension to the structural components.

**Lecture notes**

on eQuilibrium

http://www.block.arch.ethz.ch/eq

and

http://http://www.schwartz.arch.ethz.ch/

**Literature**

"Faustformel Tragwerkselement" (Philipp Block, Christoph Gengangel, Stefan Peters, DVA Deutsche Verlags-Anstalt 2013, ISBN: 978-3-421-03904-0)

Weiteres Lernmaterial:

"Form and Forces: Designing Efficient, Expressive Structures"


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<th>ECTS</th>
<th>Hours</th>
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<tbody>
<tr>
<td>051-0853-00L</td>
<td>Building Materials I</td>
<td>O</td>
<td>2</td>
<td>2V</td>
<td>J. Carmeliet, M. Koebel, O. von Trzebiatowski, F. Winnefeld, T. A. Zimmermann Schütz</td>
</tr>
</tbody>
</table>

**Abstract**

Building Materials - Structure, Quality, Usage

concrete and other mineral materials
metals, wood, glass and polymers
ecological aspects

**Objective**

The lecture describes the fundamental properties of the most important construction materials: concrete and other mineral materials, metals, wood, glass and polymers. Furthermore, the content includes the relevant ecological aspects such as availability of raw materials, effort for production, emission of hazardous substances, disposal and recycling are treated as well.

**Content**

The lecture describes the fundamental properties of the most important construction materials: concrete and other mineral materials, metals, wood, glass and polymers. Furthermore, the content includes the relevant ecological aspects such as availability of raw materials, effort for production, emission of hazardous substances, disposal and recycling are treated as well.

<table>
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<tr>
<td>051-0811-00L</td>
<td>Sociology I</td>
<td>O</td>
<td>1</td>
<td>2V</td>
<td>C. Schmid</td>
</tr>
</tbody>
</table>

**Abstract**

Sociology I investigates the relation between social developments and the production of the built environment from a macro-sociological point of view. It examines central aspects of social change, historical and present-day forms of urbanization, and typical examples of models of urbanization.

**Objective**

This series of lectures should enable students to comprehend architecture in its social context. It approaches the architectural profession from two different angles: macro-sociological and micro-sociological.
Sociology I deals with the macro-sociological point of view, and investigates the relation between social developments and the production of the built environment. In the first part some central aspects of social change are examined in particular the transition from Fordism to Postfordism and from Modernism to Postmodernism, and the interlinked processes of globalization and regionalization. The second part deals with historical and present-day forms of urbanization. Among other aspects treated here are the changed significance of urban-rural contrasts, the processes of suburbanization and periurbanization, the formation of global cities and metropolitan regions, the growth of new urban configurations in centres (gentrification) and on urban peripheries (edge city, exopolis). In the third part these general processes are illustrated by typical models of urbanization.
Addresses construction as integrating component of design processes, including considerations based on contemporary case studies.


Architectural Technology I (2-Semester Course, Exercise)  
Lecturers: D. Eberle
ECTS: 2V

How did cities develop into the cities we live in now? Which urban plans, instruments, political decisions, economic reasonings, and problems and with the conflicts that have evolved over time. Knowledge and understanding along with a critical observation of the lifecycle. That is true for the physical environment, but also for non-physical aspects, the imaginary city that exists along with its potentials and its properties, of construction principles and their specific application as well as of planning and production processes on the form as the end result will be elaborated theoretically in a series of lectures.

First and Second Year Basic Courses

Second and Third Year Basic Courses

Examination Blocks

Examination Block 1

Urban Design I  

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Further information is available at http://www.hertig.ethz.ch/education/gz-des-rechts-fuer-architektur.html

### Examination Block 2

Students are free to take the exam either in German or in French. They may choose between 851-0710-00L Introduction to Law for Civil Engineering and Architecture or 851-0709-00L Introduction to Civil Law (French).

<table>
<thead>
<tr>
<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>051-0413-00L</td>
<td>Structural Design III</td>
<td>O</td>
<td>3 credits</td>
<td>3G</td>
<td>J. Schwartz, P. Block</td>
</tr>
<tr>
<td>Abstract</td>
<td>After a review of essential facts from the first year the course will be examine the interplay of architectural concept and structural system by analyzing buildings of exemplary quality. The focus will be on the integration of specifics of structural systems made out reinforced concrete or steel into architectural design.</td>
<td></td>
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<tr>
<td>Objective</td>
<td>Students are enabled to integrate essential characteristics of structural systems made out reinforced concrete or steel into their architectural design.</td>
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<tr>
<td>Content</td>
<td>After a review of essential facts from the first year the course will be examine the interplay of architectural concept and structural system by analyzing buildings of exemplary quality. The focus will be on the integration of specifics of structural systems made out reinforced concrete or steel into architectural design.</td>
<td></td>
<td></td>
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<tr>
<td>Literature</td>
<td>All material is provided online (<a href="http://www.carmeliet.arch.ethz.ch/Education/">http://www.carmeliet.arch.ethz.ch/Education/</a> with Building Physics II: Moisture in the Documents section). The course syllabus can be bought at the Chair of Building Physics.</td>
<td></td>
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<tr>
<td>Prerequisites / notice</td>
<td>Prior knowledge of &quot;BP I: heat&quot; is required.</td>
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| 051-0519-00L | Building Physics II: Moisture | O | 3 credits | 3G | J. Carmeliet, T. Defraeye |
| Abstract | 70% of all construction problems are related to moisture. This course aims at providing the necessary theoretical background in order to foresee and avoid these problems. |
| Objective | to develop a basic understanding of mass transport and buffering to become aware of potential moisture-related damage and health risks to learn how to (i) design building components and (ii) assess their hygrothermal performance |
| Content | hygrothermal loads conservation of mass dry air: constitutive behaviour, transport, potential problems and solutions moist air: constitutive behaviour, transport, potential problems and solutions liquid water: constitutive behaviour, transport, potential problems and solutions moisture-induced degradation processes case studies exercises |
| Lecture notes | Handouts, supporting material and exercises are provided online (http://www.carmeliet.arch.ethz.ch/Education/ with Building Physics II: Moisture in the Documents section). The course syllabus can be bought at the Chair of Building Physics, |
| Literature | All material is provided online (http://www.carmeliet.arch.ethz.ch/Education/ with Building Physics II: Moisture in the Documents section) |
| Prerequisites / notice | Prior knowledge of "BP I: heat" is required. |

| 051-0551-00L | Energy- and Climate Systems I | O | 2 credits | 2G | A. Schlüter |
| Abstract | The lecture series focuses on the physical principles and technical components of relevant systems for an efficient and sustainable climatisation and energy supply of buildings. A special focus is on the interrelation of supply systems and architectural design and construction. Learning and practicing methods of quantifying demand and supply allows identifying parameters relevant for design. |
| Objective | 1. Introduction 2. Heating and cooling 3. Active and passive ventilation 4. Electricity in buildings |
| Literature | The Slides from the lecture serve as lecture notes and are available as download. A list of relevant literature is available at the chair. |

| 851-0703-01L | Introduction to Law for Architecture | W | 2 credits | 2V | G. Hertig |
| Abstract | Students who have attended or will attend the lecture "Introduction to Law for Civil Engineering *" (851-0703-03L) cannot register for this course unit. |
| Objective | This class introduces students to basic features of the legal system. Questions of constitutional and administrative law, contract law, tort law, corporate law, as well as litigation are covered. |
| Literature | There are 'Lecture Notes' (in German) for this course. Further information is available at http://www.hertig.ethz.ch/education/gz-des-rechts-fuer-architektur.html |

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The course Private Law focuses on the Swiss Code of Obligations (contracts, torts) and on Property Law (ownership, mortgage and easements). In addition, the course will provide a short overview of Civil Procedure and Enforcement.

Objective

Content
Le cours de droit civil porte notamment sur le droit des obligations (droit des contrats et responsabilité civile) et sur les droits réels (propriété, gages et servitudes). De plus, il est donné un bref aperçu du droit de la procédure et de l'exécution forcée.

Literature
Editions officielles récentes des lois fédérales, en langue française (Code civil et Code des obligations) ou italienne (Codice civile e Codice delle obbligazioni), disponibles auprès de la plupart des bibliothèques.

Sont indispensables:
- le Code civil et le Code des obligations;
- Sont conséquents:
  - Nef, Urs Ch.: Le droit des obligations à l'usage des ingénieurs et des architectes, trad. Bovay, J., éd. Payot, Lausanne
  - Boillod, J.-P.: Manuel de droit, éd Statkine, Genève

Prerequisites / notice
- Le cours de droit civil et le cours de droit public (2e sem.) sont l'équivalent des cours "Recht I" et "Recht II" en langue allemande et des exercices y relatifs.
- Les examens peuvent se faire en français ou en italien.
- Examen au 1er propédeutique; convient pour travail de semestre.

#### Examination Block 3

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<tr>
<td>051-0311-00L</td>
<td>History of Art and Architecture III</td>
<td>O</td>
<td>2</td>
<td>2V</td>
<td>L. Stalder</td>
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<tr>
<td>051-0363-00L</td>
<td>History of Urban Design I</td>
<td>O</td>
<td>2</td>
<td>2G</td>
<td>V. Magnago Lampugnani</td>
</tr>
<tr>
<td>051-0351-00L</td>
<td>Building Archeology and Conservation I</td>
<td>O</td>
<td>2</td>
<td>2V</td>
<td>S. Holzer</td>
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</tbody>
</table>

### History of Urban Design I

**Abstract**
The two-semester course offers an introduction to the history and theory of architecture from the industrial revolution up to now. Based on current questions a variety of case studies will be discussed.

**Objective**
The aim is to give an overview on crucial events, works of art, buildings and theories since the beginning of the 19th century up to today. The course should enhance the comprehension of historical and theoretical issues, and allow the students to localize their own practice within a broader historical context.

**Content**
The subject of this lecture course is the history and theory of architecture since the beginning of the 19th century up to now. It examines the architectural answers to the changing technical inventions and social practices. Consequently, the focus will be less on individual architects or buildings than on various themes that determined the architecture of the period.

**Lecture notes**
http://www.stalder.arch.ethz.ch/courses

**Literature**
- Examen au 1er propédeutique; convient pour travail de semestre.

- Notice
  - Aperçu sur HIL D 75.2 en 2016, L. Stalder

- Notice
  - Course "HIL D 75.2", L. Stalder

### History of Art and Architecture III

**Abstract**
The lecture covers the time from the beginning of urban culture until the mid 19th century. With selected examples it emphasizes on the relationships and the mechanisms that exploit the economics of real estate and the influence of building technology. Intellectual, literary or artistic modes of thought will also be assessed with regard to their impact on urban development. Urbanism has its own distinctive approach as a discipline, but it is also clearly responsive to the influence of related disciplines. Study is made of actual cities and urban expansion plans which are in the process of implementation, as well as unrealized projects and visions of the future. These projects sometimes illustrate ways of thinking that are equal to, or clearer than, actual urban situations.

**Objective**
The course should enhance the comprehension of historical and theoretical issues, and allow the students to localize their own practice within a broader historical context.

**Content**
In the first semester an introduction to the discipline and the methods are given along the thematic issues from the beginning of urban culture until the mid-19th century.

01. Introduction to the discipline and method: The history of urban design as a historical project
02. Athens and Rome in the ancient world: Myth, self-portrayal and speculation
03. From the spirit of equality to the colonial module: Greek and Roman City foundings
04. From the urban ideal to new cities in the Middle Ages and the Renaissance
05. Baroque strategies: The new organisation of Rome under Sixtus V, the production of Versailles under Louis XIV and the invention of St. Petersburg
06. The city between Absolutism and Enlightenment: baroque defence-designs, the European colonization of the American continent and the reconstruction of Lisbon
07. Ideology and speculation after the Glorious Revolution: landscapegardens and urban figurations in England from 1650-1850
08. Between modernization, Grandeur and repression: Embellishment in Paris from 1750-1830
09. The construction of the bourgeois city: Georges-Eugène Haussmann transforms Paris into the capital of the 19th century
10. Architectural insertion and plan for the expansion of the city: From the Berlin of Karl Friedrich Schinkel to James Hobrecht
11. Neoabsolut power, bourgeois self-confidence and Marxian Idealism: The Viennese Ringstrasse and Ildefonso Cerdas Ensanche for Barcelona

**Lecture notes**
The lectures are accompanied by a script (two semesters of the bachelor studies), that can be purchased at the chair for the history of urban design (HIL D 75.2) at the price of CHF 30.-. The script serves as an auxiliary means to the attended lecture compiling the most important illustrations showed and the names and dates of the buildings and its builders along with a short introductory note.

**Literature**
Further recommended literature to consult is listed within the script.

**Prerequisites / notice**
- Notice
  - Course "HIL D 75.2", L. Stalder

- Notice
  - Course "HIL D 75.2", L. Stalder

### Building Archeology and Conservation I

**Abstract**
Building archeology is an approach that provides in-depth insight into the historical documentary evidence provided by the traces of production, use, ageing, and repair which are preserved in a historical building. Based on an attentive reading of these traces, adequate methods of conservation and rehabilitation can be devised.

**Objective**
The students have a basic knowledge of the historical evolution of constructions. They are familiar with the techniques of documentation, analysis and interpretation of relevant features of historic buildings. They have basic knowledge of the history and theory of monument conservation. They are able to assess different measures of conservation and intervention.
Content

Historic buildings are historic documents testifying to the living conditions and mindset of our ancestors. They complement other historic sources such as written documents and pictorial records. They are important testimony to the history of art, science, and social conditions. Furthermore, historic monuments constitute important landmarks. Every generation develops its own attitude towards their artistic expression. In western civilizations, there is a general consensus on the conservation of historic architecture. The architect is often at the forefront of interventions in the immediate context of historic buildings, both as a designer of new buildings adjacent to historic ones and as a conservationist. The present lecture strives to enable him to cope with these tasks competently and adequately.

Part I of the lecture series deals with constructions in natural and artificial stone as well as concrete: stoneworking, masonry, arches, vaults, foundations.

 Examination Block 4

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<tr>
<td>051-0125-00L</td>
<td>Architecture V</td>
<td>O</td>
<td>1 credit</td>
<td>3V</td>
<td>P. Ursprung</td>
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</table>

Abstract

History of Art and Architecture since the 1970s

Objective

The course target is to let the students gain an overview of a line of formative occurrences, works of art, buildings and theories from the early nineteen-seventies. The students should become sensitive for questions and problems in the field of history and theory and they should increasingly be able to relate their own praxis with historical relations and conflicts which in turn help to understand historical dynamics. The course “Lehrcanapé” (one hour) is part of the course and treats alternative methods of teaching and learning.

Lecture notes

http://www.ursprung.arch.ethz.ch/courses

051-0155-00L

Architectural Technology V

Abstract

The lecture series explores the correlation among intentions of design, architectonic expression and construction premises. These critical areas or aspects of study, which are presented with selected projects, their respective theoretical backgrounds and historical development, are pluralistically associated and brought into relation with varying contemporary opinion.

Objective

The final part of the lecture series Konstruktion V/VI aims to analyse (structural) construction techniques and their formal appearance and expression in their interrelation. The different themed parts of structural design, building shell and knowledge of material get connected with architectural design in practice and reflected in the wider context of architectural theory. The intention is to consolidate the understanding of the connection between structure, process and formal appearance and expression in the architecture of the 20th century.

Content

The lecture series in the course entitled Architecture and Construction explores the correlation among intentions of design, architectonic expression and construction premises. Each lecture is focused on individual themes, as for example, the application of certain materials (glass, or natural stone), of particular construction systems (tectonic, hybrid) or design generators (grids, series) and alternatively the search for a definable, tangible architectural expression (vernacular architecture, ready-mades). These critical areas or aspects of study, which are presented with their respective theoretical backgrounds and historical development, are pluralistically associated and brought into relation with varying contemporary opinion. The yearlong lecture cycle is comprised of twenty individual lectures, in which the majority of projects being analyzed date from the last few decades.

Lecture notes

no script

Literature

list of literature per lecture

Prerequisites / notice

General remarks (on exam as well as exam preparation)

The comprehensiveness of the lectures are the subject matter of the exam. The lectures are scheduled for a full year (Konstruktion V/VI) and therefore the knowledge of the subject matter of the running as well as of the preceding semester's lectures is required. To improve your chances to pass the examination at first try, we strongly recommend you to take the exam after having visited the lecture during two semesters. If you are an exchange student, or a student from a different department and wish to take a partial examination covering only the subject matter of the last semester (Konstruktion V or VI), you need to contact the chair in advance.

The brochures published by the chair offer additional help. Knowledge of these brochures and their key subjects is recommended for the exam. The brochures can be ordered at the chair after the last lecture before the exam. However, the subject matters of the brochures and the lectures are not identical, the brochures provide information for a deeper understanding of the lectures. Apart from additional articles written by the chair, the brochures are composed of three modules: Project documentation, crucial texts on the work reception as well as theoretical articles about the particular thematic priorities by various authors. Concerning their content these anthologies allow insights into a wide range of theories, lines of reasoning and fields of research up to diverging point of views of specific problems.

051-0615-00L

Design and Strategies in Urban Space I

Abstract

Means and potentials of urban design are depicted from different perspectives to illustrate how the city can be designed as a sustainable and humane environment. For this purpose general basic principles and specific methods of urban design are going to be presented. The lectures will be given by members of the chair and invited speakers.

Objective

This lecture series imparts advanced expertise in urban planning. The main focus is to illustrate the complex manner in which various themes are embedded in the everyday practice of planning and design by addressing pressing questions of contemporary urban design practice and theory. The goal is to communicate a broad-based systemic knowledge base, which helps enable students to synthesize and evaluate complex urban design and planning problems.

Content

The fall semester introduces the notion of strategic design and imparts further knowledge about the structure and models of the contemporary city. It is structured in two parts:

Part 1: Strategic Design

The first part of the lecture series imparts general basics to understand the city and the field of urban design. Different approaches and methods of analysis are presented, the dealing with uncertainty in planning is addressed and practical methods of urban design are identified.

Part 2: Structures and Models

Urban space is shaped on different levels. The city ground plan, the relationship between public and private space, the infrastructure and mobility needs as well as various spatially relevant stakeholders offer the basic means to steer the development. The second part of the lecture series is dedicated to these structures of the city and to the models describing them.

Lecture notes

There is no script accompanying the lecture series. At the end of the semester the lecture slides and at the end of the 3rd year course a reader with secondary literature will be available for download on the homepage of the chair of architecture and urban design:

http://www.christiaanse.arch.ethz.ch

Literature

At the end of the 3rd year course a reader with secondary literature will be available for download on the homepage of the chair of architecture and urban design:

http://www.christiaanse.arch.ethz.ch

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Autumn Semester 2016
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Examination Block 5

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<tr>
<th>Number</th>
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<tr>
<td>051-0115-00L</td>
<td>Theory of Architecture I</td>
<td>O</td>
<td>1</td>
<td>2V</td>
<td>A. Vronskaya</td>
</tr>
<tr>
<td>Abstract</td>
<td>Understanding of the historic development and critical discussion of various intellectual contexts of architectural theory.</td>
<td></td>
<td></td>
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<tr>
<td>Objective</td>
<td>Architectural theory emerged as a product of the Renaissance worldview, which was both holistic and critical. Having developed alongside science, it shared the former's principles and premises. It aimed to explain the objective laws of beauty and to develop rules for their creation by architectural means. In the early twentieth century, modernism supplanted Classical architectural theory and attempted to replace it with the methods and axioms of the most cutting-edge branches of science, including engineering and psychology. Modernism's own principles were, however, soon condemned and rejected by its discontents. From the early 1970s onward, a variety of approaches have dominated architecture, none of them able to become its primary theory. Today, architectural theories no longer prescribe the rules of design. Instead, they offer solutions to the different problems that society poses for architecture, relying on methods and approaches of fields of inquiry that directly relate to these problems. In the course of the semester, we will seek to delineate this elusive space of contemporary architectural theory within the various intellectual contexts in which it operates in order to understand its role in architectural practice. The readings will introduce architectural theories written at different historic periods, while the lectures will situate them both theoretically and historically.</td>
<td></td>
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</tr>
<tr>
<td>Content</td>
<td>The building process is the main focus of this lecture series. The process is understood as a sequence of criteria in time. These criteria are divided into acquisition and building legislation, building economics and facility management, the people involved and their work, construction and planning organization. Process thinking and a glance at our foreign neighbours complete the series.</td>
<td></td>
<td></td>
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<tr>
<td>Lecture notes</td>
<td>Literaturempfehlungen unter <a href="http://www.bauprozess.arch.ethz.ch">www.bauprozess.arch.ethz.ch</a>.</td>
<td></td>
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<td>Literature</td>
<td>Sacha Menz (Hrsg.), Drei Bücher über den Bauprozess, vdf Hochschulverlag an der ETH Zürich, 2009</td>
<td></td>
<td></td>
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</tbody>
</table>

051-0757-00L Building Process I O 2 credits 2G S. Menz

Abstract
The building process is the main focus of this lecture series. The process is understood as a sequence of criteria in time. Targets: Acquisition and building legislation, building economics and facility management, the people involved and their work, construction and planning organization. Process thinking and a glance at our foreign neighbours complete the series.

Objective
Alongside a discussion of the basic principles, trends and terminologies, a closer look will be taken at each topic using case studies that investigate current structures as well as those relevant in terms of architecture and urban design. Active participation as well as interdisciplinary and process-oriented thinking on the part of students is a prerequisite.

Content
The building process is the main focus of this lecture series. The process is understood as a sequence of criteria in time. These criteria are divided into acquisition and building legislation, building economics and facility management, the people involved and their work, construction and planning organization. Process thinking and a glance at our foreign neighbours complete the series. Alongside a discussion of the basic principles, trends and terminologies, a closer look will be taken at each topic using case studies that investigate current structures as well as those relevant in terms of architecture and urban design. Active participation as well as interdisciplinary and process-oriented thinking on the part of students is a prerequisite.

Literature
Handouts and a reading list will be provided.

051-0161-00L Landscape Architecture I O 1 credit 2V C. Girot

Abstract
Introduction to the history and theory of garden design and landscape architecture. Analysis of the design of historical gardens and landscapes within the cultural background.

Objective
The course covers the basic history and theory of garden design and landscape architecture from its beginnings to the 21st century. The course aims to raise awareness of a changing perception of nature and landscape.

Content
The lecture series on History and Theory of Garden Design and Landscape Architecture deals with the historical development of designed nature, from the beginnings of cultural landscapes and gardens to 21st century landscape architecture. In the analysis of each era, the focus is on the spatial and cultural relationship between the garden, the city and the landscape, as well as the changing perceptions of nature and its representation.

Literature
Handouts and a reading list will be provided. A reading list will be provided for the exams. General Information for the final exam: Bachelor students: The content of the lectures as well as texts and exam-relevant literature provided by the Chair make up the basis for preparing for the exam. The lecture series is conceived as a yearlong course. Since the written session examination will test knowledge from both semesters, it is necessary to fully attend the lectures of both courses "Landscape Architecture I" and "Landscape Architecture II." The themes of the examination will be announced at the end of the semester. The Chair will provide literature and texts available for download as pdfs. These allow a more in-depth understanding of the lecture material.

Exchanges of students or students from other departments: Students, who are attending only one semester, may pass the oral end-of-semester examination. Test-relevant literature will also be made available for download for this purpose. The students are requested to get in touch by email with the Chair.

Architectural Design and integrated Disciplines
Architectural Design
Architectural Design (3. Semester)
The design course is built on various exercises. During Fall Term, the students are concerned with the conversion and densification of existing building structures at three different sites in Zurich.

Conveying a way of thinking that is also able to understand complex contexts and act on various levels is one of the focuses of the chair. This networked thinking relates to praxis and educates the students to be competent architects.

Achieving this goal requires a method that teaches a clearly structured, precisely formulated approach and communicates the simultaneity of complex tasks and processes.

The design course is built on four exercises. Based on the existing buildings, the themes Place, Structure and Shell are being examined - first separately and then combined in a final project. The extension and densification of existing building structures are being carried out at three different sites in Zurich; the new use is planned for work and living.

The exercises are divided into a City Level and a House Level. At the City Level a group of students examines the three building sites according to each theme. At the House Level the students develop designs addressing the themes in groups of two.

Dietmar Eberle, Pia Simmendinger, From city to house - a design theory, gta Verlag 2007

At the beginning of our investigation, based on different depths of buildings (6 to 21m), we formulate first basic rules of supporting-, room- and local public infrastructure for apartments. Based hereon and still without context we design a idealtypic apartment building with apartments of different size. Only after catching the rules of the building systematically, the urbanistic context and the front of the building will be introduced into the design process. This approach to the design task allows a self-supporting research of structural and living specific questions, this without being distracted rashly from outer inherent necessities.

The target of the design work is to improve and widen the basic knowledge of domestic architecture and housing and also to get to the bottom of former ideas.

The aim of the course is to reinforce the sensibility for such a broad attitude and at the same time to develop the skills for its application. To deal with the reality of construction and material is thereby an important concern.

The networked thinking relates to praxis and educates the students to be competent architects.

The exercises will involve design and construction, from the definition of a concept to the execution of the detailed work. Work will include procedural methods for spatial designs through form, function, technology, and materials. To promote interdisciplinarity through integrated teaching.

Exercises will involve design and construction, from the definition of a concept to the execution of the detailed work. Work will include procedural methods for spatial designs through form, function, technology, and materials. To promote interdisciplinarity through integrated teaching.

At the beginning of our investigation, based on different depths of buildings (6 to 21m), we formulate first basic rules of supporting-, room- and local public infrastructure for apartments. Based hereon and still without context we design a idealtypic apartment building with apartments of different size. Only after catching the rules of the building systematically, the urbanistic context and the front of the building will be introduced into the design process. This approach to the design task allows a self-supporting research of structural and living specific questions, this without being distracted rashly from outer inherent necessities.

Architectural Design (from 5. Semester on)

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<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
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<td>Please register (<a href="http://www.mystudies.ethz.ch">www.mystudies.ethz.ch</a>) only after the internal enrolment for the design classes (see <a href="http://www.einschreibung.arch.ethz.ch/design.php">http://www.einschreibung.arch.ethz.ch/design.php</a>).</td>
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<td>These days architecture is affected by increasingly similar images. We want to turn to another reality - the place. The strengthening of the singularity of each place is the promise for an overall more differentiated living space.</td>
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<td>In this semester we concentrate on the «ensembles» in the village of Malans in Graubünden. We seek to reinforce them through new houses and functional buildings.</td>
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<td>Architecture requires a fine perception of the existing and a brave vision for the future. The condition for both is a firm attitude coming out of a living collective.</td>
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<td>Prerequisites / notice</td>
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<td>Ausführliches Semesterprogramm: <a href="http://www.caminada.arch.ethz.ch">www.caminada.arch.ethz.ch</a></td>
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<td>Several contradictory notions of 'burda' will guide us through a semester that regards itself as a search for the textile, raw, ephemeral, adaptable, and sensual space. The students participating in the atelier will design three autonomous projects in various scales.</td>
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<td>Design skills in different parts of architecture and urbanism.</td>
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Develop various analytical and notation techniques for understanding culturally/ideologically molded architectural landscape: theoretical

Both contradictory notions of 'burda' will guide us through a semester that regards itself as a search for the textile, raw, ephemeral, adaptable, and sensual space. The students participating in the atelier will design three autonomous projects in various scales.

Burda (from Wikipedia, the free encyclopedia, 2016) Burda Style (formerly: Burda Moden) is a fashion magazine published in 17 different languages and distributed in over 99 countries. It was founded in 1950 by Aenne Burda and is published today by Hubert Burda Media. The magazine appears monthly and contains patterns to sew women's and children's clothes, at time also mens clothes.


Abstract
In the studio we will move between a landscape of ideas and the actual built landscape in East Germany, between visions and shrinking cities, between different social systems and layers of time with the goal of recovering interesting concepts from failed plans.

Objective
Develop various analytical and notation techniques for understanding culturally/ideologically molded architectural landscape: theoretical discussion of the social and architectural types of socialism with visionary potential; critical evaluation of compiled instruments; designing relevant architecture through examination of East Germany.

Content
"Draw from the heavens to the drawing board", this quote - the title of an essay collection by East German architect Herman Henselmann - speaks of the euphoria, the optimism of progress, and the belief in the messianic potential of architecture and city planning characteristic of the early years of the GDR (1). Particularly when it was a young socialist state, the hope reigned that a better and more equal society could be developed through urban planning and architecture. The many socialist utopias are products of this revolutionary thinking. As the state actually developed, however, an ever-greater disillusionment grew instead. The initial hope dimmed in the face of authoritarian government and economic mismanagement. Since reunification, consensus has been that the GDR's system and its social visions have failed - a condemnation that is now being questioned.

In the studio we will pursue the assumption that many of the hopeful utopian approaches and social attitudes upon which the socialist types were based could still be of interest today. In this sense, we will move between a landscape of ideas and the actual built landscape, between visions and shrinking cities, between different social systems and layers of time with the goal of recovering interesting concepts from failed plans.

The first step will be an archaeological investigation of the utopian fragments within the ruins of former visions, assembling an inventory of projects and socialist types with visionary potential. In a critical reflection from a contemporary perspective, the content of the architectural imprint of socialism is to be explored in order to find tools for dealing with today's territories of emigration and economic collapse.

In this way, could it be possible to develop a future for East Germany and elsewhere that doesn't put a false 'heaven' of growth and repopulation back on the drawing board, but rather, considerately and critically continues the past trajectory in a new light? Could we develop both visionary and pragmatic architectural interventions that enliven the landscape without actually imagining that it flourishes? (2)

The objective of the studio is to develop a realistically workable architectural proposal, addressing questions of urban context and
This semester we will be designing a future-oriented, sustainable accommodation complex on the rural west coast of Greece. The ambition
The goal is to communicate a broad-based systemic knowledge base, methodologies and strategies, which helps to enable students to
This part of the curriculum addresses design work in different areas of architecture and urbanism and integrates the knowledge acquired in
Architectural Design V-IX: Amsterdam Waterfront (K. Christiaanse) Please register (www.mystudies.ethz.ch) only after the internal enrolment for the design classes (see http://www.einschreibung.arch.ethz.ch/design.php).
The chair offers the integrated discipline Construction within the course. Additionally, the integrated disciplines Architecture and Building
Prerequisites / notice
051-1121-16L Architectural Design V-IX: A Policy Whispering Practice (GD P. Swinnen) Please register (www.mystudies.ethz.ch) only after the internal enrolment for the design classes (see http://www.einschreibung.arch.ethz.ch/design.php).
Abstract
Our 2016 fall semester will focus on the social and spatial possibilities of massive energy production in dense and socially challenged areas; investigating how architectural strategies of energetic abundance can produce unseen yet fruitful concepts for metropolitan cohabitation. The first testing site will be Brussels.
Objective
As a studio we are interested in educating future architects who understand that architecture is by definition a political practice, and that the architect must become a vigorous policy-whisperer, if anything.

Data: 06.03.2019 12:57 Autumn Semester 2016 Page 93 of 1571
The aim of this term is to enable and assist students to take charge of their own design process. Our thematical focus lies on sacral and monumental landscapes.

Architectural Design: Apartment Building, Scale and City Shape (M. Peter / C. Dumont d'Ayot) 051-1129-16L

Architectural Design: Hermitage (GD Van Hee) 051-1131-16L

Architectural Design V-IX: Arrival "Stadtwald" Cable Car Stettbach-Zurich 051-1125-16L

Architectural Design V-IX: Topic (N.N. Professor) 051-1133-16L

Architectural Design V-IX: Ljubljana. A Collection of Alpine Landscapes (Vogt) 051-1135-16L

Internal enrolment for the design classes (see http://www.einschreibung.arch.ethz.ch/design.php).

Data: 06.03.2019 12:57 Autumn Semester 2016 Page 94 of 1571
**Abstract**
The Alps as Common Ground

With each design semester the Chair of Professor Vogt is working its way around the Alpine arc with the thesis that it can be read as an urban Common Ground. The task of each design semester is to verify this thesis by focusing on a metropolitan region and enquiring as to its specific relationship with the Alps.

**Objective**
Independent thinking and acting.

**Content**
The Alps as Common Ground

With each design semester the Chair of Professor Vogt is working its way around the Alpine arc with the thesis that it can be read as an urban Common Ground. The task of each design semester is to verify this thesis by focusing on a metropolitan region and enquiring as to its specific relationship with the Alps.

In the coming semester we shall be working with the urban territory of Ljubljana, which covers besides the high alpine landscapes (the Julian Alps, the Karavanks, the Kamnik Alps) three more alpine regions: the Dinarides (Karst), the Pannonian Basin and the Mediterranean Coast. Geographically almost the whole territory of Slovenia could be seen a part of Alps.

Though this supposed ubiquity of the Alps, the correlation to Ljubljana remains diffuse. This is linked to the geopolitical location of the region, which was constantly changing its territorial belonging to the neighboring great powers throughout history. Moreover, the emerging industrialization in the beginning of the century and the development of the transit axis were leading to population decrease in the high alpine area. This weakened their position compared to the lower districts considerably. Looking at major infrastructure projects that are planned like the Connecting Europe Facility (CEF), it may be assumed that this trend will continue. As a consequence, economic and living areas in Slovenia's high Alps will soon «disappear» (Werner Bätzing).

The task of the semester consists of the redefinition of the meaning and use of the alpine landscape ranging between extensification (landscape as a museum) and intensification (e.g. tourism, agriculture or energy production) with the purpose to establish a productive relation to the region of Ljubljana.

We understand design not as an end product but as a process. Our first step is to investigate Ljubljana's large-scale relationships. A six-day long field trip complements this analytical gaze with a personal take on the area. Students then develop an individual programme as the foundation for their design. The proposed interventions can vary between urban planning and landscape scenarios and concrete architectural proposals.

**Lecture notes / Literature**
The Workbook is released in the first week. The relevant literature is included in the workbook.

**Prerequisites / notice**
Process Cartography
Chair of Günther Vogt
www.vogt.arch.ethz.ch
Contact: kissling@arch.ethz.ch
Assistants: Thomas Kissling, Ilkay Tanrisever, Sebastiano Brandolini
Design (051-1135-15 U - 13 KP) and integrated discipline planning / landscape architecture (051-1235-15 U - 3KP)
week 1-3 analysis (in groups), design project (individual work)
There will be a visit to Ljubljana 07.10.16 - 12.10.16.
The contribution towards expenses will be 240 CHF.


Please register (www.mystudies.ethz.ch) only after the internal enrolment for the design classes (see http://www.einschreibung.arch.ethz.ch/design.php).

**Abstract**
Working directly with the Havana city government and local institutions, students will design alternative architectural typologies and inclusive urban visions that challenge conventional approaches of urban development characterized by privatization, fragmentation and gentrification.

**Objective**
With an end to the U.S. embargo in sight, fifty-six years after the Cuban Revolution, Havana is confronted with probably the most challenging opportunity for urban development in the Americas. At the heart of this development -- and the site of our studio -- is Havana's recently decommissioned harbor, consisting of 1000 hectares of state-owned land currently lacking any comprehensive plan. Working directly with the Havana city government and local institutions, students will design alternative architectural typologies and inclusive urban visions that challenge conventional approaches of urban development characterized by privatization, fragmentation and gentrification.

Students will propose architectural projects that react to the existing built legacy, absorb the influx of capital investment, and connect the surrounding neighborhoods to the waterfront, while generating an overall urban vision that tackles issues related to tourism, infrastructure, preservation, environment, mobility, and resource.
Havana is a unique urban case study. Its strategic location in the Gulf of Mexico made Cuba one of the most important trading hubs of the Americas, a key node between the New and the Old World. At the center of the city is Havana's harbor. Through the centuries, it remained a crossroad of cultural exchange, generating wealth and a cosmopolitan flavor. With the imposition of the U.S. embargo in 1960, however, as well as the economic difficulties that flowed from the dissolution of the Soviet bloc, international trade suffered immensely. The harbor transitioned slowly into a vast area lined with vacant factories, abandoned piers, and rusted cranes.

Today, with the relocation of all industrial activities to the newly opened port of Mariel on the outskirts of the city, and the possibility of the U.S. blockade being lifted at any moment, a wealth of investment is being directed at the port of Havana presenting a new challenge for this vast stretch of latent land in the center of the city. Despite the political system means that the state owns all of the land, the direction of the development is up to them. Struggling between globalization, modernization, and the country's revolutionary socialist tradition, an alternative solution to the global commercially driven development is needed.

Can the city accept and direct this global investment while preserving its local cultural ideals? Will it learn from its specific experiences and develop its own creative urban solutions for a sustainable growth? Or will it replicate the usual mistakes of rapid urban development seen in many cities of today? Can we define this new urban agenda, together?

Students will undertake research by studying existing test cases, formulating their design hypothesis, planning individual urban scenarios, modeling their designs through various formats, and communicating their intentions in a series of critiques and reviews. Students will be encouraged to develop an individual and critical position on the potential role of the architect to guide a design process within broader social, political and economic systems.

A series of lectures, screenings, readings and discussions will accompany the design program. Workshops and in-studio tutorials will also be provided to train students in effective methods of representing complex ideas through visual media. These will be given by selected experts from the fields of architecture, urbanism, landscape, building technologies and associated disciplines, as well as experts from the UrbanThink Tank Chair.

Reading material will be provided throughout the semester, as well as references to similar case studies.

The class material can be downloaded from the student-server.

The development of this studio will benefit from the findings of our "Learning from Havana" summer school, which will be held from 22 August to 2 September, developed in close partnership with Prof. Christian Schmid (Chair of Sociology at D-ARCH ETH) and Prof. Jorge Peña Díaz (Faculty of Architecture of CUJAE, La Habana) who have been mapping and studying Havana over the past ten years.

The seminar week to Havana, Cuba is not obligatory but highly recommended.

Integrated Discipline: Planning
Language: English / German
Work: Groups (2 per)
Location: ONA, E25

Chair: Prof. Brillenberg & Prof. Klumper

Assistants: Danny Wills, Hans-Christian Rufer

All inquiries can be directed to: Danny Wills - wills@arch.ethz.ch

**051-1141-16L** Architectural Design V-IX: Social Structures (A.Caruso) ■ W 13 credits 16U A. Caruso

Please register (www.mystudies.ethz.ch) only after the internal enrolment for the design classes (see http://www.einschreibung.arch.ethz.ch/design.php).

Abstract
Starting by surveying the physical state as also trying to understand the historical and social conditions of small villages in Graubünden, developing from this observation an idea, and adding to these, proposals that will be physical as well as programmatic. At the end of the semester we would like to have an idea about how these places could become whole and coherent again.

Objective
Qualification to control the design process increasingly independent and with sole responsibility and to find to an individual design methodology and attitude.

Content
This semester we will attempt to develop models for the future of these villages. Beautiful and apparently integrated with their setting, these places are actually very fragile with diminishing populations and constrained economical potential. We will start by closely surveying their physical state at the same time as trying to understand the historical and social conditions that caused them to develop in these ways. We will then develop proposals for working with, and adding to these, proposals that will be physical as well as programmatic. At the end of the semester we would like to have an idea about how these places could become whole and coherent again. We would like to find new architectures that support a renewed and dynamic social structure. The semester will be taught in collaboration with Professor Christian Schmid whose chair will provide support that will enable our study to be both physical and social.

**051-1143-16L** Architectural Design V-IX: (M. Melii) ■ W 13 credits 16U M. Melii

Does not take place this semester.

Will follow shortly.

Will follow shortly.

This part of the curriculum addresses design work in different areas of architecture and urbanism and integrates the knowledge acquired in previous years. It involves the active participation of specialists from related disciplines (e.g. building structures, landscape architecture, history of art and architecture, monuments conservation etc.).

Free diplomas are offered only, on agreement with the chair.

**051-1145-16L** Architectural Design V-IX: Topic (N.N. open) ■ W 13 credits 16U to be announced

Does not take place this semester.

Please register (www.mystudies.ethz.ch) only after the internal enrolment for the design classes (see http://www.einschreibung.arch.ethz.ch/design.php).

To follow.

To follow.

To follow.

The Reader will be handed out at the first meeting and is in English only.
**051-1147-16L**  
Architectural Design V-IX: Lac Léman - Metropolitan Countryside (M. Topalovic)  
*Number of participants limited to 18 (6-9 teams of 2-3 students).*

Please register ([www.mystudies.ethz.ch](http://www.mystudies.ethz.ch)) only after the internal enrolment for the design classes (see [http://www.einschreibung.arch.ethz.ch/design.php](http://www.einschreibung.arch.ethz.ch/design.php)).

**Abstract**  
The studio series European Countryside investigates the terra incognita of the countryside, and its mutations. During the HS16 we will focus on Lac Léman and the concept of Metropolitan Countryside, investigating the possibilities of bringing the countryside and the metropolis closer together.

**Objective**  
The semester offers an intensive fieldwork and studio program, with an opportunity for students to focus on large-scale territorial research and design projects. Architecture of Territory’s approach enables students to work with a wide range of methods and sources pertaining to territory, including ethnographic research, literature, architectural and urban design precedents, urban theory, photography and visual art.

Students will work in groups of two. All projects will compose a common vision for Lac Léman. The work will be represented in the form of drawings, physical models and a book. All projects will be made public on Architecture of Territory website.

**Content**  
European territory has become completely urbanised. The countrysides in the traditional sense have disappeared, the distinctions between the town and the country have been blurred. In contrast to the unambiguous urban transformations of cities, the processes of urban change in the countryside are massive, yet often unnoticed. Away from the public eye and professional scrutiny, these processes have created new urban identities and configurations in the formerly rural realm of Europe. The studio series European Countryside will explore the terra incognita of the countryside, and its radical mutations. The project aims to reinvent contemporary countrysides as legitimate and critical subject of architecture profession.

Lac Léman and its urban areas surrounding the lake and extending from the lakesides into the Rhone valley and up the slopes of Jura and the Alps, will serve as the blueprint for the investigation of the Metropolitan Countryside. This is a territory where the high quality metropolitan living is embedded into the scenic landscapes of agricultural land and nature: the lake, the vineyards and the mountain slopes are not just a scenic urban background, but the key ingredients of the metropolis. The two poles of the “Léman City”, Geneva and Lausanne, define one of the most desirable international metropolises in the world, which owns its attractiveness to international institutions and businesses, and its high quality of life, precisely to the unique, countryside-like attributes of its urban landscape. Intrigued by this apparently productive contradiction, Architecture of Territory initiates a two-semester investigation on the area of Lac Léman. For autumn semester 2016, we will study the concept of Metropolitan Countryside, investigating the possibilities of bringing the countryside and the metropolis closer together:

*What are the benefits and potentials of agricultural land and nature for the contemporary metropolis? What are the new concepts of urban living, not only in the city, but in the extended metropolitan setting?*

**Lecture notes**  
Start: Tue 20 Sept, 10 am, ONA

Places: 18 students (teams of 2 students)

Travel: Integrated trip 8-12 October (cost frame B)

Integrated Discipline: Planung 063-1402-16

Contact: markaki@arch.ethz.ch

www.topalovic.arch.ethz.ch

**Literature**

Relevant course literature will be handed out in form of a reader and to be downloaded from the student server.

**Prerequisites / notice**

Investigative journey constitutes the core of the project. The field research will be organised in form of several group and individual excursions. The mandatory group trip will take place from 8-12 October 2016. Students who have obligatory courses on Monday, October 10, are required to organize their substitution or dispensation, in order to enrol. Additional 2-3 day individual trip to the research site will be required, and planned with the teaching team depending on the project task. Cost frame B.

Architecture of Territory is looking for avid travellers and team workers with high motivation and independent position.

**051-1151-16L**  
Architectural Design V-IX: Idyll and Ideology IV: Household (A. Lehnerer)

*Please register ([www.mystudies.ethz.ch](http://www.mystudies.ethz.ch)) only after the internal enrolment for the design classes (see [http://www.einschreibung.arch.ethz.ch/design.php](http://www.einschreibung.arch.ethz.ch/design.php)).*

**Abstract**  
“Idyll and Ideology” is a series of critical studies that speculates about, while also reinterpreting, the structural inventory found within our towns and countrysides.

**Objective**  
The conceptual development of an architectural and urban design and its elaboration as a specific project. The appreciation of architecture as a cultural practice with a strong but unstable connection towards society i.e. the city and the history of the built environment. The ability to produce a critical contribution to a specific discourse within the discipline by successfully employing the discursive tools and techniques of architecture. Development of the capacity to work with the speculative reality of architecture.

**Content**  
“Idyll and Ideology” is a series of critical studies that speculates about, while also reinterpreting, the structural inventory found within our towns and countrysides.

The design project is rooted within the context of the discipline between the theory of architecture and the stories of the built environment - an architecture that claims to be both cultural and contextual while simultaneously pursuing the desire for the autonomy of form. The city as a cultural expression has always been the critical project of architecture. By focusing on individual elements that make up the whole, a precise architectural discussion can be developed about collective form. The design process describes the ideological reshaping of a constructed idyll and the related negotiation of its resulting contradictions. The outcome is a third typology between house and city.

**051-1181-16L**  
Architectural Design V-IX  
*Does not take place this semester.*

Please register ([www.mystudies.ethz.ch](http://www.mystudies.ethz.ch)) only after the internal enrolment for the design classes (see [http://www.einschreibung.arch.ethz.ch/design.php](http://www.einschreibung.arch.ethz.ch/design.php)).

**Abstract**  
To follow

**Objective**  
To follow

**Content**  
To follow

**051-1115-16L**  
Architectural Design V-IX: Special Projects  
*Does not take place this semester.*

Please register ([www.mystudies.ethz.ch](http://www.mystudies.ethz.ch)) only after the
This part of the curriculum addresses design work in different areas of architecture and urbanism and integrates the knowledge acquired in previous years. It involves the active participation of specialists from related disciplines (e.g. building structures, landscape architecture, history of art and architecture, monuments conservation etc.).

**Objective**

Qualification to control the design process increasingly independent and with sole responsibility and to find to an individual design methodology and attitude.

**Content**

To follow

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**051-1105-16L Architectural Design V-IX: Built Territories / Añana**

**Salt Valley (J.M. Sánchez García)**

**Abstract**

'Built Territories Añana' explores the complementary relationship between territory and urban context, prompting students to create efficient structures for visitors and residents of Añana, but more importantly to engage in an ongoing discussion on how the construction of architecture informs cultural, social and physical landscapes.

**Objective**

1. Identify and analyze research resources that are adequate for the development of the project.
2. Acknowledge theoretical issues in order to develop a critical posture related to the design process.
3. Acknowledge the needs of inhabitants and translate them into a creative and sensible proposal.
4. Demonstrate advanced knowledge in representing architecture according to/challenging existing conventions.
5. Defend creative proposals in reference to various contextual issues informing architectural design.

**Content**

The idea that humans are the main geological agent on Earth has been around for some time now, especially since in 2000 the atmospheric chemist Paul Crutzen coined the term Anthropocene to refer to the influence of human behavior on Earth's lithosphere in recent centuries.

The Salt Flats of Añana, in Northern Spain, were naturally formed in the Triassic Period as a result of a process known as diapro, a type of geologic intrusion in which a more mobile and deformable material is forced into overlying rocks, allowing the salty water of the sea to emerge in this inland valley of the Basque Country.

Romans are believed to have operated this landscape industrially, though the first documented use dates back to 822, when Añana was started to be used with economic purposes. The landscape commenced then to be transformed in order to maximize the surface area exposed to the sun, turning the valley into a territory of platforms, subtly supported underneath by an architecture of timber-frame structures. At the time of maximum splendor, there were in the valley more than five thousand platforms for evaporation, occupying an area of 95,233m². Adjacent to the exploitation, the village of Añana was progressively built as a satellite rather than as a center, turning the salt flats into the very civic space of the valley.

'Built Territories Añana' explores the complementary relationship between territory and urban context, prompting students to create efficient structures for visitors and residents of Añana, but more importantly to engage in an ongoing discussion on how the construction of architecture informs cultural, social and physical landscapes. Due to the economic development of the region over the last decades, the population of Añana has diminished. However, the role of this territory as the definer of the collective memory of the site and its society remains untouched. Far from a nostalgic vision, the salt flats behave as an elastic territory that can shrink or expand at demand.

Thematic and methodic focus:
- Design architectural landscapes taking into account a wide range of urban, socio-cultural, economic and historical issues that are inherently connected with architectural practices.
- Recognize environmental and landscape issues that are relevant to contemporary architectural agendas.
- Consider and negotiate structural, material, functional, interior and exterior space aspects as well as all urban issues that concern the project simultaneously.
- Represent idea(s) appropriately using effective means of presentation, including digital tools.

Research Work: The Seminar Week features visits to Añana + 6 built territories in Spain. In the first three weeks of the semester each student will research and compare Añana + 1 built territory, focusing on the way the encounters between city and territory, nature and artifice, topography and construction are addressed in different scales and contexts. This will help students understand the transformation of these territories, their construction and geometry as technical and economical rather than stylistic phenomena, irrespective of the particular time frame of each site.

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**051-1183-16L Architectural Design V-IX: Architecture & Building Structure: Bridges! A Circle Road for Eglisau**

**Abstract**

The course will focus on the constructive and structural challenges of the realization. Main topic is the quality of the architectural space in the area between physical necessity and the freedom of design. The competences of all elective courses and main courses have been merged into a single, extensive course.

**Objective**

As a didactic target a profound debate on supporting structure, on construction and on room creation is declared.

**Content**

In consequence of the historic fact that the builder's profession has been divided into the professions of an engineer and an architect, a bisection of fields came up which reflects in the various types of building tasks. Hence, nowadays engineers realize a number of structures without considering an architect's expertise.

However, the functional expertise of the engineers should be merged with the design ideas of architects. That opens a field between freedom of design and functional/technical requirements.

As such buildings characterize our environment exceedingly and represent a substantial part of it, a high sophisticated design is very important for our society.

Therefore structural aspects are evaluated to their spatial and tectonic qualities. For this reason the course does not deal with classic architectural design tasks. The focus is on engineering structures.

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**Integrated Discipline Construction**

The integrated Discipline Construction can also be completed as "additional integrated Discipline", but the integrated Discipline Construction must be chosen at least once.

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**Number**

051-1201-16L

**Title**

Integrated Discipline Construction (D.Mettler/D.Studer)

**Type**

W

**ECTS**

3

**Hours**

2U

**Lecturers**

D. Mettler, D. Studer
A case study with a clear topic and a clear formulation of a question. The findings and the discoveries shall be part of the base of the design.

Integrated Discipline Building Research and Preservation of Cultural Heritage (N.N.)

Abstract
The integrated focal work has to accompany the design, though the focal work has to be an autonomous work. The formal framework needs to be discussed with the assistants.

Objective
A study in building research and preservation of building heritage with a clear topic.

Content
The formal framework needs to be discussed with the staff members.

Integrated Discipline History of Urban Design (N.N.)

Abstract
The integrated focal work has to accompany the design, though the focal work has to be an autonomous work. The written essay should be at least 10 pages. The formal framework needs to be discussed with the assistants.

Objective
An urban history case study with a clear topic and a clear formulation of a question. The findings and the discoveries shall be part of the base of the design.

Content
The integrated focal work has to accompany the design, though the focal work has to be an autonomous work. The written essay should be at least 10 pages. The formal framework needs to be discussed with the assistants.

Prerequisites / notice
For students who attend the architectural design only.

Additional Integrated Disciplines

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>051-1203-16L</td>
<td>Integrated Discipline Building Research and Preservation of Cultural Heritage (N.N.)</td>
<td>W</td>
<td>3 credits</td>
<td>2U</td>
<td>to be announced</td>
</tr>
<tr>
<td>051-1205-16L</td>
<td>Integrated Discipline History of Urban Design (N.N.)</td>
<td>W</td>
<td>3 credits</td>
<td>2U</td>
<td>V. Magnago Lampugnani</td>
</tr>
<tr>
<td>051-1207-16L</td>
<td>Integrated Discipline History of Art and Architecture (P. Ursprung)</td>
<td>W</td>
<td>3 credits</td>
<td>2U</td>
<td>P. Ursprung</td>
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<tr>
<td>051-1209-16L</td>
<td>Integrated Discipline History of Art and Architecture</td>
<td>W</td>
<td>3 credits</td>
<td>2U</td>
<td>I. Heinze-Greenberg</td>
</tr>
<tr>
<td>051-1211-16L</td>
<td>Integrated Discipline Theory of Architecture (NF Moravanszky)</td>
<td>W</td>
<td>3 credits</td>
<td>2U</td>
<td>to be announced</td>
</tr>
</tbody>
</table>

Voraussetzung ist die Anmeldung unter mystudies.ethz.ch und per e-mail an die Professur bis zum Ende der ersten Semesterwoche unter Angabe des Entwurfthemas und der betreuenden Professur. sowie die Teilnahme am Kolloquium in der zweiten Semesterwoche zur allgemeinen Einführung und konkreten Besprechung der Integrationsleistung (Ort und Uhrzeit des Kolloquiums werden auf der Homepage des Lehrstuhls Lampugnani bekannt gegeben).

Die Abgabefrist erfolgt analog zum Entwurf.

Works in the integrated discipline art and architectural history evolve in close connection with projects in design. Textual and creative works are possible. The length of the text or the extent of the creative project will be decided upon individually.

Interested students are asked to develop a (textual or diagrammatic) concept sketch explaining the content and the form.

We expect that students pursue their examination of the design process independently and in an original manner or that they develop a related theme from the perspective of the history of art and architecture.

The work should be part of the design process and interact with it formally and in regard to content.

For students who attend the architectural design only.

The integrated focal work has to accompany the design, though the focal work has to be an autonomous work. The written essay should be at least 10 pages. The formal framework needs to be discussed with the assistants.

Students interested in this course are required to enroll via mystudies.ethz.ch and apply via e-mail at the chair until end of the first week of the semester. Students are asked to indicate the theme of the design and the chair they are working with. The work is handed in at the same time as the design.

The aim is a profound examination of a topic of history of art and architecture. The gained insights will be converted into the design process.

The integrated focal work has to accompany the design, though the focal work has to be an autonomous work. The formal framework needs to be discussed with the assistants.

In the bachelor program, the integration of architectural theory into the design process is only offered in cooperation with the chair of architectural design for the whole design studio. On the basis of a reading of theoretical texts the conventions of architectural practice are critically debated. The theoretical perspective will be discussed in the midterm and/or final design studio criticism.
051-1215-16L Integrated Discipline Building Physics (J.Carmeliet) ■ W 3 credits 2U J. Carmeliet
**Abstract**
Hygrothermal analysis of a building wall component

**Objective**
The goal is that the students learn to evaluate hygrothermal performance of the building in the different stages of the design process. The students learn to evaluate and optimize their design, to choose adequate wall solutions and materials, to design details from a perspective of hygrothermal performance.

**Content**
Hygrothermal analysis of a building wall component

**Prerequisites / notice**
There is a limited number of places.
Interested students may enroll at mystudies.ethz.ch and by an email to the chair until the end of the second week of the semester. The topic and the design chair should be mentioned in this email.

051-1217-16L Integrated Discipline CAAD (L.Hovestadt) ■ W 3 credits 2U L. Hovestadt
**Abstract**
This part of the curriculum addresses design work in different areas of architecture and urbanism and integrates the knowledge acquired in previous years. It involves the active participation of specialists from related disciplines (e.g. building structures, landscape architecture, history of art and architecture, monuments conservation etc.).

**Objective**
Today architectural sketching without the employment of information technologies is only meaningful in exceptional cases, CAD plans, three-dimensional rendering, CNC model construction etc. are pervasive media for the development and presentation of architectural drafts. This elective course tries to follow questions on a new plateau: Which are the common traits of current design methods and modern information technologies and how can they symbiotically lead to a new architectural expressions in formal and constructional regard. Draft-drafts. This elective course tries to follow questions on a new plateau: Which are the common traits of current design methods and modern information technologies and how can they symbiotically lead to a new architectural expressions in formal and constructional regard.

**Content**
This part of the curriculum addresses design work in different areas of architecture and urbanism and integrates the knowledge acquired in previous years. It involves the active participation of specialists from related disciplines (e.g. building structures, landscape architecture, history of art and architecture, monuments conservation etc.).

**Prerequisites / notice**
Please contact the tutor as soon as possible at the beginning of the semester; we will set the task according to your chosen design studio.

**Lecture notes / Literature**
http://www.caad.arch.ethz.ch

051-1219-16L Integrated Discipline Building Systems (A. Schlüter) ■ W 3 credits 2U A. Schlüter
**Abstract**
The integrated discipline Building Systems adresses specific questions about building systems and system concepts. Energetic analysis and system designs are carried out on the students individual design projects. The focus lies on LowEx-systems.

**Objective**
The course aims for an ability to understand concepts of sustainable building technology coherently integrated into an architectural design. The focus lies on LowEx-systems.

**Content**
The integrated discipline Building Systems adresses specific questions about building systems and system concepts. Energetic analysis and system designs are carried out on the students individual design projects.

**Lecture notes / Prerequisites / notice**
Skripts are specific to the design task and distributed at the beginning of the course.

Having passed the lecture series of Energy and Climate Systems I & II or Technical Installations I & II respectively is required for attending the Integrated Discipline.

051-1221-16L Integrated Discipline Architecture and Building Process (S.Menz) ■ W 3 credits 2U S. Menz
**Abstract**
This part of the curriculum addresses design work in different areas of architecture and urbanism and integrates the knowledge acquired in previous years. It involves the active participation of specialists from related disciplines.

**Objective**
Alongside a discussion of the basic principles, trends and terminologies, a closer look will be taken at each topic.

**Content**
This part of the curriculum addresses design work in different areas of architecture and urbanism and integrates the knowledge acquired in previous years. It involves the active participation of specialists from related disciplines.

**Literature**
Sacha Menz (Hrsg.), Drei Bücher über den Bauprozess, vdf Hochschulverlag an der ETH Zürich, 2009

051-1223-16L Integrated Discipline Structural Design (J.Schwartz) ■ W 3 credits 2U J. Schwartz
**Abstract**
This part of the curriculum addresses design work in different areas of architecture and urbanism and integrates the knowledge acquired in previous years. It involves the active participation of specialists from building structur.

**Objective**
Understanding of the importance of the structural system for architectural design and integration of structural thinking into the design process.

**Content**
This part of the curriculum addresses design work in different areas of architecture and urbanism and integrates the knowledge acquired in previous years. It involves the active participation specialists from building structur.

**Prerequisites / notice**
Grant by lecturer is required.

051-1225-16L Integrated Discipline Architecture and Digital Fabrication (F.Gramazio/M.Kohler) ■ W 3 credits 2U F. Gramazio, M. Kohler
**Abstract**
The Integrated Discipline deals with the interrelation between material and algorithmic design. The direct control of production data opens up new possibilities for design strategies that are exempt from the limitations of standard CAD software. The Integration of process, function and design allows for a new approach to the production of architecture.

**Objective**
Data and material, programming and construction are interwoven. This synthesis is enabled by the techniques of digital fabrication, which allows the architect to control the manufacturing process through design data. Material is thus enriched by information; material becomes informed. In the future, architects ideas will permeate the fabrication process in its entirety. This new situation transforms the possibilities and thus the professional scope of the architect.
Content
We use the term digital materiality to describe an emergent transformation in the expression of architecture. Materiality is increasingly being enriched with digital characteristics, which substantially affect architectures physis. Digital materiality evolves through the interplay between digital and material processes in design and construction. The synthesis of these seemingly distinct worlds—the digital and the material—generates new, self-evident realties. Data and material, programming and construction are interwoven. This synthesis is enabled by the techniques of digital fabrication, which allows the architect to control the manufacturing process through design data. Material is thus enriched by information; material becomes informed. In the future, architects ideas will permeate the fabrication process in its entirety. This new situation transforms the possibilities and thus the professional scope of the architect.

051-1227-16L Integrated Discipline Information Architecture (G. Schmitt) W 3 credits 2U G. Schmitt

Abstract
This part of the curriculum addresses design work in different areas of architecture and urbanism and integrates the knowledge acquired in previous years. It involves the active participation of specialists from related disciplines (e.g. building structures, landscape architecture, history of art and architecture, monuments conservation etc.).

Objective
Apart from learning about and experiencing Information Architecture, the course also introduces research and management skills that will distinguish the future trained ETH architect.

Content
This part of the curriculum addresses design work in different areas of architecture and urbanism and integrates the knowledge acquired in previous years. It involves the active participation of specialists from related disciplines (e.g. building structures, landscape architecture, history of art and architecture, monuments conservation etc.).

051-1231-16L Integrated Discipline Sociology (C. Schmid) W 3 credits 2U C. Schmid

Abstract
This part of the curriculum addresses design work in different areas of architecture and urbanism and integrates sociological questions and research methods.

Objective
To consider the social context in the design process!

Content
The content is related to the design process and is defined accordingly to the individual project.

051-1233-16L Integrated Discipline Architecture and Urban Design (C. Christiaanse) W 3 credits 2U K. Christiaanse

Abstract
The integrated focal work has to accompany the design, though the focal work has to be an autonomous work. The formal framework needs to be discussed with the assistants.

Objective
An urban design case study with a clear topic and a clear formulation of a question. The findings and the discoveries shall be part of the base of the design.

Content
The integrated focal work has to accompany the design, though the focal work has to be an autonomous work. The formal framework needs to be discussed with the assistants.

051-1235-16L Integrated Discipline Landscape Architecture (G. Vogt) W 3 credits 2U G. Vogt

Abstract
Please register (www.mystudies.ethz.ch) only after the internal enrolment for the design classes (see http://www.einschreibung.arch.ethz.ch/design.php)

Objective
Learning objectives: introduction into landscape architectural issues and design approaches; designing in urban planning dimensions.

Content
Subject by arrangement

051-1237-16L Integrated Discipline Landscape Architecture (C. Girot) W 3 credits 2U C. Girot

Abstract
Design concepts ranging from architectural objects to urban planning are developed together with the discipline of landscape architecture.

Objective
Students gain an insight into the integrated disciplines of design in architecture together with landscape architecture.

Content
Design concepts ranging from architectural objects to urban planning are developed together with the discipline of landscape architecture.

Prerequisites / notice
In order to complete the subject Integrated Discipline it is necessary that students apply at the Chair of C. Girot within the first three weeks of the semester. Thereafter no applications will be processed.

Learning aids: Pamphlets Design of the Chair of Prof. Girot. www.girot.arch.ethz.ch

051-1245-16L Integrated Discipline Structural Construction (P. Block) W 3 credits 2U P. Block

Abstract
Implementation into architectural design of the gained structural construction knowledge, in order to find best possible and holistic solutions for a construction task.

Objective
The integrated course achievement is allocated to the design course and is fulfilled under the supervision of professionals out of the field of structural teaching. The main focus, the form and the scope of the thesis are specified in agreement with the chair.

Content
The integrated course achievement is shown within the design course and is performed under conducted cooperation of structure teaching. The main focus, the form and the scope of the thesis are specified in agreement with the chair.

Prerequisites / notice
Die Anzahl Plätze ist beschränkt!


Abstract
In the integrated discipline the architectural design will be juxtaposed by artistic thinking and working. The conceptional approach will in particular be rendered more precise in the dialogue between architectural and artistic methods. There is also a focus on the technique of describing the context precisely.

Objective
Art ist the discipline that is constantly creating new realities of terminology and perception. The purpose of the integrated discipline is to use this knowledge, that is produced by art, and to concern it by making design decisions.

Content
A systematic procedure for every step in the design will be supported in the integrated discipline, from the generation of new ideas through to detailing and up to presentation. Reflections on method flow into the design in an integrated manner. There will also be an emphasis on giving expression to the results of the design process using artistic means. In addition a publication should be compiled, presenting the conceptual steps developing the design.

Prerequisites / notice
Application for the coursework with the lecutter: Nikolai von Rosen, vonrosen@arch.ethz.ch

051-1251-16L Integrated Discipline Life Cycle Analysis W 3 credits 2U R. Hirschier, D. Hebel
Abstract
The Integrated Discipline LCA is based on the core idea of the overall design task - the thinking of a project within its complete life cycle. The method of LCA allows to quantify the environmental sustainability of different life stages of a building (raw materials - construction - operation - decommissioning) and thus recognize their relevance to each other as well as present them clearly.

Objective
Introduction to the topic of sustainability and teaching of fundamental method of life cycle assessment as well as its application in architecture and construction. Practical use of these method in a simplified form to assess your own planning activities within the parameters of the design studio.

Content
The Integrated Discipline LCA is divided into two phases - the first phase will conveys the methods of LCA through a mix of lectures, examples and an exercise, in order to be applied in the second phase in a simplified, yet meaningful manner in close connection with the central task of the design studio. In the center of the 2nd exercise is the specific design and constructive approach of the individual student group. Building on there design, the results of exercise 2 should be prepared so that they are suitable for integration into the final presentation wall. For this exercise should be seen as part of the overall task and relevant input for the whole semester.

Seminar Weeks

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>051-0911-16L</td>
<td>Seminar Week Autumn Semester 2016</td>
<td>W</td>
<td>2 credits</td>
<td>3A</td>
<td>Lecturers</td>
</tr>
</tbody>
</table>

Abstract
The seminar week is obligatory for students of all semesters. There are many and varied study contents.

Objective
The students will be enabled to discuss narrowly formulated factual questions in small groups and in direct contact with the professors.

GESS Science in Perspective

Recommended GESS Science in Perspective (Type B) for D-ARCH.

see GESS Science in Perspective: Type A: Enhancement of Reflection Capability

see GESS Science in Perspective: Language Courses ETH/UZH

Architecture Bachelor - Key for Type

<table>
<thead>
<tr>
<th>Key for Type</th>
<th>Description</th>
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<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
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<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
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<tr>
<td>W</td>
<td>Eligible for credits</td>
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Key for Hours

<table>
<thead>
<tr>
<th>Key for Hours</th>
<th>Description</th>
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<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
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</table>

<table>
<thead>
<tr>
<th>ECTS</th>
<th>European Credit Transfer and Accumulation System</th>
</tr>
</thead>
</table>

Special students and auditors need special permission from the lecturers.
**Architecture Master**

**Architectural Design**

**Integrated Discipline Planning**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>063-1401-16L</td>
<td>Integrated Discipline Planning - Autumn Semester 2016</td>
<td>W</td>
<td>3</td>
<td>2U</td>
<td>Lecturers</td>
</tr>
</tbody>
</table>

**Abstract**
The integrated focal work has to accompany the design, though the focal work has to be an autonomous work. The formal framework needs to be discussed with the assistants.

**Objective**
Work on a current or a passed design project in a large scale.

**Content**
The integrated focal work has to accompany the design, though the focal work has to be an autonomous work. The formal framework needs to be discussed with the assistants.

**Major Courses**

Major courses deal with architectural problems and questions in relation to other fields and they enable students to complete their expert knowledge and their theoretical know-how apart from the architectural design courses. Details of performance assessments are defined in Art. 28 of the 2011 Master curriculum D-ARCH.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>063-0366-00L</td>
<td>The Architecture of the City from Modernity to Today</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>V. Magnago Lampugnani</td>
</tr>
</tbody>
</table>

**Abstract**
The lecture covers the time of the 20th century and describes with theories, projects and implemented plannings the history of the modern city. The lectures emphasize on the historical plannings and methods and presents each specific urban development within a broader context.

**Objective**
This course analyzes the history of urban architecture primarily in its existing three dimensional form as a complex human artefact. It also explores the inspirations that prompted the creation of this artefact: philosophical and religious concepts, social conditions, property relationships and the mechanisms that exploit the economics of real estate and the influence of building technology. Intellectual, literary or artistic modes of thought will also be assessed with regard to their impact on urban development. Urbanism has its own distinctive approach as a discipline, but it is also clearly responsive to the influence of related disciplines. Study is made of actual cities and urban expansion plans which are in the process of implementation, as well as unrealized projects and visions of the future. These projects sometimes illustrate ways of thinking that are equal to, or clearer than, actual urban situations.

**Content**
The lecture which will be hold only in one semester includes the developments of the 20th century

1. Le Corbusier: theories, visions and clearcuts in the name oft he autorité
2. The United States in the Jazz Age: Between Metropolis of Tomorrow and Broadacre City
3. Italy in the Fascist Era: Monumental ensembles and new town between assiduousness of modernization and obsession of representation
4. Urban design under totalitarian regimes: The architects of the “Tausendjährige Reich” and the “engineers of luck” of the Soviet Union of Stalin
5. Coming to terms with the past and the Cold War: Reconstruction in the two German states
6. The myth of the human scale: the 1950s in Spain, Great Britain, Scandinavia and Italy
7. Postwar Experiments: Rationalistic classicism in France
8. Two new towns in the 20th century: Chandigarh and Brasilia
9. Fictions and visions: The international utopia of the city
10. The second conquest of the North American territorium: The automobile and the city in the USA
11. Analysis, analogy and renewal: The adventure of the typological city

**Lecture notes**
To each lecture an overview is listet within a script, that can be purchased at the chair for the history of urban design (HIL D 75.2) at the price of CHF 25. - The script serves as an auxiliary means to the attended lecture compiling the most important illustrations showed and the names and dates of the buildings and its builders along with a short introductory note. Aside this script the chair offers the Quellentextbände’ (sourcetexts) which help to extend the knowledge of theoretical discourses in the field of urban design. For the master program the institute offers one volume of texts at the price of CHF 5.-. The script is in German, the Quellentextbände are reprinted in their original languages.

**Literature**
Further recommended literature to consult is listet within the script.

<table>
<thead>
<tr>
<th>Number</th>
<th>Design and Building Process MBS</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>066-0427-00L</td>
<td>Design and Building Process MBS</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>A. Paulus</td>
</tr>
</tbody>
</table>

“Design and Building Process MBS” is a brief manual for prospective architects and engineers covering the competencies and the responsibilities of all involved parties through the design and building process. Lectures on twelve compact aspects gaining importance in a increasingly specialised, complex and international surrounding.
Objective
Participants will come to understand how they can best navigate the design and building process, especially in relation to understanding their profession, gaining a thorough knowledge of rules and regulations, as well as understanding how involved parties’ minds work. They will also have the opportunity to investigate ways in which they can relate to, understand, and best respond to their clients’ wants and needs. Finally, course participants will come to appreciate the various tools and instruments, which are available to them when implementing their projects. The course will guide the participants, bringing the individual pieces of knowledge into a superordinate relationship.

Content
“Design and Building Process MBS” is a brief manual for prospective architects and engineers covering the competencies and the responsibilities of involved parties through the design and building process. Twelve compact aspects regarding the establishe building culture are gaining importance in an increasingly specialised, complex and international surrounding. Lectures on the topics of profession, service model, organisation, project, design quality, coordination, costing, tendering and construction management, contracts and agreements, life cycle, real estate market, and getting started will guide the participants, bringing the individual pieces of knowledge into a superordinate relationship. The course introduces the key figures, depicts the criteria of the project and highlights the provided services of the consultants. In addition to discussing the basics, the terminologies and the tendencies, the lecture units will refer to the studies as well as the practice: Teaching-based case studies will compliment and deepen the understanding of the twelve selected aspects. The course is presented as a moderated seminar to allow students the opportunity for individual input: active collaboration between the students and their tutor therefore required.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Lecture Time</th>
<th>Credit</th>
<th>Tutor(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>063-0363-00L</td>
<td>Urban History Online. Methods for Text and Plan Analysis</td>
<td>W</td>
<td>2 credits</td>
<td>M. Gnehm</td>
</tr>
<tr>
<td>051-0765-16L</td>
<td>Building Process: Economy</td>
<td>W</td>
<td>2 credits</td>
<td>S. Menz, H. Reichel</td>
</tr>
<tr>
<td>063-0117-16L</td>
<td>Theory of Architecture III: Architectural Theories of the 20th Century Today</td>
<td>W</td>
<td>2 credits</td>
<td>M. Gnehm</td>
</tr>
<tr>
<td>063-0313-16L</td>
<td>History of Art and Architecture V: Architecture and the History of the Future</td>
<td>W</td>
<td>1 credit</td>
<td>N. K. Naehrig</td>
</tr>
</tbody>
</table>
### History and Methods in Building Research

**063-0315-16L**  
**History of Art and Architecture V: America**

*W*  
1 credit  
1V  
P. Ursprung

**Objective**

Deeper the basic knowledge

**Content**

The idea of the future not as a divinely predetermined, but as a designable space in time, was developed since the early modern period. The discovery of the future opened a rich field of activity also for architects: beyond traditional building tasks, dealing with future designs such as "The House of the Future" and "The City of the Future" have become leitmotifs of architectural production. Beginning in the Renaissance this lecture uses case studies to retrace the appropriation of the principle of the future by architects. Besides well-known designs for homes of the future, as of Alison and Peter Smithson (1956), and the presentation of futuristic living arrangements at exhibitions ("Homes of Tomorrow", Chicago, 1933), the creation and transformation of the concept of future will be discussed, that, as in the case of the Italian Futurism (1909-1944), was decisive for certain phases of Western cultural history.

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### Experimental Explorations on Space and Structure

**063-0353-16L**  
**Construction History: Bâtir la ville du 19ème siècle:**

*Paris a*

1 credit  
3G  
S. Holzer

**Objective**

History of the notion of future in architectural production since the early modern period

**Content**

- Paris is the 19th century metropolis par excellence. There is hardly any city with a more abundant architectural, urban and infrastructural development in the 19th century, and hardly anywhere more monuments of his period have been preserved. Furthermore, an outstanding amount of contemporary scientific and architectural discussion has been published which allows us to reconstruct the details of the design and planning processes. The variety of preserved monuments includes late examples of classical French construction highlights such as the coup des pierres architecture like the flat vaults of the Odéon, innovative uses of traditional materials like timber (timber vaults of the neo-classical churches following Saint-Philippe-du-Roule, de l'Orme roofs of Bourse and Bibliothèque Sainte-Geneviève, iron churches of Saint-Eugène, Saint-Augustin and Notre-Dame-du-Travail), experimental iron architecture (roofs of Bourse and Bibliothèque Sainte-Geneviève, iron churches of Saint-Eugène, Saint-Augustin and Notre-Dame-du-Travail), extensive infrastructural developments (Belgrand's water supply and sewer systems) and historicist architecture with hidden technical innovations (Sainte-Trinité, Opéra).

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### Architecture and Structure

**063-0371-16L**  
**History and Methods in Building Research**

*Does not take place this semester.*

*W*  
4 credits  
3U  
S. Holzer

**Objective**

Introduction into an experimental approach to architectural design based on the application of methods that integrate structural and spatial principles.

**Content**

- The focus is on structural and statical issues with respect to realization. Exemplary buildings are analyzed using graphic statics and specific properties of different materials discussed.
- The course is centered around a design exercise where the form should be the result of a structural design implemented in an architectural design, combined with a deep knowledge of architectural space.
- Understanding of structural design as translation of structural concepts into building materials with respect to design concepts.
- The focus is on structural and statical issues with respect to realization. Exemplary buildings are analyzed using graphic statics and specific properties of different materials discussed.
- The course is centered around a design exercise where the form should be the result of a structural design implemented in an architectural design, combined with a deep knowledge of architectural space.

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### Experimental Explorations on Space and Structure

**063-0417-16L**  
**Experimental Explorations on Space and Structure**

*Does not take place this semester.*

*W*  
2 credits  
2G  
J. Schwartz

**Objective**

Basic understanding of the experimentation with design methods in architecture. Ability to build up models throughout digital and physical exploration integrating space and structure.

**Content**

- In recent decades, new methodologies have emerged in architectural design that exploit the implementation of different parameters as generators of the design concept. Building on the programmatic idea of the Chair of Structural Design of reconciliation of the disciplines of engineering and architecture, the course experiments with the application of design methods that integrate structural and spatial principles from the early stages of the design process. These methods are based on simple geometrical rules that relate spatial and structural parameters. The experimental process will be carried out through the development and construction of physical and digital models. This will allow for the exploration of the permeability of the boundary between the physical and the digital realm.

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### Digital Urban Simulation

**063-1357-16L**

*Digital Urban Simulation*

*W*  
4 credits  
4G  
E. Tapia Pedraza

**Objective**

The students learn how the design and planning of cities can be evidence based by using scientific methods. The teaching unit conveys knowledge in state-of-the-art and emerging spatial analysis and simulation methods and teaches students with skills in modern software systems. The course consists of lectures, associated exercises and workshops, as well as of one integral project work.

**Content**

- In a series of theory lectures we explore how the design and planning of cities can be evidence based using scientific methods. By various exercises the students are equipped with skills in modern software systems. In an integral project work knowledge in state-of-the-art and emerging spatial analysis and simulation methods is deepened. Based on the imparted methods the effects of planning and design interventions can be simulated and understood. An important focus of this course is the interpretation of the analysis and simulation results and the application of the correspondent computational methods in early planning phases.
Following the insight into historical perspective and contemporary models of governance and planning, the course focuses on understanding political contingencies in architecture and its history.

**Objective**
- To interpret the history of spatial planning at the transnational scale
- To understand and explain the content of the European spatial policy agenda
- To describe and analyze the role of territorial cooperation in making European spatial development patterns and planning procedures
- To discuss the changing role of planners and evaluate the ways of their engagement in European spatial policy-making

**Content**
- European spatial policy agenda: introduction and basic directives
- Governance models
- Planning models; collaborative planning model (main concepts & criticism)
- Post-positivist approach to spatial planning
- Transnational spatial planning in Europe; questioning the European spatial planning; spatial development trends in Europe
- EU as a political system: EU institutions & non-EU actors
- Planning families in Europe; the European spatial planning agenda
- Spatial planning strategies and programmes on territorial cooperation
- The notion of planning culture and planning system; planning cultures in Europe
- Basic characteristics of planning systems in Europe
- The relevance of European transnational cooperation for spatial planning
- European transnational initiatives: CODE 24 (Rotterdam-Genoa); Orient/east-Med corridor (Hamburg-Athens); Danube region

**Lecture notes**
The documents for the lecture will be provided at the moodle, [https://moodle-app2.let.ethz.ch/course/view.php?id=2298](https://moodle-app2.let.ethz.ch/course/view.php?id=2298).

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**851-0252-08L Cognition in Studio Design - Analytic Tools for Evidence-Based Design**

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Credits</th>
<th>Module</th>
<th>Professor(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognition in Studio Design - Analytic Tools for</td>
<td>3</td>
<td>W</td>
<td>B. E. Nax,</td>
</tr>
<tr>
<td>Evidence-Based Design</td>
<td></td>
<td></td>
<td>M. Brösamle,</td>
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<td></td>
<td></td>
<td></td>
<td>C. Hölsc</td>
</tr>
</tbody>
</table>

**Abstract**
How can Behavioral and Cognitive Science inform architecture? In this project-oriented course, students are introduced to cognitive and analytical methods to evaluate their design projects. Existing theories are introduced and complemented with hands-on sessions, in which students learn how to implement a range of methods. The course is tailored for students from relevant design studios.

**Objective**
- Taking the perspectives of the end user (occupants and visitors) is vital for a human-centered design approach. Students will learn about relevant theory and methods in cognitive science and environmental psychology that can be used to address human cognitive and behavioral needs in built environments.
- The foundations of environmental psychology and human spatial cognition will be introduced. A focus of the course will be on how people perceive their surroundings and orient in space. Students will learn about a range of methods including real-world observation, and methods of architectural analysis such as space syntax.
- Students will also be exposed to behavior simulation in design, virtual reality experiments, and eye-tracking. Students will reflect the roles of designers and other stakeholders with respect to human-centered design as well as an evidence-based design perspective.
- The course is tailored for students from a relevant design studio. Upon registering, students should send an email about their design studio to b.emo@gess.ethz.ch.

As an alternative to obtaining D-GESS credit, architecture students can obtain course credit in "Vertiefungsfach" or "Wahlfach".

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**851-0317-16L History of Art and Architecture: Architecture and Climate Change (P. Ursprung)**

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Credits</th>
<th>Module</th>
<th>Professor(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>History of Art and Architecture and Climate Change</td>
<td>4</td>
<td>W</td>
<td>E. E. Scott</td>
</tr>
<tr>
<td>(P. Ursprung)</td>
<td></td>
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</tbody>
</table>

**Abstract**
This seminar will investigate intersections between architecture and climate change, one of the defining phenomena of our age. The course will begin to map out the spectrum of manners in which architecture already engages with this vast and highly unsettling topic as well as how they might be more fully interrogated, invented, and instituted.

**Objective**
- Students should come away with a clearer sense of the latitudes of climate change for architecture and of architecture for climate change, as well as a deepened familiarity with relevant projects from the present and recent past.
- This seminar will investigate intersections between architecture--as a practice, set of objects, and research orientation--and climate change, one of the defining phenomena of our age.

**Content**
- The discipline of architecture has been slow to engage with the vast and highly unsettling topic of climate change in ways beyond the technical (e.g., new materials, efficiency standards) despite the fact that issues of a social, political, economic, ethical, and even existential order are also, if not foremost, at root and at stake. Our own class discussions will indeed grapple with a set of unwieldy and interrelated questions, including: At what scales does architecture intersect with climate change? Are planetary and highly local scales newly entwined and, if so, how might architecture respond to and elucidate this condition? Which skills do architects bring to the table, and what is their revised role, in light of this accelerating and encompassing phenomenon? Does climate change demand a reimagining of the field? What would architecture look like that, rather than sheltering us from our surroundings, instead served as an interface between the human and the nonhuman at the same time?

With a focus on the contemporary but eye to the recent past, we will begin to map out the spectrum of manners in which architecture has already engaged with climate change as well as how these might be more fully interrogated, invented, and instituted.

**Lecture notes**
A syllabus, required readings, and other course materials will be published/downloadable from the website of Professor Ursprung's chair at the beginning of the semester.

**Literature**
For further information, including literature, see: [http://www.ursprung.arch.ethz.ch/lehrveranstaltungen](http://www.ursprung.arch.ethz.ch/lehrveranstaltungen)

**Prerequisites / notice**
All lectures, readings and discussions will be held in English. If you wish to participate in the course, attendance at this first meeting is compulsory. For any questions, please contact Dr. Emily Eliza Scott (emily.scott@gta.arch.ethz.ch).

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**063-0311-16L Transitional Periods: Political Iconology - Architecture W in Central Europe 1450-1800**

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Credits</th>
<th>Module</th>
<th>Professor(s)</th>
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</thead>
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<tr>
<td>Transitional Periods: Political Iconology -</td>
<td>1</td>
<td>W</td>
<td>M. Gnehm</td>
</tr>
<tr>
<td>Architecture W in Central Europe 1450-1800</td>
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</tbody>
</table>

**Abstract**
The lecture course discusses issues of architecture as a bearer of political meaning in central Europe from 1450 to 1800.

**Objective**
- Understanding of political contingencies in architecture and its history.

**Content**
The notion "central Europe" is a highly politicised geographical term in historiography. During the period in question (1450-1800) the history of central Europe is primarily the history of the Holy Roman Empire and the House of Habsburg. Although the huge area was shaped by the Habsburg idea of empire, it was characterized by the particularistic sovereignty of the many territorial lords. Religious wars further complicated the situation. The lecture course analyses with regard to political and historical changes to what extent secular and sacred buildings in Germany, the Czech Republic, Croatia, Poland, Hungary, Switzerland, and Austria could assume functions as a bearer of political meaning.

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**051-0317-16L History of Art and Architecture: Architecture and Climate Change (P. Ursprung)**

<table>
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</tr>
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<td>W</td>
<td>E. E. Scott</td>
</tr>
<tr>
<td>(P. Ursprung)</td>
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</tbody>
</table>

**Objective**
- Students should come away with a clearer sense of the latitudes of climate change for architecture and of architecture for climate change, as well as a deepened familiarity with relevant projects from the present and recent past.

**Content**
- This seminar will investigate intersections between architecture--as a practice, set of objects, and research orientation--and climate change, one of the defining phenomena of our age.

**Lecture notes**
A syllabus, required readings, and other course materials will be published/downloadable from the website of Professor Ursprung's chair at the beginning of the semester.

**Literature**
For further information, including literature, see: [http://www.ursprung.arch.ethz.ch/lehrveranstaltungen](http://www.ursprung.arch.ethz.ch/lehrveranstaltungen)

**Prerequisites / notice**
All lectures, readings and discussions will be held in English. If you wish to participate in the course, attendance at this first meeting is compulsory. For any questions, please contact Dr. Emily Eliza Scott (emily.scott@gta.arch.ethz.ch).

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**010-0569-00L European Aspects of Spatial Development**

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Credits</th>
<th>Module</th>
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</thead>
<tbody>
<tr>
<td>European Aspects of Spatial Development</td>
<td>3</td>
<td>W</td>
<td>A. Peric Momcilovic</td>
</tr>
</tbody>
</table>

**Abstract**
Following the insight into historical perspective and contemporary models of governance and planning, the course focuses on the international dimension of spatial planning in Europe. This includes a discussion of how European spatial policy is made and by whom, how planners can participate in such process and how they can address transnational challenges of spatial development cooperatively.

**Objective**
- To discuss the changing role of planners and evaluate the ways of their engagement in European spatial policy-making.

**Content**
- European spatial policy agenda: introduction and basic directives
- Governance models
- Planning models; collaborative planning model (main concepts & criticism)
- Post-positivist approach to spatial planning
- Transnational spatial planning in Europe; questioning the European spatial planning; spatial development trends in Europe
- EU as a political system: EU institutions & non-EU actors
- Planning families in Europe; the European spatial planning agenda
- Spatial planning strategies and programmes on territorial cooperation
- The notion of planning culture and planning system; planning cultures in Europe
- Basic characteristics of planning systems in Europe
- The relevance of European transnational cooperation for spatial planning
- European transnational initiatives: CODE 24 (Rotterdam-Genoa); Orient/east-Med corridor (Hamburg-Athens); Danube region

**Lecture notes**
The documents for the lecture will be provided at the moodle, [https://moodle-app2.let.ethz.ch/course/view.php?id=2298](https://moodle-app2.let.ethz.ch/course/view.php?id=2298).
New perceptions of architecture are studied on behalf of film analyses and experimental topics. During the course space-effective creative means such as editing or framing will be introduced and analyzed, the dispositions of perception and effect will be compared and thus will sharpen the view for a architectural way of looking at filmic space situations and performance discloses new perceptions of architecture which will be studied on behalf of film analyses and experimental topics. During the course space-effective creative means such as editing or framing will be introduced and analyzed, the dispositions of perception and effect will be compared and thus will sharpen the view for a architectural way of looking at filmic space situations and performance discloses new perceptions of architecture which will be studied on behalf of film analyses and experimental topics.

The seminar is structured in three sections. In a first step, theoretical foundations will be established based on reading and discussing seminal texts, as well as guest lectures by established critics. A second phase will include site visits of selected buildings in order to intervene in situations in which we ourselves are implicated, raising questions about the relationship between architecture and social environments.

The course deals with spatial phenomena at the interface of film and architecture. The alternating influence of these two media will be discussed under perceptive aspects. Mediality within spatial perception can thus be integrated into a development of cultural history and leads towards a conception which goes beyond the limits of architecture and stimulates new processes of design.

The medium of performance art is the human being, whose voice and body send out messages into surrounding society. Performance art attempts to create an awareness of how such messages are sent and received. We will examine the significance of speech, posture, clothing and movement using selected examples from performance art. Interpersonal relationships are regulated by political, legal, economic and cultural structures which are given representative physical form by architecture. Intervention art critiques the relationship between social structure and built-up space. We seek to develop ways of intervening in situations in which we ourselves are implicated, raising questions about the relationship between architecture and social environment.

Territorial cooperation in Europe:

Planning families and cultures:

Planning systems in Europe:

Electives / notice
Only for master students, otherwise a special permission by the lecturer is required.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Lecturers</th>
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<tr>
<td>051-0173-16L</td>
<td>Spatial Concepts in Film and Architecture (Prof A.Gigon/M.Guyer)</td>
<td>W</td>
<td>1</td>
<td>1V</td>
<td>D. E. Agotai Schmid, M. Bächtiger Zwicky</td>
</tr>
<tr>
<td>051-0193-16L</td>
<td>Performance and Intervention</td>
<td>W</td>
<td>2</td>
<td>2U</td>
<td>S. Keller Roca</td>
</tr>
<tr>
<td>Course Code</td>
<td>Course Title</td>
<td>Type</td>
<td>Credits</td>
<td>Prerequisites / notice</td>
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<tr>
<td>051-0195-16L</td>
<td>Kritik und Theorie</td>
<td>W</td>
<td>2</td>
<td>K. Sander</td>
<td></td>
</tr>
<tr>
<td>Abstract</td>
<td>Against the background of my self-developed ten-line-format we are going to discover thematically partly fee, partly architecture related topics, by writing.</td>
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<tr>
<td>Objective</td>
<td>Structure and/or strengthening of the capability to express oneself in writing on a journalist level - effortlessly, flexibly and easily , thus primarily on special guidelines with regard to a tight text volume (i.e. blurbs on books or short contributions in magazines).</td>
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<tr>
<td>Content</td>
<td>Against the background of my self-developed ten-line-format we are going to discover thematically partly fee, partly architecture related topics, by writing. The seminar enables students to work out concise and coherent texts of high linguistic expression to various topics within very short time.</td>
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<tr>
<td>Literature</td>
<td>Mohafez, Sudabeh: das zehn-zeilen-buch; Dresden 2016 (2010) Queueneau, Raymond: Stilübungen; Frankfurt am Main 1990 (1947)</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Enrolment on agreement with the Assistant, Ms. Sudabeh Mohafez <a href="mailto:mohafez@arch.ethz.ch">mohafez@arch.ethz.ch</a>.</td>
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<tr>
<td>051-0199-16L</td>
<td>Architecture and Photography</td>
<td>W</td>
<td>2</td>
<td>T. Wootton</td>
<td></td>
</tr>
<tr>
<td>Abstract</td>
<td>The aim of the course is to reach a higher competence level of the media through applying cultural techniques of photography. Through critical discussions and analyses of the medium, participants will develop their concept of photography and confront its theoretical and practical challenges.</td>
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<tr>
<td>Objective</td>
<td>Participants will analyze the motivations, strategies, and technical methods of artists and photographers. These analyses will also include the effectiveness and the history of reception of the given work or artist. Based on practical examples, theories of photography will be applied, i.e. through discussing reference, reproducibility, image time, etc.</td>
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<tr>
<td>Content</td>
<td>For participation a motivation letter has to be handed in until Friday 16th September 2016, 12:00 noon, to send to Mr. T. Wootton, Email: <a href="mailto:wootton@arch.ethz.ch">wootton@arch.ethz.ch</a>.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Places are limited. Enrolment by agreement with the lecturer. Please Motivation letter to be sent until 10.9.2015 an Wirz Mirjam <a href="mailto:wirz@arch.ethz.ch">wirz@arch.ethz.ch</a></td>
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<tr>
<td>051-0201-16L</td>
<td>3D Scanning and Freeform Modeling</td>
<td>W</td>
<td>2</td>
<td>K. Sander</td>
<td></td>
</tr>
<tr>
<td>Abstract</td>
<td>Since the mid 19th century the representation of architecture is inextricably linked to photography. Many buildings are being discussed on the basis of photographs. The artist and photographer Tobias Wootton (HHG Karlsruhe) will teach the students the various techniques (large scale, medium format, small format, digital photography).</td>
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<tr>
<td>Objective</td>
<td>The department of Architecture and Fine Arts has a 3D-Bodyscanner available for the digitalization of persons and objects, and is complemented by a special software for modeling the 3D data. After a period of training and practice, participants are asked to develop ideas and concepts for their own projects. These concepts should be used to lead and expand the system and the possibilities of its application. The process of readjustment and its realization will be a continual part of developing the individual projects.</td>
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<tr>
<td>Content</td>
<td>Digital Sculpture. Experimental use of a system for digitalizing and modeling 3D objects. Practicing and playing with dimensionality and sense of space.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>The number of participants is limited to 14 students and enrolments need the lecturer's allowance! We Works with a 3D Touch Mouse, see Youtube <a href="https://www.youtube.com/watch?v=NF7nfktef2Q">https://www.youtube.com/watch?v=NF7nfktef2Q</a></td>
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<tr>
<td>051-0219-16L</td>
<td>Artistic and Conceptual Thinking and Working</td>
<td>W</td>
<td>2</td>
<td>S. Keller Roca</td>
<td></td>
</tr>
<tr>
<td>Abstract</td>
<td>We approach the prelinguistic space of artistic thinking and agency from its context, which supports, mediates, criticizes, sells and preserves its artworks. We listen to the various protagonists of this space - cultural agents in civil service institutions, art mediators, critics, curators, gallerists, custodians; for in this space surrounding the prelinguistic one, nothing is left to chance.</td>
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<tr>
<td>Objective</td>
<td>This seminar aims at providing access to the prelinguistic space of artistic thinking and agency, in order to be able to observe the artists in their immediate working process. This space can only be entered if we successfully leave all layers of mediation behind us and cease to force an understanding.</td>
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<td></td>
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<tr>
<td>Literature</td>
<td>Artistic and Conceptual Thinking and Working: Artistic and Conceptual Thinking and Working by Brian O'Doherty: Inside the White Cube. The Ideology of the Gallery Space. When these essays first appeared in Artforum in 1976, their impact was immediate. They were discussed, annotated, cited, collected, and translated; the three issues of Artforum in which they appeared have become nearly impossible to obtain. Having Brian O'Doherty's provocative essays available again is a signal event for the art world. This edition also includes &quot;The Gallery as Gesture,&quot; a critically important piece published ten years after the others.</td>
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<td>Prerequisites / notice</td>
<td>The number of participants is limited.</td>
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<tr>
<td>051-0223-16L</td>
<td>Free Drawing</td>
<td>W</td>
<td>2</td>
<td>Z. Leutenegger Küng</td>
<td></td>
</tr>
<tr>
<td>Abstract</td>
<td>Free Drawing - Structure and/or strengthening of the capability to express oneself in writing on a journalist level - effortlessly, flexibly and easily , thus primarily on special guidelines with regard to a tight text volume (i.e. blurbs on books or short contributions in magazines).</td>
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<td>Objective</td>
<td>Against the background of my self-developed ten-line-format we are going to discover thematically partly fee, partly architecture related topics, by writing. The seminar enables students to work out concise and coherent texts of high linguistic expression to various topics within very short time.</td>
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<td>Literature</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Application for the course with the lecuturer also via e-mail: <a href="mailto:stefan.keller@arch.ethz.ch">stefan.keller@arch.ethz.ch</a>.</td>
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</tbody>
</table>
The script is provided by the teaching chair and can be purchased the day the elective course starts.

With the architectural drawing we can refer to one of the most important and primary design tools. Imaginations, ideas, as also the observation of important scenarios and impressions could be visualized with the appropriate technique.

Based on the process of the concrete, practical drawing, we can sensitize our perception and enhance also the interaction between head and hand. Also the digital drawing with Wacom tablet (if available) should not be missed out as an additional challenge.

The focus of the drawings are determined in the study of architectural references as: figure, plasticity, body, space, light, atmosphere, etc.

The number of participants is limited.

<table>
<thead>
<tr>
<th>051-0227-16L</th>
<th>Architectural Drawing</th>
<th>W</th>
<th>2 credits</th>
<th>2G</th>
<th>R. Fässer</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Abstract</strong></td>
<td>With the architectural drawing we can refer to one of the most important and primary design tools. Imaginations, ideas, as also the observation of important scenarios and impressions could be visualized with the appropriate technique.</td>
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<tr>
<td><strong>Prerequisites / notice</strong></td>
<td>The number of participants is limited. Application for the course with the lecutrer also via e-mail: Zilla Leutenegger <a href="mailto:leutenegger@arch.ethz.ch">leutenegger@arch.ethz.ch</a></td>
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</table>

In the course of this seminar, we will collectively prepare the exhibition "The Architecture of Russian Revolution" (included in the "gta 50" exhibition series, to be open in February 2017).

To commemorate the 100-year anniversary of the Russian revolution (1917), this seminar examines the impact of the political revolution upon architectural education. We focus on teaching architecture at Moscow Higher Art and Technical Studios (VKhUTEIMAS; 1920-1927), a school that rivaled the Bauhaus as one of the earliest and most important "avant-garde" pedagogical institutions. This experimental-format seminar will serve as a preparation for the exhibition "The Architecture of Russian Revolution," which will open in February 2017 a part of the series of exhibitions devoted to the 50th anniversary of the gta (Institute for the History and Theory of Architecture at ETHZ). The exhibition's particular focus will be on the importance of VKhUTEIMAS legacy for architectural pedagogy (especially, at ETHZ) today.

Collectively, we will develop the concept of the exhibition and make curatorial and installation decisions.

The second hour of lecture is booked for the review of the weekly exercises.

This is not a lecture course. Attendance and active participation is required. There will be weekly mandatory reading and creative assignments (expect circa two hours per week of homework).

Enrolment in agreement with the lecturer only.

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<td><strong>Objective</strong></td>
<td>To commemorate the 100-year anniversary of the Russian revolution (1917), this seminar examines the impact of the political revolution upon architectural education. We focus on teaching architecture at Moscow Higher Art and Technical Studios (VKhUTEIMAS; 1920-1927), a school that rivaled the Bauhaus as one of the earliest and most important &quot;avant-garde&quot; pedagogical institutions. This experimental-format seminar will serve as a preparation for the exhibition &quot;The Architecture of Russian Revolution,&quot; which will open in February 2017 a part of the series of exhibitions devoted to the 50th anniversary of the gta (Institute for the History and Theory of Architecture at ETHZ). The exhibition's particular focus will be on the importance of VKhUTEIMAS legacy for architectural pedagogy (especially, at ETHZ) today.</td>
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</table>
| **Content**    | The Russian Revolution (1917) dramatically changed not only political system, but also the lifestyle and culture in the country, including approaches to architectural education. Student protests against old, academic system of education followed the revolution, leading to a creation, in 1920, of one of the earliest "avant-garde" architectural institutions, the Higher Art and Technical Studios (VKhUTEIMAS) in Moscow.

Instead of the old practice of moving from drawing details to smaller buildings and finally finishing their education by designing a large building, the students now started by analyzing formal elements important for different arts: "Color" served an introduction to painting, "Volume"--to sculpture, "Space"--to architecture, and "Drawing" (that is, line) as an introduction to graphic design. The most developed of the introductory courses, Ladovskii's course "Space," analyzed three-dimensional reality as a combination of "elements of sensation": the basic physical, geometrical, and spatial properties of form, such as mass, volume, gravity, or dynamics. This course will be at a particular focus of our attention. We will approach it from a variety of contexts: the political situation in the aftermath of the Revolution; the changes in Russian culture and society; the developments in science (in particular, experimental psychology) and the new concept of the human that they entailed; the emergence of modernist approaches to architecture and its pedagogy; the challenges that these changes and developments posed for architectural education. As a result of our study, we will develop the concept of an exhibition on VKhUTEIMAS and its importance for architectural pedagogy today. |
| **Prerequisites / notice** | This is not a lecture course. Attendance and active participation is required. There will be weekly mandatory reading and creative assignments (expect circa two hours per week of homework). |

Enrolment in agreement with the lecturer only.

<table>
<thead>
<tr>
<th>051-0621-16L</th>
<th>Architecture and Digital Fabrication</th>
<th>W</th>
<th>4 credits</th>
<th>4G</th>
<th>F. Gramazio, M. Kohler</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Abstract</strong></td>
<td>Advance in technology revolutionizes design and fabrication processes within architecture. Digital fabrication allows immediate production from design data. The architect as author of these data takes a key role in this development. This course focuses on strategies for architectural production by means of algorithmic design tools and computer controlled fabrication methods.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>The goal of the Wahlfach is to learn basic approaches to designing with the knowledge about digital fabrication techniques and their creative application within a specific task.</td>
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<tr>
<td><strong>Content</strong></td>
<td>We use the term digital materiality to describe an emergent transformation in the expression of architecture. Materiality is increasingly being enriched with digital characteristics, which substantially affect architectures physis. Digital materiality evolves through the interplay between digital and material processes in design and construction. The synthesis of two seemingly distinct worlds—the digital and the material generates new, self-evident realities. Data and material, programming and construction are interwoven. This synthesis is enabled by the techniques of digital fabrication, which allows the architect to control the manufacturing process through design data. Material is thus enriched by information; material becomes informed. In the future, architects ideas will permeate the fabrication process in its entirety. This new situation transforms the possibilities and thus the professional scope of the architect.</td>
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<tr>
<td><strong>Lecture notes</strong></td>
<td>The script is provided by the teaching chair and can be purchased the day the elective course starts.</td>
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<tr>
<td><strong>Prerequisites / notice</strong></td>
<td>Limited places (enrolment on lecturer’s acceptance only).</td>
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<table>
<thead>
<tr>
<th>051-0731-16L</th>
<th>CAAD Theory: A Quantum City - How to Think About Cities</th>
<th>W</th>
<th>2 credits</th>
<th>2G</th>
<th>L. Hovestadt</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Abstract</strong></td>
<td>What if cities are not connected in space and time? You easily can talk to them. Just by taking a phone for example. But they are species in parallel universes.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>This course will explore the role of computational power and information technologies in the creation of our imaginaries around the city. We will show you how models and theories, emerging mainly during the 19th and 20th centuries, present leapng correspondences with more ancient conceptions of the city, when observed from an informational perspective.</td>
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</table>
This course will explore the role of computational power and information technologies in the creation of our imaginations around the city. We will show you how models and theories, emerging mainly during the 19th and 20th centuries, present leaping correspondences with more ancient conceptions of the city, when observed from an informational perspective. We will establish a refreshing dialogue in times where we seem to be overwhelmed by the wide range of possibilities that technology and the abundance of information are opening up. We are bored by the overused debates around urbanization as a threat, energy crisis, climate change, smart cities: the same problematic is elucidated, no matter which city you are looking at. Instead, we will explore the possibilities that the digital has to offer to us, the world citizens. Such transformations have taken place since the very inception of cities, and this is why we are convinced that each era including our own has to reinvent its City within its corresponding cultural galaxies.

Throughout this tutorial we will learn to code in Python and further learn to put together a number of custom-made and open source algorithms in order to operate the web programmatically.

#### Literature
- [CAAD Practice: Bots, Characters & Architecture](http://www.caad.arch.ethz.ch)
- [360° - Reality to Virtuality](http://www.caad.arch.ethz.ch)

### Construction / Building Technology

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0587-00L</td>
<td>Workshop on Sustainable Building Certification</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>D. Kellenberger</td>
</tr>
</tbody>
</table>

#### Literature
- [CAAD Practice: Bots, Characters & Architecture](http://www.caad.arch.ethz.ch)
- [360° - Reality to Virtuality](http://www.caad.arch.ethz.ch)
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>ECTS</th>
<th>Instructor(s)</th>
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</thead>
<tbody>
<tr>
<td>101-0177-00L</td>
<td>Building Physics: Moisture and Durability</td>
<td>3</td>
<td>2G</td>
<td>J. Carmeliet, T. Defraeye</td>
</tr>
</tbody>
</table>

**Abstract**

Moisture transport and related degradation processes in building and civil engineering materials and structures; concepts of poromechanics and multiscale analysis; analysis of damage cases.

**Objective**

- Basic knowledge of moisture transport and related degradation processes in building and civil engineering materials and structures
- Introduction to concepts of poromechanics and multiscale analysis
- Application of knowledge by the analysis of damage cases

**Content**

1. Introduction
   - Moisture damage: problem statement
   - Durability

2. Moisture Transport
   - Description of moisture transport
   - Determination of moisture transport properties
   - Hysteresis
   - Transport in cracked materials
   - Damage and moisture transport in cracked media

3. Poromechanics
   - Moisture and mechanics: poro-elasticity
   - Poro-elasticity and salt crystallisation
   - Poro-elasticity and damage
   - Case studies

4. Multiscale analysis
   - Problem statement
   - Multiscale transport model
   - Multiscale coupled transport - damage model

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<tr>
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<th>Instructor(s)</th>
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</thead>
<tbody>
<tr>
<td>101-0577-00L</td>
<td>An Introduction to Sustainable Development in the Built Environment</td>
<td>3</td>
<td>2G</td>
<td>G. Habert</td>
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</tbody>
</table>

**Abstract**

This year the UN Conference in Paris will shape future world objectives to tackle climate change. Dealing with the structural necessity against the background of the formal intent often lead, besides discourses, to architectural and technical enrichment as well as unique buildings. This seminar focuses on the work of key figures, that will be discussed on the basis of short presentations, models, input lectures and invited guests, as well as films and excursions.

**Objective**

At the end of the semester, the students have an understanding of the term of sustainable development, its history, the current political and scientific discourses and its relevance for our built environment.

In order to address current challenges of climate change mitigation and resource depletion, students will learn a holistic approach of sustainable development. Ecological, economical and social constraints will be presented and students will learn about methods for argumentation and tools for assessment (i.e. life cycle assessment).

For this purpose an overview of sustainable development is presented with an introduction to the history of sustainability and its today definition as well as the role of cities, urbanisation and material resources (i.e. energy, construction material) in social economic and environmental aspects.

The course aims to promote an integral view and understanding of sustainability and describing different spheres (social/cultural, ecological, economical, and institutional) that influence our built environment.

Students will acquire critical knowledge and understand the role of involved stakeholders, their motivations and constraints, learn how to evaluate challenges, identify deficits and define strategies to promote a more sustainable construction.

After the course students should be able to define the relevance of specific local, regional or territorial aspects to achieve coherent and applicable solutions toward sustainable development.

The course offers an environmental, socio-economic and socio-technical perspective focussing on buildings, cities and their transition to resilience with sustainable development. Students will learn on theory and application of current scientific pathways towards sustainable development.

**Content**

The following topics give an overview of the themes that are to be worked on during the lecture.

- Overview on the history and emergence of sustainable development
- Overview on the current understanding and definition of sustainable development
- Case Study 1: Sustainable construction, the role of construction industry (national/international)
- Case Study 2: Cities, forms of settlements
- Case Study 3: Material resources, scenarios, energy, construction materials, urban metabolism
- Case Study 4: Buildings, heating/cooling, consumers, prosumers and other stakeholder, cooperations
- Method 1: Life cycle assessment (planning, construction, operation/use, deconstruction)
- Method 2: Economics for sustainable construction
- Method 3: Construction, flexibility, modularity
- Synthesis 1: Climate Change mitigation and adaptation in cities
- Synthesis 2: Transition to sustainable development

**Lecture notes**

All relevant information will be online available before the lectures. For each lecture slides of the lecture will be provided.

**Literature**

A list of the basic literature will be offered on a specific online platform, that could be used by all students attending the lectures.

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<tbody>
<tr>
<td>051-0415-16L</td>
<td>Negotiating Structural Forms: History of Structural Design</td>
<td>2</td>
<td>2G</td>
<td>J. Schwartz</td>
</tr>
</tbody>
</table>

**Abstract**

Does not take place this semester.

**Prerequisite:** Successful completion of Structural Design I-IV.

**Objective**

Getting to know key designers on the borderline between architecture and structural engineering, their positions, concepts and most important buildings.

**Content**

Seminar focusing on the discussion of important essays and buildings of distinguished builders and architects on the basis of short presentations, models, input lectures and invited guests, as well as films and excursions.
The main focus of the diploma elective subject is in showing the building process by means of current examples of urban design with history, theory and methods in historic building.

Visits to construction sites and interdisciplinary lectures on the topics of communication, complexity, landscape and investment are the objective of this course.

None for the time being

The elective is organised as a laboratory where one particular material will be explored on a theoretical and practical level. During this time, the number of participants is limited and enrolment is only possible in agreement with the chair.

In this sense, the course is also intended for civil / structural engineering students and presents a possible bridge between the two development of the project.

In line with the approach of P.L. Nervi’s book, our study is based on factors that, outlined by him, are still today all the more relevant as a new focal points of construction. "Most viewed", "most technically daring", "most unknown", "most discussed" or "most worthy of discussion", and carry valuable criteria and indispensable tools for observation and carrying out investigations of the built environment.

The comparative analysis of built constructions serves as a basis for further development of hypothetical future constructions.

Lessons learned from this can enrich the design work of today’s and tomorrow's architects.

The main focus of the workshop. In addition, the term process is to be depicted by means of visits to manufacturers of construction components.

In line with the approach of P.L. Nervi’s book, "structures", 1956, p.28", the study of the architectural works of the past should consist in the critical examination of their functional and structural needs. [P.L. Nervi: Costruire correttamente, Milano 1955; English version titled "Structures", 1956, p.28].

All of these (see abstract) i.e. analyses, observations, hypotheses, groupings and cross-comparisons, will help the students in their careers to find their own strategies and approaches to design and to be aware of them. And so, according to the advice of Pier Luigi Nervi : "...At every stage of his training, the future architect should be constantly and methodically guided to search for essential elements in each problem, be it large or small. The study of the architectural works of the past should consist in the critical examination of their functional and structural solutions and of the relation between these and form, in order to show that form is a consequence and not a determinant of functional and structural needs." [P.L. Nervi: Costruire correttamente, Milano 1955; English version titled "Structures", 1956, p.28].

The comparative analysis of built constructions serves as a basis for further development of hypothetical future constructions.

The main thread of this course, that runs over two semesters (*), are buildings of all ages that could be categorised under notions such as "most viewed ", "most technically daring ", "most unknown ", "most discussed " or "most worthy of discussion ", and carry valuable criteria and indispensable tools for observation and carrying out investigations of the built environment.

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Lessons learned from this can enrich the design work of today’s and tomorrow's architects.

The main focus of the workshop. In addition, the term process is to be depicted by means of visits to manufacturers of construction components.

In this sense, the course is also intended for civil / structural engineering students and presents a possible bridge between the two prospective project partners - architect and engineer.

(*) Begins in the autumn semester. Entry into the course in the spring is possible.

None for the time being
Theory of Urban Design: Lecturers

The City of Zurich rises there where Celtic tribes settled and the Romans founded a city. In the past two millennia, authorities, planners, and residents have sought to understand the urban history of Zurich through selected case studies.

Abstract

The focus of the seminar is to understand the urban history of Zurich through selected case studies.

Objective

The prospective architect shall develop necessary skills to be able to think in construction in its complex relationships and to face future discussions in practice competently.

Content

The structure of the course contains:

1. Impartation of basic knowledge of construction
2. Seminar / exercises on the state of technology / research
3. Integration of practical case studies and problems

Prerequisites / notice

Enrolment on agreement with lecturer only.

051-0855-16L Masterclass Construction: Steelwork ■ W 2 credits 2G C. Vogt

Number of participants limited to 24.

Abstract

The 'Meisterkurs Konstruktion' is seeking a critical discussion on relevant constructive (and energetic) questions of our time. Alternating each semester, one of the typical construction methods will be examined: masonry, concrete, steel, woodwork, and curtain wall facades. In the autumn semester 2016 we'll focus on contemporary steel constructions.

Objective

The aim of the seminar is to discuss the selected Zurich case studies against the background of the history of urban design.

Content

The City of Zurich rises there where Celtic tribes settled and the Romans founded a city. In the past two millennia, authorities, planners of different disciplines, merchants and craftsmen, institutions and investors have shaped the city upon the Limmat. The physical outcome of these interventions stand in close relationship with the knowledge of the time and reflect the prevailing positions and theories, which were thought, published, and built elsewhere. For that matter, the history of urban design of Zurich can be well understood as a branch of the history of European urban design, as well as the individual steps of development are offsprings of international reflexions and tendencies.

Prerequisites / notice

Having passed the lecture series of Energy and Climate Systems I & II or Technical Installations I & II respectively is required for attending the Integrated Discipline.

051-1219-16L Integrated Discipline Building Systems (A. Schlüter) ■ W 3 credits 2U A. Schlüter

The integrated discipline Building Systems addresses specific questions about building systems and system concepts. Energetic analysis and system designs are carried out on the students' individual design projects.

Objective

The course aims for an ability to understand concepts of sustainable building technology coherently integrated into an architectural design.

Content

The integrated discipline Building Systems addresses specific questions about building systems and system concepts. Energetic analysis and system designs are carried out on the students' individual design projects.

Lecture notes

Skripts are specific to the design task and distributed at the beginning of the course.

Prerequisites / notice

Please contact the tutor as soon as possible at the beginning of the semester; we will set the task according to your chosen design studio.

051-0831-16L Summer School: Pavilion on Lantian Land (China) W 2 credits 4G D. Liu

Does not take place this semester.

This course has been CANCELLED.

issippi Planning / Environmental Design

Number Title Type ECTS Hours Lecturers

051-0369-16L Theory of Urban Design: Does not take place this semester. W 2 credits 2G to be announced

Abstract

The focus of the seminar is to understand the urban history of Zurich through selected case studies.

Objective

The aim of the seminar is to discuss the selected Zurich case studies against the background of the history of urban design.

Content

The City of Zurich rises there where Celtic tribes settled and the Romans founded a city. In the past two millennia, authorities, planners of different disciplines, merchants and craftsmen, institutions and investors have shaped the city upon the Limmat. The physical outcome of these interventions stand in close relationship with the knowledge of the time and reflect the prevailing positions and theories, which were thought, published, and built elsewhere. For that matter, the history of urban design of Zurich can be well understood as a branch of the history of European urban design, as well as the individual steps of development are offsprings of international reflexions and tendencies. Presentations in the seminar room and the visit of the selected ensembles in Zurich will help to tell the story of the urban development from the Middle Ages up to today. With this basic knowledge gained in the seminar and the walks the students will have to discuss the historical theories and developments as well as the urban qualities of the ensembles.

Prerequisites / notice

The number of participants is limited to 24 persons.

051-0625-16L Serendipity: Audiovisual Fieldwork - Gotthard Soundwalking (Ch.Girot) ■ Limited number of participants (limitation due to technical equipment).

W 2 credits 4G C. Girot

Abstract

We will map the landscape above the new Gotthard Base Tunnel with sound recorders and photo cameras, and landscape interventions. Back in our AudioVisual Lab, we will work with audio editing tools, spatial sound design and photographic processing in order to compose a collective multisensory map of the Gotthard.

Objective

The goal of this elective course is to explore the perception, use and representation of landscape through the use audiovisual tools. In this process, spatial, dynamic and cultural aspects are highlighted.

Content

Above the new high-speed Gotthard Base Tunnel lies a fascinating mountain landscape steeped in myths and stories. On an alpine walking tour, we will trace the tunnel's course and mark points a hundred meters higher: alpine pastures, rugged mountains, deep forests, clear lakes, weekend cottages.

We will discover the audiovisual qualities of the mountain landscape, map our overground "tunnel journey" with sound recorders and photo cameras, and intervene in the environment at vertical points of intersection. How is our perception on the surface shaped through the awareness of the tunnel below? How do we experience the vast and lonesome mountain area at a walking pace instead of rushing through it in a secure enclosure? Using techniques from sound art, land art and "strollology", we want to examine the Gotthard, understood as both archaic nature and cultivated alpine landscape, a higtech transit area and a pre-modern refuge, the "center of Europe" and the periphery of Switzerland.

Back in our AudioVisual Lab, we will work with audio editing tools, spatial sound design and photographic processing in order to explore new ways of perceiving and portraying landscape. Through audiovisual journeys and mixed media installations we will compose a collective multisensory map of the Gotthard.
The term 'Urban Food' implicitly questions how the production, processing, distribution, consumption and disposal of food influence the architecture of power in this region. Students will look at the site and its specific organization through various architectural and landscape elements (zero-canal, dam, hydroelectric power plant, bridges). The work will be developed in a condensed weekend workshop.

**Objectives**

- The course will be limited to 16 students. Participation on all dates of the course is mandatory. The costs for the excursion (traveling, overnight stay, food and drinks, ca. 200 CHF) are asked to be paid by the participants. Basic trekking experience and equipment are required (latter can be rented for ca 30 CHF).
- Weekly course dates: on Thursdays, 12:45-14:30h.
- Weekend Workshop/Exkursion: 8./9.10.2016 (further information and costs will follow).
- Final Crit: 1.12.2016 (End of the course)

**Content**

At the end of the elective, we offer the possibility to extend the work of the Elective Course with a Thesis Elective ("Wahlfacharbeit" 6 ECTS). The work will finalize the study done previously towards a publication and exhibition. The thesis elective will be conducted in the form of a 2-week workshop in January 2017. The elective course is compulsory to do the thesis elective.

**Lecture notes**

A reader will provide the theoretical framework.

**Prerequisites / notice**

- Introduction: 22.09.2016, 15:00h HIL H40.9 (Foyer)
- Lectures are given 15-17h in HIL H40.8 (LVML)
- The course is limited to 22 participants
- The lectures will be in English, assistance in E/D/F is required (latter can be rented for ca 30 CHF).
- Further information is available on www.girot.arch.ethz.ch

**Data: 06.03.2019 12:57 Autumn Semester 2016 Page 114 of 1571**
## Positions on Form in the Urban Design Discourse

In this seminar we will take a journey through different positions concerning form in the urban design discourse of the last decades with special regard to the role of utopian visions in the achievement of the "good city form".

### Objective

The aim of the reading seminar is to gain deeper understanding of themes, positions and discourses within the field of urban design.

"What is the ideal city (...) that best expresses the power and beauty of modern technology and the most enlightened ideas of social justice?" - asks Robert Fishman in his opus, Urban Utopias in the Twentieth Century (1977). For Fishman, Ebenezer Howard's Garden City (1898), Le Corbusier's Ville Radieuse (1924) and Frank Lloyd Wright's Broadacre City (1932) stand out among utopian projects for their radically original urban designs, their revolutionary approaches to social change, and their authors' sustained personal commitment to realize the plans. Besides these ideal cities, Fishman suggests that utopian projects fall into two further categories; they are either utopian romances, that is, technical exercises without explicit social agenda, such as the technological utopias of Archigram or Yona Friedman; or urban ideologies, that is, projects that might bear social content but could still be carried out without revolutionary social change, as they tend to preserve an already powerful class. Such are designs produced by totalitarian regimes or dictated by powerful market conditions.

Following Fishman's theoretical grid, we will read concepts from each of his rubrics, while considering utopian design thinking within a broader and more fundamental discussion about the means and ends of urban design. Kevin Lynch asserts that the purpose of urban design is the 'good city' (1981). What is then the role of utopias in achieving this goal? While exploring this question, we will also confront utopias with critical approaches that could be described as pragmatic. Jane Jacobs, for example, argues that utopias demand totalitarian control, whereas urban neighborhoods should be developed and rejuvenated employing bottom-up approaches.

We will ultimately link the studied concepts with various urban forms, such as the megastructure in relation to technological utopias or the Manhattan block in Rem Koolhaas' interpretation. In his book Finding Lost Space (1986) Roger Trancik identifies three major approaches to theories of urban form: the figure-ground, linkage, and place theories. We will classify each of the discussed forms into the above three categories. Thus, we will wrap up the class with a basic grid on form theories - after having started it with another regarding utopian visions.

After an introductory lecture, we will discuss one edited text each week, and confront the different positions they represent with each other. Accordingly, participants will be expected to read one text and write a half-page response each week, to once prepare and hold a 15-minute presentation of a text (including a compact handout), and to actively participate in the discussions. Optionally, 10 to 15-page position papers can be written after the semester as elective theses, honored by additional credit points. A reader with selected texts and thematic introductions will be provided.

A reader will be handed out at the intro event of the elective course. There will be no script handed out.

### Literature

- **Prerequisites / notice**
  - The number of participants is limited to max. 30 students.

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### 051-0701-16L

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<thead>
<tr>
<th>Systematic Principles of Urban Design: Learn from the European City</th>
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<tr>
<td><strong>Abstract</strong> Urban Ensembles of the Modern City: Strategies for Dealing with the Twentieth-Century City</td>
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<tr>
<td><strong>Objective</strong> The seminar will focus on case studies in order to reveal strategies for dealing with the modern city. Built urban-development ensembles from the twentieth century will be embedded in their architectural and historical context, studied with an eye to their constitutive elements and discussed in connection with current urban-planning projects. In addition to various forms of methodological engagement with urban contexts, students will experience how the disciplines of urban-planning history and urban development can be considered in a more integrated way. Moreover, they will receive feedback on how to present the result of their analyses in concise, well-structured talks and in drawings.</td>
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<tr>
<td><strong>Content</strong> The approach to urban-planning ensembles of the twentieth-century city is characterized by their enormous quantity - which also makes dealing with them more difficult. The building stock dating from this era is immense. There is little discussion currently of how larger spatial contexts - housing estates, neighbourhoods, entire cities - can be not just designed and planned but also continuously developed as overall ensembles. Moreover, strategies, instruments and procedures for dealing with the vestiges of twentieth-century urban planning have yet to be established. In the seminar we will discuss how specific approaches to analysing, assessing and further developing of specific case studies have been formulated and explored recently as well as the extent to which they are experimental and deviate from traditional means for preserving and developing the city. Any discussion of an example of urban planning from the previous century must begin with precise analysis: taking up its original urban-planning principles in their historical dimension and all of the features that affect urban planning. The seminar will emphasise this sort of contextual discussion of modern urban space.</td>
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<tr>
<td><strong>Lecture notes</strong> Literature will be distributed as bibliographical list at the first session.</td>
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### 051-0723-16L

<table>
<thead>
<tr>
<th>Information Architecture and Future Cities: Smart Cities</th>
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<tr>
<td><strong>Abstract</strong> What are SMART CITIES and how do they emerge? What is the role of architects and urban designers in this process? How do data turn into information as a building material for the future city? The course covers concepts, methods and techniques in design, simulation and communication of cities. The goal is to learn principles and preconditions for the design of sustainable and smart cities.</td>
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<tr>
<td><strong>Objective</strong> Students gain insight into the next generation of design processes for architects and urban designers, and into concepts of the Information Architecture of SMART CITIES, including the influence of Big Data. They learn about the expanded roles of information and of architecture: information and simulation in architecture as means to make the invisible visible, and architecture as a metaphor and ordering system to structure the immense amounts of data of the Information Society. The seminar is highly interactive and discusses visionary case studies in Europe and Asia and new techniques in Big Data informed smart urban design. Apart from learning about and experiencing Information Architecture and SMART CITIES, the course also introduces research and management skills that will distinguish the future ETH architect. An iBook and the edX Massive Open Online Course (MOOC) Future Cities support the course.</td>
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<tr>
<td><strong>Content</strong> SMART CITIES - What will happen when cities change from static configurations into responsive and dynamic structures? What does it mean to design buildings that undergo the same changes? What is the impact on architectural and urban design education? How can citizens influence this development? The SMART CITIES course will answer these questions and supply you with the necessary skills and knowledge to understand and design such dynamic structures. The intelligent use of data and information are at the core of this course. Data and information are new building materials of future cities. Citizens produce increasing amounts of data in their daily life, with stationary sensors and mobile smartphones. Using those data, citizens begin to influence the design of future cities and the re-design of existing ones. The course will be a first step towards the emerging citizen design science and cognitive design computing. Those will be the next generation of participatory design and design computing.</td>
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<tr>
<td><strong>Lecture notes</strong> iBook INFORMATION CITIES</td>
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<tr>
<td><strong>Literature</strong> The necessary texts will be found on the Chair's website at: <a href="http://www.ia.arch.ethz.ch">http://www.ia.arch.ethz.ch</a>. We specifically recommend the consultation of the Future Cities Website at: <a href="http://www.futurecities.ethz.ch">http://www.futurecities.ethz.ch</a> during the entire course. The iBook INFORMATION CITIES is available in the iBooks Store for free.</td>
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<td><strong>Prerequisites / notice</strong> Interactive seminar including 3 exercises</td>
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### 051-0725-16L

<table>
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<tr>
<th>Digital Urban Visualization: People as Flows</th>
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<tr>
<td><strong>Abstract</strong> We examine patterns of crowd-flows in an extraordinary urbanisation phenomena: festivals.</td>
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<td><strong>Literature</strong></td>
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<td><strong>Prerequisites / notice</strong></td>
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**Data:** 06.03.2019 12:57

**Autumn Semester 2016**

**Page 115 of 1571**
The objective is that the students engage in a debate of a differentiated functional planning as a basis for complex buildings which are to be

We will look at those patterns from two sides. One being the view of a planner asking to find bottle necks or the ideal place for amenities
such as booths, toilets etc. Another being the view of visitors. We will program different behaviours that should compete against each other
in order to compare their different strategies. As a case study we will use the Caliente Festival in Zurich.

For deepening the learnt in a semester thesis we offer to optimise the created simulations to make them available in interactive planning
workshops. Additionally they could be converted into interactive web apps.

http://www.ia.arch.ethz.ch

No programming skills are required.

<table>
<thead>
<tr>
<th>course code</th>
<th>course name</th>
<th>credits</th>
<th>semester</th>
<th>pre-requisites</th>
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<tbody>
<tr>
<td>051-0815-16L</td>
<td>ACTION! On the Real City: Wunderkammer</td>
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<td></td>
<td>A full urban block in the center of Opfikon's Glattpark area is the site of</td>
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<td>intervention for this semester's elective. Students will learn how to</td>
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<td>develop and realize ideas for rapid change in context of both existing</td>
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<td>initiatives and future plans. They will negotiate, edit, intervene, and</td>
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<td>explore the relationship between visionary goals, planning regulations and</td>
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<td>operational possibilities.</td>
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<td></td>
<td>How can we increase urban value through an open and inclusive process? And</td>
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<td>how can we improve upon current planning paradigms via active experimentation?</td>
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<td>The course is run in collaboration with the &quot;Wunderkammer&quot; project, lead by</td>
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<td>Zurich's very own Jane Jacobs, Vesna Tomse, who is well-known for her</td>
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<td>ability to rejuvenate public open space through activating bottom-up</td>
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<td>initiatives. Supported by Stadt Opfikon, the project's mandate is to</td>
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<td>transform the undeveloped site into an area of opportunity through</td>
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<td>incremental change and community buy-in.</td>
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<td>051-0819-16L</td>
<td>Planning Strategies for Complex Buildings Using the Example of Health Facilities</td>
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<td>Independently written scientific paper concerning a subject of planning of</td>
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<td>complex buildings - such as health facility planning and design -</td>
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<td>with special focus upon the dynamic changes in this context and the</td>
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<td>related planning and building reactions to them.</td>
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<td>The objective is that the students engage in a debate of a</td>
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<td>differentiated functional planning as a basis for complex buildings which</td>
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<td>are to be successful functionally, operationally and in design.</td>
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<td>On the basis of a given scope of themes the students carry out research</td>
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<td>aiming for possible improvements for example in health facility planning.</td>
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<td>The scope of subjects is announced at the beginning of each semester.</td>
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<td>Complex buildings such as health care buildings are subject to constant</td>
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<td>change. In a new hospital building 60% of the diagnostic and</td>
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<td>treatment areas are subject to building changes within the first 10 years of</td>
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<td>operation. Architecture has to develop concepts which accommodate this level</td>
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<td>of dynamics into the building structure in a better way.</td>
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<td>In the coming years this need for adaptability is going to be</td>
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<td>challenges even further by the even more reducing health care resources.</td>
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<td>The paper should discuss in this context a specific question in detail by</td>
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<td>analysing problems and developing and discussing potential planning</td>
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<td>solutions.</td>
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<td>Presentations of the lecturer and guests will be made available</td>
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<td>051-0827-16L</td>
<td>Sand: an (in)finite Resource? - Engineering for Development (E4D) Summer</td>
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<td>School</td>
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<td>Number of participants limited.</td>
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<td>The programme revolves around the depleting resource sand and the question</td>
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<td>of how to develop alternative building materials for future</td>
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<td>cities. The course is for 30 master and doctoral students from ETH Zurich</td>
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<td>and other academic institutions (from different disciplines related to</td>
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<td>the topic), joined by faculty members and external experts from fields of</td>
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<td>expertise related to the winter school topic.</td>
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<td>The E4D summer school 2016 aims to develop an integrated vision to a global</td>
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<td>challenge of today's construction industry. The programme revolves around</td>
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<td>the depleting resource sand and the question of how to develop alternative</td>
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<td>building materials for future cities. Led by different experts from around</td>
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<td>the world, students will not only learn the theoretic background of this</td>
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<td>resource but experiment with current and future technologies to transform</td>
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<td>sand and building waste. In the workshops the acquired knowledge will be</td>
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<td>tested and applied. The summer school presents three areas that could</td>
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<td>mobilise sand alternatives for construction and other applications: (i) I.</td>
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<td>Microbiologically Induced Calcite Precipitation (MICP), (ii) Chemical</td>
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<td>Crystalization Processes and (iii) 3D printing.</td>
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</table>
The objective of the summer school is to support PhD researchers in their individual research and specific research stages by sharing their experiences. The summer school will open with an excursion to the housing project Hunzikerareal by the housing cooperative Mehr als wohnen in Zurich. This large mixed-use area development is used as an instructor of how institutions, individuals and artefacts mediate the planning process towards an inclusive and diverse project.

Sustainability is often referred to as an interaction of social, cultural, economic, and ecological aspects. In the construction industry sustainability has been perceived as the optimisation of existing material and energy uses, yet the fundamental energetic and material character of these base resources has not been questioned. The speed of consumption of these resources increases constantly due to demographic pressure and resulting construction, as seen around the world and in particular in developing and emerging countries. A fundamental understanding of metabolic processes is required to frame the question of material and energetic sustainability. At the same time the definition of resources expands to include previously undervalued materials and waste. Finally, advances in digital technology and science have opened new avenues for alternative materials and processes.

The summer school presents three areas that could mobilise sand alternatives for construction and other applications:

I. Microbiologically Induced Calcite Precipitation (MICP): Also known as bio-cementation it is a process utilised in self-healing concrete and soil stabilisation. The application to sand will produce naturally grown structural sand bricks. This workshop will compare MICP for various sand types, building wastes and bacterial cultures.

II. Chemical Crystallization Processes: Based on material computation experiments pioneered by architect and engineer Frei Otto, this workshop combines form finding properties of sand with structural and thinking and chemical crystallization processes.

III. 3D Printing: 3D printing with sand and building waste, finally, explores the potential of sand as a substrate within a binding agent. In combination with a robotic arm, 3D printing of sand is an in situ digitally controlled construction process. It overcomes the need for traditional form-work and transportation of material, thereby reducing the grey energy.

Taking place from 4 to 22 July 2016 at the TU Delft in The Netherlands.

Costs: CHF 500, including board and accommodation. All participants are responsible for organising and financing their own domestic or international travel to Delft, The Netherlands.

The Engineering for Development (E4D) Winter School 2016 will invite 30 master and doctoral students from different disciplines related to the topic of the summer school. Applicants will be selected based on their academic record and previous work experiences. Applicants must send a one-page CV and one-page letter of motivation in PDF format stating their interest, to Ms. Maria Ubiera Apancio (ubiera@fu.baug.ethz.ch) Deadline: 31 March 2016 Notification: 15 April 2016

The summer school aims to bring together an interdisciplinary group of doctoral students who treat the city as their empirical site. Academic backgrounds include, but are not limited to: anthropology, architecture, geography, history, philosophy, political science, sociology, visual arts, and urban planning. In particular, the summer school addresses research exploring the borders of the diverse fields of STS and urban studies. It will be of particular interest to PhD candidates who have already begun their research and are in the stages before or after conducting field studies. As participants are required to enrol in one of three thematic groups, their stages of research may differ per group.

The objective of the summer school is to support PhD researchers in their individual research and specific research stages by sharing their work with keynotes and colleagues. Accordingly, participants are expected to develop their skills of articulating and communicating their ideas, examine various STS methods and techniques of approaching cities, and to discuss their research and obstacles in an academic setting.

During the three sessions; problematizing, describing and assembling, participants are required to indicate which theme fits their paper best as they will be shared within the thematic groups. The first day will include a keynote presentation followed by an informal poster session for each thematic group. The poster sessions are a chance for the other two groups to learn about participants' research and ask questions. The following day two sessions will be held with the support of the respective keynote. During the first (morning) session the participants will present their papers (max 15 min) within their thematic groups followed by a general 20 min discussion. During this time, key points will be noted and later discussed in the second (afternoon) session in which each group will present their plenary discussion and final presentation. The final day presentation for the final day. The final day presentation will be moderated by members of the thematic group. Each thematic group will summarise their discussions and final presentation in a final presentation. The framework for the discussion and presentations will be defined together with the keynotes and could be, for example, a specific question and/or obstacle, a clear toolbox, or excerpts from selected presentations related to each respective theme.

The summer school will open with an excursion to the housing project Hunzikerareal by the housing cooperative Mehr als wohnen in Zurich. This large mixed-use area development is used as an instructor of how institutions, individuals and artefacts mediate the planning process towards an inclusive and diverse project.
Summer School: Learning from Havana

Abstract
The course will function as an inter-disciplinary think-tank exploring the requisites for sustainable urban development of the Old Havana Port (UNESCO World Heritage site) through the lens of architecture, engineering, and social sciences. The challenge is to work in an intensive cross-cultural setting and develop solutions in a complex, real-life context with local practitioners and stakeholders.

Objective
You will receive full support on-site from the Polytechnic University José Antonio Echeverría, La Habana (PUJAE) and ETH tutors from your discipline. In developing the scenarios you will work side by side with young professionals with a grounded knowledge of the field, and be joined by a wide variety of local stakeholders.

The program will combine site visits, expert lectures and workshops to allow you to develop the following skills:
- Conduct your own research within a limited time frame and through quantitative and qualitative analysis;
- Cross cultural understanding and skills in an international collaboration;
- Developing integrated and sustainable urban development strategies.

Content
Cities on the border or an outpost of Western European influence, struggling between globalization, modernization and local traditions, are characterized by great social and spatial disparity. Havana is a characteristic case of such a city, which is currently undergoing rapid urbanization and experiences a critical moment of transition.

At this very moment, the political and economical situation is changing rapidly, with a contradictory process of economic and social opening that becomes now more and more visible in the streets of Havana, with new businesses, restaurants and street activities, announcing further changes in everyday life. How can such fragmented conditions within cities be tackled by integrated and inclusive solutions, rather than fragmented interventions that exclude the challenged local communities?

Moreover, the lack of resources in cities of the Global South often prevents the gathering of modern, digitalized data, while the unstable political structures prevent the implementation of durable planning strategies. These cities need a rapid assessment procedure, in order to identify relevant priorities and potentials. How can we create a comprehensive understanding of the system and propose appropriate solutions, while using quantitative and qualitative data?

The summer school will build on the current "Atlas Urbano de La Habana - Urban Atlas of Havana" and on the project SeDUT (Seminario Internacional de Desarrollo Urbano y Transporte), a three-year Swiss-Cuban cooperative research project on the urban development of Havana and its mobility potentials. The SeDUT project involved many academic, governmental and private stakeholders, such as the Polytechnic University José Antonio Echeverría, the Centro de Estudios Urbanos de La Habana, the Instituto de Planificación Física, the Dirección Provincial de Planificación Física de la Ciudad de La Habana and the design office of Metron AG. Together they represent an important expertise and a high degree of accumulated knowledge.

In a team, you will produce alternative urban scenarios for the planned redevelopment of the Old Port of Havana. You will contribute your expertise and unpack the realities of sustainable development in a tropical climate. How can knowledge from the ETH be combined with Cuban research and translated to a Caribbean context? Through debate, controversy and collaboration it is expected you produce scenarios that integrate your different disciplines and question the preconceptions of sustainable urban development.

This immersive summer school will be structured in three interlocking modules:

In the first module you will investigate the Old Port and gain a strong understanding of the social, environmental and built context in Havana. You will employ analytical mapping to integrate and synthesize different disciplinary knowledge, ranging from quantitative data to subjective observation.

In the second module, you will develop a series of scenarios for the Old Port, proposing alternatives for its sustainable future. You will build on the research from the first module, and explore the potential of your ideas with local stakeholders and professionals from your field. You will document these scenarios using creative and varied representational methods.

In the final module you will pitch your scenarios to decision makers. During this event you will measure their preferences, debate the associated trade-offs, and provide a series of orientations for those planning the future of Havana.

More information on: http://iu-itt.com/teaching/havana-summer-school

Who should apply?
Enthusiastic students currently enrolled in a masters program in ETH Zurich and PUJAE Havana. A balanced group of 15 ETH master students from the D-ARCH, D-BAUG, D-GESS and D-USYS departments will be selected. They will be joined by 15 Cuban students from our partner university.

Applicants should have a strong interest in sustainable urban development and transdisciplinary collaborative research. They should be able to demonstrate their academic strength, motivation, interest and expertise. Knowledge of Spanish is welcome but not obligatory.

Dates in Cuba: 21 August to 1st of September.
Contact: Marie Grob at grob@arch.ethz.ch, enrollment procedure on our webpage.

Summer School: Summer Chantier Valparaiso Chile

Abstract
This program serves to guide the project at its origins. During the summer, and in the intervening school year, groups and students and faculty respond to the existing conditions with tests and interventions that develop the project. This development is also influenced by poetic acts that take place on the project site that open up or introduce new prerogatives or potentials into the work.

Objective
An alternative, experiential approach to architectural education; a humanistic understanding of architecture's relationship to language; a direct relationship to site where drawing and observation are used as practical tools; a direct contact with materials, fabrication and assembly that draws on "low-tech", handson construction methods and their poetic potential; these are the main objectives and principal achievements of the Building Cultures_Summer Chantier program.
Site: La Ciudad Abierta (the Open City)
Founded in 1970, the Open City occupies a 300 hectare parcel of land on the Pacific Ocean, 1 hour north of Valparaiso, Chile and 20 minutes north of Concon. The land comprises diverse ecosystems including wetlands, dunes and temperate forests and is divided in two by a busy two-lane highway. Founded by teachers from the School of Architecture and Design of the Pontifical Catholic University of Valparaiso (e[ad]PUCV) as a place to explore the humanistic potential of architecture - as a poetic space making discipline and as a means to propose new forms of community. The Open City is home to 14 families who live there on a permanent-basis and is also the site of weekly classes and activities for students and faculty from the e[ad]PUCV. The structures nestled in the landscape have been developed and built by students and faculty over the course of the Open City's history.

Project: El Portico de los Huéspedes
El Portico de los Huéspedes is the first permanent structure to be proposed in the Open City in nearly 12 years and was begun through the collaboration between Summer Chantier and the e[ad]PUCV in the summer of 2014. An initial program for the structure was developed by the Open City members and responds to a need within the community for permanent space for both the administrative secretary of the Open City and for guests conducting research. In addition, the program responded to a desire to create a space large enough for the entire e[ad]PUCV community to assemble within the Open City itself. This program is not a set of fixed guidelines but served, and serves, to guide the project at its origins. Similarly, le Portico de los Huéspedes has no fixed plan or finality. During the summer, and in the intervening school year, groups and students and faculty respond to the existing conditions with tests and interventions that develop the project. This development is also influenced by poetic acts that take place on the project site that open up or introduce new prerogatives or potentials into the work.

Project History 2014/15:
Poetic act defining the amplitude of the necessary site;
Definition of the site location, development of principal structure based on a study of Gunnar Asplund's Woodland chapel;
Replacement of wooden pile foundations with concrete foundations;
Poetic Act defining points within the site that became manifested through flexible form-work columns;
Development of secondary structure in wood and brick plazas on northeast and south west corner of site.

Program Outline:
Lausanne Week (late July): The Lausanne week is an intense period of analysis of the existing site conditions. This first encounter with the Open City and le Portico de los Huéspedes is supplemented with lectures that introduce students to some of the ideas defining practice and pedagogy at the Open City: the role of poetry and poiesis, observation and the open-ended project. Site analysis is done through drawing (by hand with tools supplied by the workshop) and model making. Work-days finish with informal critiques where findings are discussed. During the week there will also be an introduction to the working and safety issues related to the chantier and to living near the Open City. Students will work in teams and one of the goals of the week is to already to create a group spirit that will develop throughout the workshop.

Open City (August): The first days of the chantier is meant as a practical introduction to some of the ideas encountered during the Lausanne week. Lectures and events by members of the Open City community introduce students to the pedagogical and poetic potentials into the work.

Applications will be expected until 18th March with interviews conducted in early April and decisions made shortly afterwards.

Applications should be sent via email to summerchantier@epfl.ch and should comprise a brief letter that describes why you are interested in the project and expectations for the Summer Chantier. All candidates will also be interviewed as part of the selection process.

Summer Chantier is looking for self-motivated students who are interested in an experience that provides human, intellectual and physical challenges.

Applications will be expected until 18th March with interviews conducted in early April and decisions made shortly afterwards.

<table>
<thead>
<tr>
<th>051-0623-16L</th>
<th>Travellers. Ocean Territories - Mapping Maritime Geopolitics, Migration and Global Trade</th>
<th>W</th>
<th>1 credit</th>
<th>1V</th>
<th>M. Topalovic</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Abstract</strong></td>
<td>Travellers is a series of five lectures and conversations about ways of perceiving, studying and portraying urban territories. Each of the guest speakers is a traveler - a person who places the direct observation and experience of urban landscapes in the core of their practice. During the autumn of 2016, we will investigate the ocean as a territory.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>The architectural ways of looking, concepts and techniques are unstable at large territorial scales, and yet, urban territories can be seen as crucial contexts for the production of architecture. Seeing an extended urban territory as part of the city - its mirror - can reflect back in the ways we see the city itself, and its architectures. Once a year in autumn, with students and invited guests, we will consider: How can architects look at, study and design urban territories or the &quot;city's constitutive outside&quot;: the periphery, the agglomeration, the countryside and the hinterland? What are the motives (aesthetic, political) architects can have in engaging these territories? The aim is to discuss concepts and techniques for territorial investigations and projects. During the autumn of 2016, we will investigate the ocean as a territory through the lens of artists, researchers and architects focusing on mapping maritime geopolitics, migration and global trade.</td>
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</table>
The topics consider historical periods more deeply. Personalities or specific themes will be examined paradigmatically. Besides the

Hours
History of Art and Architecture: Chicago, Searching Historicism in Zurich
L. Schmitt

What is the ocean as a territory? Once imagined as a boundless space, largely untouched by human activity, are oceans still a common
horizon bringing together the cities and peoples along their shores? Can the open nature of the sea resist the transformative forces of the
carved and conflicted earthly masses it is enclosing? Is the ocean space shaped by the strategic control of resources and trade routes?
What is the role of the architects in investigating, describing and visualising the urban dynamic of the ocean space? Can ocean territories
be designed?

Taking different perspectives, from history, to activism, geopolitics, and design, travellers who have been crossing the global ocean
following refugee migrations, onboard container ships and along ancient maritime routes, contribute elements for an urban portrait of ocean
territories.

03.10.2016
On Migration:
MANUEL HEIZ
architect/researcher

17.10.2016
On Urbanisation of the Sea:
NANCY COULING
architect/researcher

31.10.2016
(TBC)

14.11.2016
(TBC)

28.11.2016:
On the Island of Lampedusa:
ANA DANA BEROS
architect/researcher
conversation with Dubravka Sekulic

Please visit http://topalovic.arch.ethz.ch/projects/ocean-territories/ for updates!

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<tr>
<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>051-0171-15L</td>
<td>History, Criticism and Theory of Architecture: Architecture Machine VI: Ghost Storeys</td>
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</table>

Abstract
The seminar analyses the conditions of contemporary architectural production. In doing so, the importance and meaning of architectural
conventions for the design, construction as well as for the transformation of single buildings is systematically challenged.

Objective
The seminar aims at a critical analysis of both material and ideological conventions of the architectural practice. On the basis of the
historical analysis the students will acquire instruments for a critical examination of the conditions of the current production of the built
environment, in order to develop a sovereign theoretical position on the contemporary architecture.

Content
The seminar will deal with the conventions of the contemporary architectural practice. The proposed topics should be researched out of a
twofold, historical as well as systematic perspective. A detailed description of the syllabus can be found on the homepage of the
professorship: http://stalder.gta.arch.ethz.ch/seminarien.php

051-0319-16L | History of Art and Architecture: Chicago, Searching another American Architecture |

Not eligible as a Compulsory GESS Elective for students of D-ARCH.

Abstract
The history of Chicago and the search of an American architecture. Buildings designed by Henry Hobson Richardson, Louis Sullivan, Frank
Lloyd Wright, Mies van der Rohe, and others.

Objective
The topics consider historical periods more deeply. Personalities or specific themes will be examined paradigmatically. Besides the
transmission of knowledge the main intention is an introduction into the methodology of historical research. Active participation by students is
required.

Content
In the last third of the 19th Century Chicago became center of attraction for a whole generation of American architects, William Le Baron
1893 Chicago was the site of the World’s Columbian Exposition in honour of America's discovery 400 years ago. Chicago, the city in the
middle west, had competed successfully against New York, Cincinnati and Washington D.C to get this once-in-a-hundred-years-event.
In historical view this is less than understandable, because not even 25 years before that Chicago hardly counted 220’000 inhabitants.
Upon connection to the railway net and the subsequent settlement of meat manufacture industries the city had a cometlike rise which
couldn’t even be stopped by a conflagration in 1871.
In the shade of the technical and industrial progress social circumstances which were criticized severely arose.

The seminar investigates Chicago’s role as model for the American large city in the 20th Century. Particularly, the influence of property
speculation and technical improvement - responsible for the nearly unlimited growth of the city (mainly into the hight) - are critically
analyzed. At the same time we investigate the architects’ handling with new technical possibilities, bus also with social problems related to
it, as Louis Sullivan did in a exemplary way in «The tall office building artistically considered» in 1896.

Prerequisites / notice
Not eligible as a Compulsory GESS Elective for students of D-ARCH.
Content

The turn of the 19th century is defining Zurich still today. Even though the older core of the town overlooking the Limmat with its two cathedrals is likewise shaping image and perception, it was through major architectural and structural interventions of the waning 19th century such as the train station, Bahnhofstrasse, Seeufer and larger constructions as the Opera House and Tonhalle, office and commercial buildings, residential quarters and administration and infrastructure buildings that the major city of today was accomplished. Lectures will provide a first introduction into construction activities of these years, fostered by property inspections that will investigate the preserved history of Zurich and its restorations. In brief statements, the students will present literature, inventories or single prominent buildings such as the Zurich Stadthaus, but also the large-scale urban planning concepts. A further emphasis of the seminar is set on the constructional and technical developments of the period.

051-0367-16L
Seminar History of Urban Design: Elements of Urban Space

Abstract
Within our series «Elements of the urban space» we will focus on urban housing. In the parishes Niederdorf, Stiftfeld, Unterstrass, Fluntern und Hirslanden, we will look at numerous housing types on the level of the metropolis, the neighborhood, the building and the urban detail. In doing so, we aim to gather criteria, that are fundamental to an urban living situation.

Objective
The aim of the seminar series is to provide a sound methodological approach in analysing urban space on the scale of the metropolis, the neighborhood, the building and the urban detail. Through a series of neighborhood walks and excursions to the four major city archives, our students gain a methodological approach to city analysis. In the discourse of the seminar, we will gain fundamental criteria for the design of urban situations.

Literature
We will provide our students with a selection of literature and all necessary planning documents in digital form.

051-0783-16L
Special Questions in History of Art and Architecture: Making of the gta

Abstract
In this seminar we will document with video interviews how the Institute for the History and theory of architecture (gta) has studied and shaped the Swiss and international history of architecture and its debates in the past fifty years.

Objective
We will explore the history of the gta as well as the historical and theoretical dimensions of the interview as a research and documentary tool while also developing practical interview skills.

Content
Interviews with architects and artists are popular and versatile. They are a means of research as well as mediation in books and exhibitions. In this seminar we will discuss the many forms and functions of interviews.

The occasion is the jubilee of the Institute for the History and Theory of Architecture (gta), which was founded in 1967. We will interview the protagonists who shaped its formation and development. The video interviews we will conduct will be present at the jubilee exhibition in 2017. We will explore how the gta studied and shaped the Swiss and international history of architecture and its debates. We will discuss different formats of video in exhibitions and develop our own practice.

051-0779-16L
History of Architecture: Colonialism, Architecture & Urbanism in Africa (P.Ursprung)

Abstract
In the 19th and 20th centuries Belgium, Britain, France, Germany, Italy, Portugal, and Spain invaded and colonized the great majority of the African continent. This was coupled with the invention of an unprecedented European modern architecture that was expected to face Africa’s climates and to satisfy colonial administrators, military officers, settlers, tourists, and in rare cases Africans.

Objective
The course examines the multifaceted relationships between colonialism, architecture, and urbanism in Africa under European rule. The aim is to explore and discuss European production, transfer, adaptation, transformation, and exchange of modern architecture and urbanism within and among African colonies and protectorates ruled by the various European powers. Specific examples will be drawn from across the African continent in order to examine the formal, spatial, social, and political characteristics and impacts of new towns, villages, buildings, and elements designed by European architects and planners.

Content
The course is delivered through a series of weekly lectures, discussions of assigned readings, and students’ presentations, which are centered around key themes and specific contexts. Students will be expected to complete one reading per week and one presentation per semester. Each student is invited to choose a town, a building, a personage, a construction material, or an aspect of colonialism in Africa and present it to the class.

Literature
All readings will be available on the course website at the beginning of the semester: http://www.ursprung.arch.ethz.ch/lehrveranstaltungen

Number
Title
Type
ECTS
Hours
Lecturers
851-0252-03L
Cognition in Architecture - Designing Orientation and Navigation for Building Users
W
3 credits
2S
V. Schinazi, B. Emo Nax, C. Hölscher

Abstract
How can behavioral and cognitive science inform architecture? This project-oriented seminar investigates contributions of cognitive science to architectural design with an emphasis on orientation and navigation in complex buildings and urban settings. It includes theories on spatial memory and decision-making as well as hands-on observations of behavior in real and virtual reality.

Objective
The students will learn about relevant theory and methods in cognitive science and environmental psychology that can be used to understand human behavior in built environments. The foundations of environmental psychology and human spatial cognition will be introduced. A focus of the seminar will be on how people perceive their surroundings, how they orient in a building, how they memorize the environment and how they find their way from A to B. Students will also learn about a range of methods including real-world observation, virtual reality experiments, eye-tracking and behavior simulation for design. Students will reflect on the roles of designers and other stakeholders with respect to human-centered design and an evidence-based design perspective. The seminar is geared towards a mix of students from architecture / planning, engineering, computer science and behavioral science as well as anybody interested in the relation between design and cognition.

051-0165-16L
Housing
W
2 credits
2G
to be announced

Abstract
Module 1: Suburban Housing
Module 2: Urban Housing

Objective
Students should be able to recognise and place in context the characteristic features of suburban and urban housing. They will get to know the architectural, socio-cultural aspects of suburban and urban housing.

Data: 06.03.2019 12:57  Autumn Semester 2016  Page 121 of 1571
Housing considered in context: architectural, cultural, social, technical and economic conditions and processes influence housing and modes of habitation. To what extent have they changed in the last century? The construction and renovation of domestic space is a cultural process. What forces construct that space, and according to which criteria? What are the constructional and organizational solutions with which they confront the diversity and metamorphosis of contemporary modes of habitation? How can postulates concerning a sustainable development be implemented? Insights culled from housing research and practice, podium discussions with guests and current examples of innovative housing are included.

Literature

als grundlegende Einführung:

Dietmar Eberle u. Marie Glaser (Hrsg.): Wohnen im Wechselspiel zwischen privat und öffentlich, Niggli Verlag 2009

Leseliste: Obligatorische Literatur zum Thema ist unter www.wohnforum.arch.ethz.ch abrufbar

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<tr>
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<tr>
<td>051-0619-15L</td>
<td>Urban Mutations on the Edge: Commoning</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>M. Angélil</td>
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<tr>
<td>Abstract</td>
<td>The Urban Mutations on the Edge seminar is a series of public lectures by ETH faculty and invited guests addressing the dynamic global peripheries that we believe are most actively changing our conception of the city.</td>
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<tr>
<td>Objective</td>
<td>Participants should leave the course with an understanding of current urban research issues and an introduction to the political dimension of contemporary architectural production.</td>
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<tr>
<td>Content</td>
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<tr>
<td>Lecture notes</td>
<td>Texts to accompany and provide context for each lecture are sent weekly by email.</td>
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<tr>
<td>051-0813-16L</td>
<td>Sociology: Urban Quality of Life - Ethnological Field</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>C. Schmid, H. Nigg</td>
</tr>
<tr>
<td>Research in District 5 and in Zurich North</td>
<td>In this ethnographic field research we examine the question, how people are perceiving and creating their environment, and how an urban quality of life is forming. We investigate four neighborhoods in the Zurich Region: upper District 5, Zurich West, Seebach and Glattpark.</td>
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<tr>
<td>Objective</td>
<td>This elective course highlights the sociological perspective on architectural practice and provides an introduction to sociological research. It focuses on two main procedures: on the one hand, a systematic reading and discussion of theoretical texts, and on the other, empirical case studies of social aspects of the production of the built environment. In this course, a wide set of qualitative research methods is used (including various forms of interview, participant observation, image and text analyses). This approach enables students to gain their own experience by dealing with the various participants and constellations in the social field of architecture and building construction, and to familiarize themselves with the approaches and perceptions of various different participants.</td>
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<tr>
<td>Content</td>
<td>An introduction into ethnographic field research. Urban ethnology concentrates on the urban space, on urban actors, on the cityscape and compares cities of different continents and cultures with each other. Urban ethnology investigates symbols and practices representing and participating in the normal course of city life. Urban ethnology understands urban space not only as built environment, but also as a lived cultural and social context. With an ethnographic field research the perception of actors in local milieus is investigated. How do they see and experience urban contexts? How do they move in the city area? How do they recognize houses, roads and places? How do they hear the city? The perception of local milieus, their obstinacy, creativity and their special way of life is considered significant for better understanding the city as central point of current social development. For ethnographic surveys of the built environment architects nowadays use a number of methods and techniques: participating in observation, interviews, photo and video site inspections in urban rooms, mindmapping etc.</td>
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Dr. Heinz Nigg ist Ethnologue und Kulturschaffender

### Thesis Electives

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>Hours</th>
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<tbody>
<tr>
<td>Abstract</td>
<td>The knowledge gained from the lecture series of technical installations will be applied in this elective course work. Focusing on specific questions, this knowledge will be deepened. Each topic will be individually discussed with each student. Based on the design of studios or other projects, a building will be examined with the goal of emissions-free building operation.</td>
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<tr>
<td>Objective</td>
<td>The objectives are to understand the challenges that arise with these aspects of sustainability, to dimension the resulting technical systems and components, and to implement this in architecture.</td>
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<tr>
<td>Content</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Language: German or English</td>
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<td>Literature</td>
<td>Siehe LITERATURLISTE unter: <a href="http://www.wohnforum.arch.ethz.ch/lehre/wiss_wahlfach-wohnen.html">http://www.wohnforum.arch.ethz.ch/lehre/wiss_wahlfach-wohnen.html</a></td>
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<tbody>
<tr>
<td>063-0165-16L</td>
<td>Housing (Elective Thesis)</td>
<td>W</td>
<td>6</td>
<td>11A</td>
<td>G. Precht</td>
</tr>
<tr>
<td>Abstract</td>
<td>The seminar aims to analyse housing in context. Group discussions, working with literature and data material as well as the elective thesis focus on architectural, cultural, social and economic conditions and processes that influence housing and the modes of habitation.</td>
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<tr>
<td>Objective</td>
<td>The students will provide a differentiated analysis on the subject housing within its social, cultural and economic context. By working scientifically on a individually chosen subject in their elective thesis, they reflect and analyse on the major problems and determine the players and practices, as well as they depict well structured outcomes.</td>
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<td>Content</td>
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<tr>
<td>063-0169-16L</td>
<td>Seminar Architectural Criticism (Thesis Elective)</td>
<td>W</td>
<td>6</td>
<td>11A</td>
<td>L. Stalder</td>
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<tr>
<td>Abstract</td>
<td>In the framework of three elective courses, students need to prepare elective works (seminar works).</td>
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<tr>
<td>Objective</td>
<td>The aim of these papers is to foster an independent engagement with the subjects of the seminar. A scientific familiarization with the respective themes is required. The extent of such a paper ranges from 20 to 30 pages.</td>
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<tr>
<td>Content</td>
<td>The contents of these elective studies are expected to link to the subject matter of the course architectural criticism. Interested students are kindly asked to contact us in order to discuss possible projects.</td>
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<td>063-0171-16L</td>
<td>History, Criticism and Theory of Architecture: City and</td>
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<td>11A</td>
<td>L. Stalder</td>
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<tr>
<td>Architecture (Thesis Elective)</td>
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Data: 06.03.2019 12:57  Autumn Semester 2016  Page 122 of 1571
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<td>063-0173-16L</td>
<td>Spatial Concepts in Film and Architecture (Thesis Elective)</td>
<td>6</td>
<td>Fall</td>
<td>D. E. Agotai Schmid</td>
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<tr>
<td></td>
<td>Within three elective courses the students need to fulfill an elective work</td>
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<td>M. Bächinger Zwicky</td>
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<td>Seminar work. Elective works serve the independent way of dealing with the</td>
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<td></td>
<td>contents of the attending course.</td>
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<tr>
<td>063-0187-16L</td>
<td>Procedures in Design - Techniques of Construction (Thesis Elective)</td>
<td>6</td>
<td>Fall</td>
<td>M. Peter</td>
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<tr>
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<td>Within three elective courses the students need to fulfill an elective work</td>
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<td>contents of the attending course.</td>
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<tr>
<td>063-0193-16L</td>
<td>Performance and Intervention (Thesis Elective)</td>
<td>6</td>
<td>Spring</td>
<td>S. Keller Roca</td>
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<td>Individual completion of an artistic project and public presentation</td>
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<td>(elective coursework).</td>
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<tr>
<td>063-0195-16L</td>
<td>Criticism and Theory (Thesis Elective)</td>
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<td>Fall</td>
<td>K. Sander</td>
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<td>The aims of the Thesis Elective is an independent engagement with the subjects</td>
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<td>of the related Elective Course.</td>
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<tr>
<td>063-0197-16L</td>
<td>Photography (Thesis Elective)</td>
<td>6</td>
<td>Fall</td>
<td>K. Sander</td>
</tr>
<tr>
<td></td>
<td>Individual completion of an artistic project and public presentation</td>
<td></td>
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<tr>
<td></td>
<td>(elective coursework).</td>
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<tr>
<td>063-0201-16L</td>
<td>3D Scanning and Freeform Modeling (Thesis Elective)</td>
<td>6</td>
<td>Fall</td>
<td>K. Sander</td>
</tr>
<tr>
<td></td>
<td>Individual completion of an artistic project with 3-d photography and</td>
<td></td>
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<tr>
<td></td>
<td>digital modeling (elective coursework).</td>
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<tr>
<td>063-0219-16L</td>
<td>Artistic and Conceptual Thinking and Working (Thesis Elective)</td>
<td>6</td>
<td>Fall</td>
<td>S. Keller Roca</td>
</tr>
<tr>
<td></td>
<td>Thesis Elective for Master class students.</td>
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<tr>
<td></td>
<td>Prerequisites: &quot;Artistic and Conceptual Thinking and Working&quot;.</td>
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<tr>
<td></td>
<td>Issues and questions of the artistic project can be brought to the course.</td>
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<tr>
<td>063-0223-16L</td>
<td>Free Drawing (Thesis Elective)</td>
<td>6</td>
<td>Fall</td>
<td>Z. Leutenegger Küng</td>
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<tr>
<td></td>
<td>An elective project in drawing is an assignment with the characteristics</td>
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<td></td>
<td>of research. A topic, a graphic assignment or problem, selected by the</td>
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<tr>
<td></td>
<td>student is furthered through independent work and its evolution documented.</td>
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<tr>
<td>063-0227-16L</td>
<td>Architectural Drawing - Image Lab (Thesis Elective)</td>
<td>6</td>
<td>Fall</td>
<td>R. Fässer</td>
</tr>
<tr>
<td></td>
<td>Practical application and realization of the elective study in collaboration</td>
<td></td>
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<tr>
<td></td>
<td>with the current architectural design project, or as a separate independent</td>
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<tr>
<td></td>
<td>project.</td>
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<td></td>
<td>The architectural visualization, from the first sketch to the substantial</td>
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<tr>
<td></td>
<td>image, establishes itself as an important &quot;decision-maker&quot; for the</td>
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<tr>
<td></td>
<td>progress of the design project. The essential intensity, technique and</td>
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<td>experimental keen, as the search for new forms of representations should be</td>
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<tr>
<td></td>
<td>sought.</td>
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Prerequisites / notice
The prior visit of the elective Architectural Drawing or Image-Laboratory is assumed.
Project proposal please to: faesser@arch.ethz.ch

Abstract
An elective master thesis in architectural theory is a written student assignment of an architectural problem or question, which is to be elaborated into a scientific paper in consultation with the advisors of the chair. The examination of a specific problem asks for a conscious and critical reflection of interdisciplinary approaches and methods.
Objective
Within the framework of an elective master thesis the student can enhance the acquired knowledge in architectural theory in written form. The major thesis serves the development of scientific methods, the derivation, development and verbalization of conclusions and the contextualization within a theoretical setting. In a broader sense it serves the training of verbal skills, the development of a critical verbal, cognitive and imaginary access to problems in the realm of architecture and its neighboring disciplines in the humanities.
Content
The contents of these elective studies are expected to link to the subject matter of the attended course.

063-0317-16L History of Art and Architecture (Thesis Elective) ▼ W 6 credits 11A P. Ursprung
Abstract
Independent and scientific thesis on a monographic or thematic topic within the scope of the history of art and architecture.
Objective
The objective is to write an independent thesis on a monographic or thematic topic within the scope of the history of art and architecture. The focus is to thus exemplify a comprehensive view of the approach and methods towards the modern history of art.
Content
The objective of the elective subject is, in coordination with the advisors, to work autonomously on a subject from the history of architecture. Beside own ideas also positions of research should be considered; we set value on a correct scientific form as well as a clear language. The work should cover 36'000 signs as well as image material if needed. At the beginning and before delivery of the work an elaborate discussion will take place.

Abstract
Essay on a Subject from the Field of Architectural History
Objective
Independent preparation of a scholarly essay on a topic from the field of architectural history.
Content
The aim of the elective course paper is to discuss a topic freely selected from the field of architectural history, in agreement with the assistant lecturer(s). In addition to original ideas, positions taken in the history of research on the subject should also be discussed. It is important to use the correct scholarly format and clear language. The paper should be approximately 40'000 characters in length and should also include as much pictorial material as needed.
Prerequisites / notice
Please contact the assistants before the inscription.

063-0355-16L Preservation of Cultural Heritage (Thesis Elective) ▼ W 6 credits 11A S. Holzer
Abstract
Does not take place this semester.
Objective
The Elective Subject Degree Tests are meant to enable a deeper level of individual engagement with the contents of the elective subjects. Topics of electives can be elaborated into elective degree tests.
Content
Contents depend on the specific curriculum of each semester and will be determined in consultation with the faculty advisor. Independent study is possible, however, only after consultation.

063-0367-16L History of Urban Design (Thesis Elective) ▼ W 6 credits 11A V. Magnago Lampugnani
Abstract
Within three elective courses the students need to fulfill an elective work (seminar work). Elective works serve the independent way of dealing with the contents of the according elective course.
Objective
Aim of this seminar work is to learn how to write a small thesis on a case study. This work should include a creative text, but also to obey certain rules, which turn a regular text into a scientific one.
Content
The contents of these elective studies are expected to link to the subject matter of the attended course.
Prerequisites / notice
Einer Anmeldung zum Wahlfach muss ein Gespräch mit einem der Assistenten des Lehrstuhls vorangehen. Es ist daher vor einer Anmeldung ratsam Kontakt zu einem der Betreuungsassistenten aufzunehmen.

Abstract
Feminine theory of urban design (18th-21st century). The task of this seminar is working with texts about the city written by women. The texts will be analysed, compared and examined employing different scientific methods.
Objective
The main aim of this seminar is learning the scientific handling of theoretical texts on the city. These texts range from pamphlets, to commentaries and literary products.
Content
The contents of these elective studies are expected to link to the subject matter of the attended course.

Abstract
The efforts for entanglements of architectonic and constructive concepts had resulted in wide discussions and in unique buildings during different time periods (i.e. ferroconcrete in the nineteen-thirtees and nineteen-fifties), furthermore to architectonic and technical enrichments.
Objective
Getting to know important critical figures between architecture and engineering as well as their attitudes and concepts and the most distinguished buildings.
Content
Seminar to the studies and for discussion of important texts and buildings of the most famous construction engineers and architects by listening to reviews, presentations and models, input lectures and guest speeches, films and joint surveys.

063-0515-16L Building Physics (Thesis Elective) ▼ W 6 credits 11A J. Carmeliet
Abstract
Prerequisites for Urban Physics: successful termination of "Building Physics IV: Urban Physics". For Building Physics in general: Knowledge in the relevant field.
Objective
The aims of the elective work is to gain comprehensive insight in specific issues related to urban physics and low-energy buildings. These issues may concern: wind & thermal comfort in the built environment, heat islands, cross-ventilation, driving rain, pollution dispersion, new technologies for low-energy buildings, design of building systems, optimal control. The work may include computational modelling and prototype testing in laboratory.
Content
The contents of these elective studies are expected to link to the subject matter of the attended course.

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Within three elective courses the students need to fulfill an elective work (seminar work). Elective works serve the independent way of understanding and engagement within existing academic discourse. Work is typically conducted in teams of two.

The goal of the Wahlfacharbeit is the in-depth analysis of a topic in the field of digital design and fabrication. The students should develop a personal, algorithmic design system till fabrication. A theoretical placement of the work within the current research discourse is desirable.

The term "pairi-daeza", Persian for "a wall surrounding a garden", is the point of origin for an elective series addressing basic elements of landscape architecture. Architecture students develop a project based on the perception of place, Metropolis, including the topics of border, threshold, water, vegetation, topography, choreography, and metaphor. The elective course serves as an introduction to landscape architectural design. Architecture students develop a project based on the perception of place, cognizance of landscape-architectonic typologies, and conception of public space. They become familiar with model building as a design methodology as well as with representation in plan form. The design process is accompanied by workshops, lectures, excursions, critiques, and a workbook.

Pairi-Daeza: Water (Elective Thesis)

The elective thesis HS15 will be held as part of the current edition of the Swisspearl® Summerschool, 31.08. to 11.09.2015, thus on site, in the Eternit production facilities in Payerne! Everybody can participate in the Summerschool, enrolment details will be given within due time on the chair's webpage.

Pairi-Daeza: Water (Elective Thesis)

This Thesis Elective is an introduction to urban research, how to conduct it, and why it is a useful undertaking. The basis of the course is the Urban Mutations on the Edge lecture series. Additional seminar and individual meetings are held on select Thursdays throughout the semester.

The final product of the research is a publication-quality scientific article of approximately 2000 words that demonstrates a basic level of personal, algorithmic design system till fabrication. A theoretic placement of the work within the current research discourse is desirable.

The objective of the elective works is to work independently in a scientific way on a problem in contemporary urban design.

The use and development of concepts, methods and techniques in computer-based design, simulation and analysis, in communication and in the visualization of information.

Information Architecture (Thesis Elective)

The students can explore an ongoing subject from teaching or research of the chair "Information Architecture" in detail. In consultation with the chair individual topics are possible, too.

The contents of these elective studies are expected to link to the subject matter of the attended course.

The elective thesis HS15 will be held as part of the current edition of the Swisspearl® Summerschool, 31.08. to 11.09.2015, thus on site, in the Eternit production facilities in Payerne! Everybody can participate in the Summerschool, enrolment details will be given within due time on the chair's webpage.

Serendipity (Thesis Elective)

The elective gives students the opportunity to expand their knowledge in the area of landscape architecture. Free thesis is only possible after consultation with the tutor and has to be well prepared by the student (statement, catalogue of questions).

The elective thesis HS15 will be held as part of the current edition of the Swisspearl® Summerschool, 31.08. to 11.09.2015, thus on site, in the Eternit production facilities in Payerne! Everybody can participate in the Summerschool, enrolment details will be given within due time on the chair's webpage.
Further information: http://www.caad.arch.ethz.ch

**063-0731-16L**  
**CAAD Theory (Thesis Elective)** - 6 credits - 11A  
**Abstract**  
Within three elective courses the students need to fulfill an elective work (seminar work). Elective works serve the independent way of dealing with the contents of the according elective course.  
**Objective**  
Within three elective courses the students need to fulfill an elective work (seminar work). Elective works serve the independent way of dealing with the contents of the according elective course.  
**Content**  
AUTUMN SEMESTER: In this course an introduction to programming is given with the intention to understand programming as formulation of an intention which eventually yields architectural results. In addition, fundamental techniques are explained and as well as elements of graphics programming introduced. On the other hand, methods are also taught which permit ideas to be converted into viable programs. Although in the course the programming language C++ and a special programming environment is used, a large part of the learning can be used for other programming languages.  
**Lecture notes**  
www.caad.arch.ethz.ch  
**Literature**  
www.caad.arch.ethz.ch

**063-0733-16L**  
**CAAD Practice (Thesis Elective)** - 6 credits - 11A  
**Abstract**  
Within three elective courses the students need to fulfill an elective work (seminar work). Elective works serve the independent way of dealing with the contents of the according elective course.  
**Objective**  
Within three elective courses the students need to fulfill an elective work (seminar work). Elective works serve the independent way of dealing with the contents of the according elective course.  
**Content**  
http://www.caad.arch.ethz.ch  
**Lecture notes**  
http://www.caad.arch.ethz.ch  
**Literature**  
www.caad.arch.ethz.ch

**063-0761-16L**  
**History, Theory and Methods in Historic Building Conservation and Building Research (Thesis Elective)** - 6 credits - 11A  
**Abstract**  
Does not take place this semester.  
**Objective**  
The Elective Subject Degree Tests are meant to enable a deeper level of individual engagement with the contents of the elective subjects. Topics of electives can be elaborated into elective degree tests.  
**Content**  
The general aim of this intensification is teaching competency in analysis and interpretation in the following areas: knowledge of artifacts, dynamics of systems, historical contexts, history of knowledge and theory as well as an approach to scholarly work.  
**Prerequisites / notice**  
Contents depend on the specific curriculum of each semester and will be determined in consultation with the faculty advisor. Independent study is possible, however, only after consultation.  
**Lecture notes**  
Script only available in german.  
**Literature**  
“Economic modell for real estate development”  
http://www.bauoek-modell.ethz.ch  
The registration sheet can be downloaded here:  
http://www.bauprozess.arch.ethz.ch/education-okonomie

**063-0765-16L**  
**Building Process: Economy (Thesis Elective)** - 6 credits - 11A  
**Abstract**  
E lective works serve the independent way of dealing with the contents of the according elective course.  
**Objective**  
To grasp the coherences of costs, income and income return. In-depth studies of the interaction of the market, building costs, finance and location.  
**Content**  
Elective works serve the independent way of dealing with the contents of the according elective course.  
**Prerequisites / notice**  
Economic model for real estate development  
http://www.bauoek-modell.ethz.ch

**063-0767-16L**  
**Building Process: Thesis Elective** - 6 credits - 11A  
**Abstract**  
E lective works serve the independent way of dealing with the contents of the according elective course.  
**Objective**  
Goal of this elective thesis is a self-dependent and coherent argumentation with the contents of the previous visited elective course "Building Process: Design Phase".  
**Content**  
Elective works serve the independent way of dealing with the contents of the according elective course.  
**Literature**  
Sacha Menz (Hrsg.), Drei Bücher über den Bauprozess, vdf Hochschulverlag an der ETH Zürich, 2009  
L iteraturempfehlungen unter www.bauprozess.arch.ethz.ch

**063-0781-16L**  
**Costruire correttamente/Construire Correctly (Thesis Elective)** - 6 credits - 11A  
**Abstract**  
Writing a thesis elective will enable the student to carry out an architecturally and constructionally founded discussion of a topic (to be chosen by the student from the lecture material). The lessons learned and experience gained should stimulate the design work of the future architect.  
**Objective**  
The ability to recognize, understand and interpret connections in the built environment between architecture, the design of spaces and structural design so that these connections can support design work as an architect.  
**Content**  
The thesis elective represents a consolidation or one or more stages of a topic, that are outlined in the objectives. These stages include the analysis, understanding, interpretation and application of this knowledge in one's own design.  
**Prerequisites / notice**  
To apply for a thesis elective (possible alone or in a pair), please speak with the lecturers about the topic, approach and time plan.

**063-0813-16L**  
**Sociology (Thesis Elective)** - 6 credits - 11A  
**Abstract**  
Individual thesis with connection to a Master course in sociology III  
**Objective**  
Thesis Electives are reports oriented on the standards of social sciences. Students learn to write a scientific report which follows the state of the art in respect of content, methods, format, internal coherence and scientific validity.  
**Content**  
The contents of these elective studies are expected to link to the subject matter of the attended course.

**063-0815-16L**  
**ACTION! Empowering the Real City (Thesis Elective)** - 6 credits - 11A  
**Abstract**  
In relation to the elective course "ACTION!" students will have the possibility to extend their research into the behaviours and components that make up the urban realm. A special focus on the processes and mechanisms of (in)formal urban forms and systems will characterise the research. Specific research goals tailored to individual interests will be discussed before proceeding.
Within three elective courses the students need to fulfill an elective work (seminar work). Elective works serve the independent way of working and research. In the elective thesis "New focal points of construction" constructive points as base, wall, chamber, roof etc. are rethought reflecting the need for adaptability which is going to be challenges even further by the even more reducing health care resources. The paper should discuss in this context a specific question in detail by analysing problems and developing and discussing potential planning solutions.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>063-0823-16L</td>
<td>Material-Lab (Thesis Elective)</td>
<td>W</td>
<td>6 credits</td>
<td>11A</td>
<td>A. Spiro</td>
</tr>
<tr>
<td>063-0825-16L</td>
<td>Master Class Construction (Thesis Elective)</td>
<td>W</td>
<td>6 credits</td>
<td>11A</td>
<td>C. Vogt</td>
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</table>

**Seminar Weeks**

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>051-0911-16L</td>
<td>Seminar Week Autumn Semester 2016</td>
<td>W</td>
<td>2 credits</td>
<td>3A</td>
<td>Lecturers</td>
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**GESS Science in Perspective**

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>363-1065-00L</td>
<td>Design Thinking: Human-Centred Solutions to Real World Challenges</td>
<td>W</td>
<td>5 credits</td>
<td>5G</td>
<td>A. Cabello Llamas, F. Rittiner, S. Brusoni, C. Hölscher, M. Meboldt</td>
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</table>

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Objective
During the course, students will learn about different design thinking methods and tools. This will enable them to:
- Generate deep insights through the systematic observation and interaction of key stakeholders.
- Engage in collaborative ideation with a multidisciplinary (student) team.
- Rapidly prototype and iteratively test ideas and concepts by using various materials and techniques.

Content
The purpose of this course is to equip the students with methods and tools to tackle a broad range of problems. Following a Design Thinking approach, the students will learn how to observe and interact with key stakeholders in order to develop an in-depth understanding of what is truly important and emotionally meaningful to the people at the center of a problem. Based on these insights, the students ideate on possible solutions and immediately validate them through quick iterations of prototyping and testing using different tools and materials. The students will work in multidisciplinary teams on a set of challenges that are organized as a one-week, a three-week, and a final six-week project with an external project partner. In this course, the students will learn about the different Design Thinking methods and tools that are needed to generate deep insights, to engage in collaborative ideation, rapid prototyping and iterative testing.

Design Thinking is a deeply human process that taps into the creative abilities we all have, but that get often overlooked by more conventional problem solving practices. It relies on our ability to be intuitive, to recognize patterns, to construct ideas that are emotionally meaningful as well as functional, and to express ourselves through means beyond words or symbols. Design Thinking provides an integrated way by incorporating tools, processes and techniques from design, engineering, the humanities and social sciences to identify, define and address diverse challenges. This integration leads to a highly productive collaboration between different disciplines.

For more information and the application visit: http://sparklabs.ch/ethz

Prerequisites / notice
Class attendance and active participation is crucial as much of the learning occurs through the work in teams during class. Therefore, attendance is obligatory for every session. Please also note that the group work outside class is an essential element of this course, so that students must expect an above-average workload.

Master's Thesis

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<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>051-0141-00L</td>
<td>Master's Thesis</td>
<td>O</td>
<td>33 credits</td>
<td>40D</td>
<td>Professors</td>
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</table>

Only students who fulfill the following criteria are allowed to begin with their master thesis:

a. successful completion of the bachelor programme;
b. fulfilling of any additional requirements necessary to gain admission to the master programme.

Abstract
The Master-Thesis contains a written proposal due to a given master-programme within the work-field of an architect.

Objective
The Master-Thesis has to be an individual work by the students and be proof of the ability to independent design work.

Course Units for Additional Admission Requirements

The courses below are only available for MSc students with additional admission requirements.

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<thead>
<tr>
<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>051-1100-AAL</td>
<td>Architectural Design V-IX</td>
<td>E-</td>
<td>13 credits</td>
<td>16U</td>
<td>Lecturers</td>
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</tbody>
</table>

Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Please register (www.mystudies.ethz.ch) only after the internal enrolment for the design classes (see http://www.einschreibung.arch.ethz.ch/design.php)

Abstract
For Master students with additional obligations only! - Out of the offered courses "Architectural Design V-IX" the student is required to achieve 13 ECTS. There are 2 attempts only.

Objective
Qualification to control the design process increasingly independent and with sole responsibility and to find to an individual design methodology and attitude.

Content
For Master students with additional obligations only! - Out of the offered courses "Architectural Design V-IX" the student is required to achieve 13 ECTS. There are 2 attempts only.

Architecture Master - Key for Type

<table>
<thead>
<tr>
<th>Key for Type</th>
<th>Description</th>
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<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
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<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
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<tr>
<td>W</td>
<td>Eligible for credits</td>
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</table>

Key for Hours

<table>
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<tr>
<th>Key</th>
<th>Description</th>
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<tr>
<td>V</td>
<td>lecture</td>
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<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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<table>
<thead>
<tr>
<th>ECTS</th>
<th>Description</th>
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<tbody>
<tr>
<td>E</td>
<td>Recommended, not eligible for credits</td>
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<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
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</tbody>
</table>

European Credit Transfer and Accumulation System

<table>
<thead>
<tr>
<th>Key for Hours</th>
<th>Description</th>
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<tbody>
<tr>
<td>V</td>
<td>lecture</td>
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<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<td>S</td>
<td>seminar</td>
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<td>K</td>
<td>colloquium</td>
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Special students and auditors need special permission from the lecturers.
This course will be designed as a reading course in 1-2 small groups of 8 students maximum. It will be based on the textbook below. The

<table>
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<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>701-1221-00L</td>
<td>Dynamics of Large-Scale Atmospheric Flow</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>H. Wernli, S. Pfahl</td>
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<tr>
<td></td>
<td>Dynamic, synoptic Meteorology</td>
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<tr>
<td></td>
<td>Understanding the dynamics of large-scale atmospheric flow</td>
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<td></td>
<td>Dynamical Meteorology is concerned with the dynamical processes of the earth's atmosphere. The fundamental equations of motion in the atmosphere will be discussed along with the dynamics and interactions of synoptic system - i.e. the low and high pressure systems that determine our weather. The motion of such systems can be understood in terms of quasi-geostrophic theory. The lecture course provides a derivation of the mathematical basis along with some interpretations and applications of the concept.</td>
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<td>Lecture notes</td>
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<tr>
<td>Literature</td>
<td>Dynamics of large-scale atmospheric flow</td>
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<tr>
<td></td>
<td>- Pichler H., Dynamik der Atmosphäre, Bibliographisches Institut, 456 pp. 1997</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Physics I, II, Environmental Fluid Dynamics</td>
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<tr>
<td>651-4053-05L</td>
<td>Boundary Layer Meteorology</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>M. Rotach, P. Calanca</td>
</tr>
<tr>
<td></td>
<td>The Planetary Boundary Layer (PBL) constitutes the interface between the atmosphere and the Earth's surface. Theory on transport processes in the PBL and their dynamics is provided. This course treats theoretical background and idealized concepts. These are contrasted to real world applications and current research issues.</td>
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<td>Objective</td>
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<td>Overall goals of this course are given below. Focus is on the theoretical background and idealised concepts. Students have basic knowledge on atmospheric turbulence and theoretical as well as practical approaches to treat Planetary Boundary Layer flows. They are familiar with the relevant processes (turbulent transport, forcing) within, and typical states of the Planetary Boundary Layer. Idealized concepts are known as well as their adaptations under real surface conditions (as for example over complex topography).</td>
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<td>Content</td>
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<td>- Introduction</td>
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<td>- Turbulence</td>
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<td>- Statistical tratment of turbulence, turbulent transport</td>
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<td>- Spectral characteristics</td>
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<td></td>
<td>- Concepts for non-ideal boundary layer conditions</td>
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<tr>
<td>Lecture notes</td>
<td>available (i.e. in English)</td>
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<td>Prerequisites / notice</td>
<td>Umwelt-Fluiddynamik (701-0479-00L) (environment fluid dynamics) or equivalent and basic knowledge in atmospheric science</td>
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</table>

#### Weather Systems and Atmospheric Dynamics

#### Climate Processes and Feedbacks

#### Atmospheric Composition and Cycles
materiel is distributed during the lecture

List of literature included in scrip

2G
B. Buchmann, A. Stenke

Short presentation of thermodynamical and kinetic basics of chemical reactions: bi- and termolecular reactions, photo-dissociation.

Type
Hours
This course will introduce some of the main quantitative methods available for the quantitative treatment of geochemical data, as well as

ECTS

<table>
<thead>
<tr>
<th>102-0635-01L</th>
<th>Air Pollution Control</th>
<th>W</th>
<th>6 credits</th>
<th>4G</th>
<th>B. Buchmann, P. Hofer</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Abstract</strong></td>
<td>The lecture provides in the first part an introduction to the formation of air pollutants by technical processes, the emission of these chemicals into the atmosphere and their im-pact on air quality. The second part covers different strategies and techniques for emission reduction. The basic knowledge is deepened by the discussion of specific air pollution problems, scrubbers) with their different mechanisms (field forces, impaction and diffusion processes) and the modelling of these mechanisms. Procedures for the removal of gaseous pollutants and the description of the driving forces involved, as well as the equilibrium and the kinetics of the relevant processes (absorption, adsorption as well as thermal, catalytic and biological conversions). Discussion of the technical possibilities to solve the actual air pollution problems.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>The students gain general knowledge of the factors resulting in air pollution and the techniques used for air pollution control. The students can identify major air pollution sources and understand the methods for measurement, data collection and analysis. The students can evaluate possible control methods and equipment, design a control system and estimate the efficiency and cost. The students know the different techniques of air pollution control and their scientific backbones. They are able to incorporate goals concerning the air quality into their engineering work.</td>
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</table>
| **Content** | Part 1 Emission, Immission, Transmission
- fluxes of pollutants and their environmental impact
- physical and chemical processes leading to emission of pollutants
- mass and energy of processes
- emission measurement techniques and concepts
- quantification of emissions from individual and aggregated sources
- extent and development of the emissions (Switzerland and global)
- propagation and transport of pollutants (transmission)
- meteorological parameters influencing air pollution dispersion
- deterministic and stochastic models, describing the air pollution dispersion
- dispersion models (Gaussian model, box model, receptor model)
- measurement concepts for ambient air (immission level)
- extent and development of ambient air mixing ratios
- goal and instrument of air pollution control | 
| **Part 2 Air Pollution Control Technologies** | The reduction of the formation of pollutants is done by modifying the processes (pro-cess-integrated measures) and by different engineering operations for the cleaning of waste gas (downstream pollution control). It will be demonstrated, that the variety of these procedures can be traced back on the application of a few basic principles of physical chemistry.
- Procedures for the removal of particles (inertial separator, filtration, electrostatic precipitators, scrubbers) with their different mecha-nisms (field forces, impaction and diffusion processes) and the modelling of these mechanisms.
- Procedures for the removal of gaseous pollutants and the description of the driving forces involved, as well as the equilibrium and the kinetics of the relevant processes (absorption, adsorption as well as thermal, catalytic and biological conversions).
- Discussion of the technical possibilities to solve the actual air pollution problems. | 
| **Lecture notes** | Brigitte Buchmann, Air pollution control, Part I
- Peter Hofer, Air pollution control, Part II
- Lecture slides and exercises | 
| **Literature** | List of literature included in scrip | 
| **Prerequisites / notice** | College lectures on basic physics, chemistry and mathematics | 

701-1233-00L | Stratospheric Chemistry | W | 4 credits | 2+V+1U | T. Peter, A. Stenke |
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<tr>
<td><strong>Objective</strong></td>
<td>The lecture gives an overview on the manifold reactions which occur in the gas phase, in stratospheric aerosol droplets and in polar cloud particles. The focus is on the chemistry of stratospheric ozone and its influence through natural and anthropogenic effects. Especially the intercontinental air traffic and the ozone depletion caused by FCKW CFC in the mid-latitude and the polar regions as well as coupling with the greenhouse effect.</td>
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<tr>
<td><strong>Content</strong></td>
<td>Short presentation of thermodynamical and kinetic basics of chemical reactions: bi- and thermo- molecular reactions, photo-dissociation. Introduction to the chemical family concept: active species, their source gases and reservoir gases. Detailed treatment of the pure oxygen family (odd oxygen) according to the Chapman chemistry. Radical reactions of the oxygen species with nitric oxide, active halogens (chlorine and bromine) and odd hydrogen. Ozone depletion cycles. Methane depletion and ozone production in the lower stratosphere (photo-smog reactions). Heterogeneous chemistry on the background aerosol and its significance for heavy air traffic. Chemistry and dynamics of the ozone hole: Formation of polar stratospheric clouds and chloride activation.</td>
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<tr>
<td><strong>Lecture notes</strong></td>
<td>Documents are provided in the contact hours.</td>
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<tr>
<td><strong>Prerequisites / notice</strong></td>
<td>Prerequisites: Basics in physical chemistry are required and an overview equivalent to the bachelor course in atmospheric chemistry (lecture 701-0471-01) is expected.</td>
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701-1233-00L starts in the first week of the semester. The exercises 701-1233-00 U will start only in the 2nd week of the semester.

Climate History and Paleoclimatology

<table>
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<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
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<tr>
<td>651-4049-00L</td>
<td>Conceptual and Quantitative Methods in Geochemistry</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>O. Bachmann, M. Schönächler, D. Vance</td>
</tr>
</tbody>
</table>
| **Abstract** | This course will introduce some of the main quantitative methods available for the quantitative treatment of geochemical data, as well as the main modelling tools. Emphasis will both be on conceptual understanding of these methods as well as on their practical application, using key software packages to analyse real geochemical datasets. 
For this course the successful completion of the BSc-course "Geochemistry" (651-3400-00L) is a condition. | 
| **Objective** | Development of a basic knowledge and understanding of the main tools available for the quantitative analysis of geochemical data. | 

Data: 06.03.2019 12:57
Autumn Semester 2016
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The following approaches will be discussed in detail: major and trace element modelling of magmas, with application to igneous systems; methods and statistics for calculation of isochrons and model ages; reservoir dynamics and one-dimensional modelling of ocean chemistry; modelling speciation in aqueous (hydrothermal, fresh water sea water) fluids.

We will discuss how these methods are applied in a range of Earth Science fields, from cosmochemistry, through mantle and crustal geochemistry, volcanology and igneous petrology, to chemical oceanography.

A special emphasis will be put on dealing with geochemical problems through modeling. Where relevant, software packages will be introduced and applied to real geochemical data.

Lecture notes
Slides of lectures will be available.

Prerequisites / notice
Pre-requisite: Geochemistry (651-3400-00L), Isotope Geochemistry and Geochronology (651-3501-00L).

Lecture notes
Slides of lectures will be available.

Prerequisites / notice
Pre-requisite: Geochemistry (651-3400-00L), Isotope Geochemistry and Geochronology (651-3501-00L).

651-4057-00L Climate History and Palaeoclimatology

Abstract
The course "Climate history and palaeoclimatology gives an overview on climate through geological time and it provides insight into methods and tools used in palaeoclimate research.

Objective
The student will have an understanding of evolution of climate and its major forcing factors -orbital, atmosphere chemistry, tectonics- through geological time. He or she will understand interaction between life and climate and he or she will be familiar with the use of most common geochemical climate "proxies", he or she will be able to evaluate quality of marine and terrestrial sedimentary palaeoclimate archives. The student will be able to estimate rates of changes in climate history and to recognize feedbacks between the biosphere and climate.

Content
Climate through geological time: "lessons from the past"

Cretaceous greenhouse climate

The Late Paleocene Thermal Maximum (PETM)

Cenozoic Cooling

Onset and Intensification of Southern Hemisphere Glaciation

Onset and Intensification of Northern Hemisphere Glaciation

Pliocene warmth

Glacial and Interglacials

Millennial-scale climate variability during glaciations

The last deglaciation(s)

The Younger Dryas

Holocene climate - climate and societies

651-4043-00L Sedimentology II: Biological and Chemical Processes in Lacustrine and Marine Systems

Prerequisite: Successful completion of the MSc-course "Sedimentology I" (651-4041-00L).

Abstract
The course will focus on biological amd chemical aspects of sedimentation in marine environments. Marine sedimentation will be traced from coast to deep-sea. The use of stable isotopes palaeoceanography will be discussed. Neritic, hemipelagic and pelagic sediments will be used as proxies for environmental change during times of major perturbations of climate and oceanography.

Objective
-You will understand chemistry and biology of the marine carbonate system
-You will be able to relate carbonate mineralogy with facies and environmental conditions
-You will be familiar with cool-water and warm-water carbonates
-You will see carbonate and organic-carbon rich sediments as part of the global carbon cycle
-You will be able to recognize links between climate and marine carbonate systems (e.g. acidification of oceans and reef growth)
-You will be able to use geological archives as source of information on global change
-You will have an overview of marine sedimentation through time

Content
-carbonates,; chemistry, mineralogy, biology
-carbonate sedimentation from the shelf to the deep sea
-carbonate facies
-cool-water and warm-water carbonates
-organic-carbon and black shales
-C-cycle, carbonates, Corg : CO2 sources and sink
-Carbonates: their geochemical proxies for environmental change: stable isotopes, Mg/Ca, Sr
-marine sediments through geological time
-carbonates and evaporites
-lacustrine carbonates
-economic aspects of limestone

Lecture notes
no script. scientific articles will be distributed during the course

Literature
We will read and critically discuss scientific articles relevant for "biological and chemical processes in marine and lacustrine systems"

Prerequisites / notice
The grading of students is based on in-class exercises and end-semester examination.

Hydrology and Water Cycle

Number Title Type ECTS Hours Lecturers
701-1251-00L Land-Climate Dynamics W 3 credits 2G S. I. Seneviratne, E. L. Davin

Abstract
The purpose of this course is to provide fundamental background on the role of land surface processes (vegetation, soil moisture dynamics, land energy and water balances) for the climate system. The course consists of 2 contact hours per week, including 2 computer exercises.
The Planetary Boundary Layer (PBL) constitutes the interface between the atmosphere and the Earth's surface. Theory on transport tools for hydrodynamical modeling are discussed at the event and continuous scale. The focus is on the description of physical processes and their modelling with practical examples.

**Lecture notes**

Powerpoint slides will be made available

**Prerequisites / notice**

Prerequisites: Introductory lectures in atmospheric and climate science


**102-0237-00L**

**Hydrology II**  
**W**  
3 credits 2G  
P. Burlando, S. Fatchi

**Abstract**

The course presents advanced hydrological analyses of rainfall-runoff processes. The course is given in English.

**Objective**


**Lecture notes**

Parts of the script for "Hydrology I" are used. Also available are the overhead transparencies used in the lectures. The semester project consists of a two part instruction manual.

**Literature**

Additional literature is presented during the course.

**701-1253-00L**

**Analysis of Climate and Weather Data**  
**W**  
3 credits 2G  
C. Frei

**Abstract**

Observation networks and numerical climate and forecasting models deliver large primary datasets. The use of this data in practice and in research requires specific techniques of statistical data analysis. This lecture introduces a range of frequently used techniques, and enables students to apply them and to properly interpret their results.

**Objective**

Observation networks and numerical climate and forecasting models deliver large primary datasets. The use of this data in practice and in research requires specific techniques of statistical data analysis. This lecture introduces a range of frequently used techniques, and enables students to apply them and to properly interpret their results.

**Content**

Introduction into the theoretical background and the practical application of methods of data analysis in meteorology and climatology. Topics: exploratory methods, hypothesis tests, analysis of climate trends, measuring the skill of climate and forecasting models, analysis of extreme events, principal component analysis and maximum covariance analysis.

**Lecture notes**

Documentation and supporting material include:
- documented view graphs used during the lecture
- exercise sets and solutions
- R-packages with software and example datasets for exercise sessions

**Literature**

All material is made available via the lecture web-page.

Suggested literature:

**Prerequisites / notice**

Prerequisites: Atmosphäre, Mathematik IV: Statistik, Anwendungsnahes Programmieren.

**651-4053-05L**

**Boundary Layer Meteorology**  
**W**  
4 credits 3G  
M. Rotach, P. Calanca

**Abstract**

The Planetary Boundary Layer (PBL) constitutes the interface between the atmosphere and the Earth's surface. Theory on transport processes in the PBL and their dynamics is provided. This course treats theoretical background and idealized concepts. These are contrasted to real world applications and current research issues.

**Objective**

Overall goals of this course are given below. Focus is on the theoretical background and idealised concepts.

**Students have basic knowledge on atmospheric turbulence and theoretical as well as practical approaches to treat Planetary Boundary Layer flows. They are familiar with the relevant processes (turbulent transport, forcing) within, and typical states of the Planetary Boundary Layer. Idealized concepts are known as well as their adaptations under real surface conditions (as for example over complex topography).**

**Content**

- Introduction
- Turbulence
- Statistical treatment of turbulence, turbulent transport
- Conservation equations in a turbulent flow
- Closure problem and closure assumptions
- Scaling and similarity theory
- Spectral characteristics
- Concepts for non-ideal boundary layer conditions

**Lecture notes**

available (i.e. in English)

**Literature**


**Prerequisites / notice**

Umwelt-Fluiddynamik (701-0479-00L) (environment fluid dynamics) or equivalent and basic knowledge in atmospheric science

**Electives**

The students are free to choose individually from the entire course offer of ETH Zürich and the universities of Zürich and Bern.

**Weather Systems and Atmospheric Dynamics**

Courses are only offered in FS.

**Climate Processes and Feedbacks**

Two additional courses are offered in HS by University of Berne.

**701-1221-00L**

**Dynamics of Large-Scale Atmospheric Flow**  
**W**  
4 credits 2V+1U  
H. Wernli, S. Pfahl

**Abstract**

Dynamic, synoptic Meteorology

**Objective**

Understanding the dynamics of large-scale atmospheric flow
Dynamical Meteorology is concerned with the dynamical processes of the earth's atmosphere. The fundamental equations of motion in the atmosphere will be discussed along with the dynamics and interactions of synoptic system - i.e. the low and high pressure systems that determine our weather. The motion of such systems can be understood in terms of quasi-geostrophic theory. The lecture course provides a derivation of the mathematical basis along with some interpretations and applications of the concept.

**Lecture notes**
Dynamics of large-scale atmospheric flow

**Literature**
- Pichler H., Dynamik der Atmosphäre, Bibliographisches Institut, 456 pp. 1997

**Prerequisites / notice**
Physics I, II, Environmental Fluid Dynamics

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**651-4057-00L Climate History and Palaeoclimatology**

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<tr>
<td>701-1235-00L</td>
<td>Cloud Microphysics</td>
<td>W</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>U. Lohmann, Z. A. Kanji</td>
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**Abstract**
The course "Climate history and palaeoclimatology gives an overview on climate through geological time and it provides insight into methods and tools used in paleoclimate research.

**Objective**
The student will have an understanding of evolution of climate and its major forcing factors -orbital, atmosphere chemistry, tectonics-through geological time. He or she will understand interaction between life and climate and he or she will be familiar with the use of most common geochronolog climate "proxies", he or she will be able to evaluate quality of marine and terrestrial sedimentary paleoclimate archives. The student will be able to estimate rates of changes in climate history and to recognize feedbacks between the biosphere and climate.

**Content**
Climate system and earth history - climate forcing factors and feedback mechanisms of the geosphere, biosphere, and hydrosphere.
- Geological time, stratigraphy, geological archives, climate archives, paleoclimate proxies
- Climate through geological time: "lessons from the past"
- Cretaceous greenhouse climate
- The Late Paleocene Thermal Maximum (PETM)
- Cenozoic Cooling
- Onset and Intensification of Southern Hemisphere Glaciation
- Onset and Intensification of Northern Hemisphere Glaciation
- Pliocene warmth
- Glacial and Interglacials
- Millennial-scale climate variability during glaciations
- The last deglaciation(s)
- The Younger Dryas
- Holocene climate - climate and societies

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**Atmospheric Composition and Cycles**

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<td>M. Rotach, P. Calanca</td>
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**Abstract**
The Planetary Boundary Layer (PBL) constitutes the interface between the atmosphere and the Earth's surface. Theory on transport processes in the PBL and their dynamics is provided. This course treats theoretical background and idealized concepts. These are contrasted to real world applications and current research issues.

**Objective**
Overall goals of this course are given below. Focus is on the theoretical background and idealised concepts. Students have basic knowledge on atmospheric turbulence and theoretical as well as practical approaches to treat Planetary Boundary Layer flows. They are familiar with the relevant processes (turbulent transport, forcing) within, and typical states of the Planetary Boundary Layer. Idealized concepts are known as well as their adaptations under real surface conditions (as for example over complex topography).

**Content**
- Introduction
- Turbulence
- Statistical treatment of turbulence, turbulent transport
- Conservation equations in a turbulent flow
- Closure problem and closure assumptions
- Scaling and similarity theory
- Spectral characteristics
- Concepts for non-ideal boundary layer conditions

**Lecture notes**
available (i.e. in English)
Literature

Prerequisites / notice
Umwelt-Fluidynamik (701-0479-00L) (environment fluid dynamics) or equivalent and basic knowledge in atmospheric science

★★ Climate History and Paleoclimatology
Two courses are offered in autumn semester at University of Berne. ETH courses are only offered in FS.

★★ Hydrology and Water Cycle

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<tr>
<td>651-4023-00L</td>
<td>Groundwater</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>M. O. Saar, X.Z. Kong</td>
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</table>

Abstract
The course provides an introduction into quantitative analysis of groundwater flow and solute/heat transport. It is focussed on understanding, formulating, and solving groundwater flow and solute/heat transport problems.

Objective
a) Students understand the basic concepts of groundwater flow and solute/heat transport processes and boundary conditions.

b) Students are able to formulate simple, practical groundwater flow and solute/heat transport problems.

c) Students are able to understand and apply simple analytical and/or numerical solutions to fluid flow and solute/heat transport problems.

Content
1. Introduction to groundwater problems. Concepts to quantify properties of aquifers.

2. Flow equation. The generalised Darcy law.

3. The water balance equation.


5. Analytical solutions to flow problems I

6. Analytical solutions to flow problems II

7. Finite difference solution to flow problems.


12. Analytical solutions to transport problems I.

13. Analytical solutions to transport problems II


Lecture notes
Handouts of slides.

Script in English is planned.

Literature


de Marsily G., Quantitative Hydrogeology, Academic Press, 1986

102-0287-00L | Fluvial Systems | W | 3 credits | 2G | P. Molnar |

Abstract
The course presents a view of the processes acting on and shaping the landscape and the fluvial landforms that result. The fluvial system is viewed in terms of the production and transport of sediment on hillslopes, the structure of the river network and channel morphology, fluvial processes in the river, riparian zone and floodplain, and basics of catchment and river management.

Objective
The course has two fundamental aims: (1) it aims to provide environmental engineers with the physical process basis of fluvial system change, using the right language and terminology to describe landforms; and (2) it aims to provide quantitative skills in making simple and more complex predictions of change and the data and models required.

Content
The course consists of three sections: (1) Introduction to fluvial forms and processes and geomorphic concepts of landscape change, including climatic and human activities acting on the system. (2) The processes of sediment production, upland sheet-rill-gully erosion, basin sediment yield, rainfall-triggered landsliding, sediment budgets, and the modelling of the individual processes involved. (3) Processes in the river, floodplain and riparian zone, including river network topology, channel geometry, aquatic habitat, role of riparian vegetation, including basics of fluvial system management. The main focus of the course is hydrological and the scales of interest are field and catchment scales.

Lecture notes
There is no script.

Literature
The course materials consist of a series of 13 lecture presentations and notes to each lecture. The lectures were developed from textbooks, professional papers, and ongoing research activities of the instructor. All material is on the course webpage.

Prerequisites / notice
Prerequisites: Hydrology 1 and Hydrology 2 (or contact instructor).

701-0535-00L | Environmental Soil Physics/Vadose Zone Hydrology | W | 3 credits | 2G+2U | D. Or |

Abstract
The course provides theoretical and practical foundations for understanding and characterizing physical and transport properties of soils/ near-surface earth materials, and quantifying hydrological processes and fluxes of mass and energy at multiple scales. Emphasis is given to land-atmosphere interactions, the role of plants on hydrological cycles, and biophysical processes in soils.
Students are able to
- characterize quantitative knowledge needed to measure and parameterize structural, flow and transport properties of partially-saturated porous media.
- quantify driving forces and resulting fluxes of water, solute, and heat in soils.
- apply modern measurement methods and analytical tools for hydrological data collection
- conduct and interpret a limited number of experimental studies
- explain links between physical processes in the vadose-zone and major societal and environmental challenges

Weeks 1 to 3: Physical Properties of Soils and Other Porous Media
Units and dimensions; definitions and basic mass-volume relationships between the solid, liquid and gaseous phases; soil texture; particle size distributions; surface area; soil structure. Soil colloids and clay behavior

Soil Water Content and its Measurement - Definitions; measurement methods - gravimetric, neutron scattering, gamma attenuation; and time domain reflectometry; soil water storage and water balance.

Weeks 4 to 5: Soil Water Retention and Potential (Hydrostatics) - The energy state of soil water; total water potential and its components; properties of water (molecular, surface tension, and capillary rise); modern aspects of capillarity in porous media; units and calculations and measurement of equilibrium soil water potential components; soil water characteristic curves definitions and measurements; parametric models; hysteresis. Modern aspects of capillarity

Demo-Lab: Laboratory methods for determination of soil water characteristic curve (SWC), sensor pairing

Weeks 6 to 9: Water Flow in Soil - Hydrodynamics:
Part 1 - Laminar flow in tubes (Poiseuille's Law); Darcy's Law, conditions and states of flow; saturated flow; hydraulic conductivity and its measurement.

Lab #1: Measurement of saturated hydraulic conductivity in uniform and layered soil columns using the constant head method.

Part 2 - Unsaturated steady state flow; unsaturated hydraulic conductivity models and applications; non-steady flow and Richards Eq.; approximate solutions to infiltration (Green-Ampt, Philip); field methods for estimating soil hydraulic properties.

Midterm exam

Lab #2: Measurement of vertical infiltration into dry soil column - Green-Ampt, and Philip's approximations; infiltration rates and wetting front propagation.

Part 3 - Use of Hydrus model for simulation of unsaturated flow

Week 10 to 11: Energy Balance and Land Atmosphere Interactions - Radiation and energy balance; evapotranspiration definitions and estimation; transpiration, plant development and transpiration coefficients small and large scale influences on hydrological cycle; surface evaporation.

Week 12 to 13: Solute Transport in Soils - Transport mechanisms of solutes in porous media; breakthrough curves; convection-dispersion eq.; solutions for pulse and step solute application; parameter estimation; salt balance.

Lab #3: Miscible displacement and breakthrough curves for a conservative tracer through a column; data analysis and transport parameter estimation.

Additional topics:
Temperature and Heat Flow in Porous Media - Soil thermal properties; steady state heat flow; nonsteady heat flow; estimation of thermal properties; engineering applications.

Biological Processes in the Vadose Zone - An overview of below-ground biological activity (plant roots, microbial, etc.); interplay between physical and biological processes. Focus on soil-atmosphere gaseous exchange; and challenges for bio- and phytoremediation.

Lecture notes
Classnotes on website: Vadose Zone Hydrology, by Or D., J.M. Wraith, and M. Tuller
(available at the beginning of the semester)
http://www.step.ethz.ch/education/active-courses/vadose-zone-hydrology

Literature
Supplemental textbook (not mandatory) - Environmental Soil Physics, by: D. Hillel

651-2915-00L Seminar in Hydrology Z 0 credits 1S P. Burlando, J. W. Kirchner, S. Löw, D. Or, C. Schär, M. Schirmer, S. I. Seneviratne, M. Stähli, C. H. Stamm, University lecturers

8-671-0471-01L Atmospheric Chemistry W 3 credits 2G M. Ammann, D. W. Brunner

Objective
The lecture provides an introduction to atmospheric chemistry at bachelor level. It introduces the kinetics of gas phase and heterogeneous reactions on aerosols and in clouds and explains the chemical and physical mechanisms responsible for global (e.g. stratospheric ozone depletion) as well as regional (e.g. urban air pollution) environmental problems.

The students will understand the basics of gas phase and heterogeneous reactions and will know the most relevant atmospheric chemical processes taking place in the gas phase as well as between different phases including aerosols and clouds.

The students will also acquire a good understanding of atmospheric environmental problems including air pollution, stratospheric ozone destruction and changes in the oxidative capacity of the global atmosphere.
- Origin and properties of the atmosphere: structure, large scale dynamics, UV radiation
- Thermodynamics and kinetics of gas phase reactions: enthalpy and free energy of reactions, rate laws, mechanisms of bimolecular and termolecular reactions.
- Tropospheric photochemistry: Photolysis reactions, photochemical O3 formation, role and budget of HOx, dry and wet deposition
- Aerosols and clouds: chemical properties, primary and secondary aerosol sources.
- Multiphase chemistry: heterogeneous kinetics, solubility and hygroscopicity, N2O5 chemistry, SO2 oxidation, secondary organic aerosols
- Air quality: role of planetary boundary layer, summer- versus winter-smog, environmental problems, legislation, long-term trends
- Stratospheric chemistry: Chapman cycle, Brewer-Dobson circulation, catalytic ozone destruction cycles, polar ozone hole, Montreal protocol
- Global aspects: global budgets of ozone, methane, CO and NOx. air quality - climate interactions

Vorlesungunterlagen (Folien) werden laufend während des Semesters jeweils mind. 2 Tage vor der Vorlesung zur Verfügung gestellt.

Vorlesungsvorarbeiten werden mit der Vorlesung durchgeführt.

There is a lab tour, in which we demonstrate with some instruments how some of the processes, that are discussed in the lectures, are measured.

There is a additional tutorial right after each lecture to give you the chance to ask further questions and discuss the exercises. The participation is recommended but voluntary.

- to explain the mechanisms of cloud and precipitation formation using knowledge of humidity processes and thermodynamics.
- to evaluate the significance of clouds and aerosol particles for climate and artificial weather modification.

Powerpoint slides and script will be made available.

- to explain how mountain influence the atmospheric flow on different scales

- to discuss the mathematical basis of atmospheric dynamics, based on selected atmospheric flow phenomena

- 50% of the time we use the concept of "flipped classroom" (en.wikipedia.org/wiki/Flipped_classroom), which we introduce at the beginning.

- to explain the basic dynamics of the global circulation and of synoptic- and meso-scale flow features

We offer a lab tour, in which we demonstrate with some instruments how some of the processes, that are discussed in the lectures, are measured.

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- explain up-to-date meteorological observation techniques and the basic methods of theoretical atmospheric dynamics

Lecturers

Weather Systems

M. A. Sprenger, C. Grams

Lecture notes and slides


Lecturers

Environmental Physics

U. Lohmann, A. A. Mensah

Lecture notes and slides

Numerical Methods in Environmental Sciences

C. Schär, O. Fuhrer

Lecture notes and slides

- to evaluate the significance of clouds and aerosol particles for climate and artificial weather modification.
- to explain the basic dynamics of the global circulation and of synoptic- and meso-scale flow features

- to explain the mechanisms of cloud and precipitation formation using knowledge of humidity processes and thermodynamics.
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Lecture notes

Lecture notes and slides

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### 651-1010-00L

**Physics of Glaciers**

- **Abstract:** Understanding glaciers and ice sheets with simple physical concepts. Topics include the reaction of glaciers to the climate, ice rheology, temperature in glaciers and ice sheets, glacier hydrology, glacier seismology, basal motion and calving glaciers. A special focus is the current development of Greenland and Antarctica.
- **Objective:** After the course the students are able understand and interpret measurements of ice flow, subglacial water pressure and ice temperature. They will have an understanding of glaciology-related physical concepts sufficient to understand most of the contemporary literature on the topic. The students will be well equipped to work on glacier-related problems by numerical modeling, remote sensing, and field work.
- **Content:** The dynamics of glaciers and polar ice sheets is the key requisite to understand their history and their future evolution. We will take a closer look at ice deformation, basal motion, heat flow and glacier hydraulics. The specific dynamics of tide water and calving glaciers is investigated, as is the reaction of glaciers to changes in mass balance (and therefore climate).
- **Lecture notes / Literature:** [http://people.ee.ethz.ch/~luethim/teaching.html](http://people.ee.ethz.ch/~luethim/teaching.html)
- **Prerequisites / notice:** Für aktuelle Fallbeispiele werden risikobasierte Massnahmen bei glaziologischen Naturgefahren diskutiert. Voraussetzungen: Es werden Grundkenntnisse in Mechanik und Physik vorausgesetzt.

### 651-4077-00L

**Quantification and Modeling of the Cryosphere: Dynamic Processes (University of Zurich)**

- **Abstract:** Overview of the most important earth surface processes and landforms in cold regions (regions with glaciers and intense frost) with emphasis on high-mountain aspects. Discussion of present research challenges.
- **Objective:** Knowledge of the most prominent climate-related geomorphological processes and phenomena in high-mountain regions, understanding of primary research challenges.
- **Content:** Erosion and sedimentation by glaciers as a function of topography, englacial temperature, sediment balance, sliding and melt water runoff. Processes and landforms in regions of seasonal and perennial frost (frost weathering, rock falls, debris cones/talus, solifluction, permafrost creep/rock glaciers, debris flows).
- **Lecture notes / Literature:** Glacial and periglacial geomorphodynamics in high-mountain regions, ca. 100 pages. References in script.

### 651-1581-00L

**Seminar in Glaciology**

- **Abstract:** Studium aktueller und klassischer Arbeiten der glaziologischen Forschung
- **Objective:** Vertiefte Kenntnisse in ausgewählten Bereichen der glaziologischen Forschung erarbeiten. Kennenlernen von Formen der wissenschaftlicher Präsentation und Verbessern der eigenen Fähigkeit in der Diskussion von wissenschaftlichen Themen.
- **Content:** Studium aktueller und klassischer Arbeiten der glaziologischen Forschung benötigte Unterlagen werden im Verlauf der Veranstaltung abgegeben

### Minor in Biogeochemistry

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-1313-00L</td>
<td>Isotopic and Organic Tracers in Biogeochemistry</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>R. Kipfer, S. Ladd</td>
</tr>
<tr>
<td></td>
<td>The course introduces the scientific concepts and typical applications of tracers in biogeochemistry. The course covers stable and radioactive isotopes, geochemical tracers and biomarkers and their application in biogeochemical processes as well as regional and global cycles. The course provides essential theoretical background for the lab course “Isotopic and Organic Tracers Laboratory”.</td>
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<td></td>
<td>The course aims at understanding the fractionation of stable isotopes in biogeochemical processes. Students learn to know the origin and decay modes of relevant radiogenic isotopes. They discover the spectrum of possible geochemical tracers and biomarkers, their potential and limitations and get familiar with important applications</td>
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<td></td>
<td>Geogenic and cosmogenic radionuclides (sources, decay chains); stable isotopes in biogeochemistry (natural abundance, fractionation); geochemical tracers for processes such as erosion, productivity, redox fronts; biomarkers for specific microbial processes.</td>
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<tr>
<td></td>
<td>Lecture notes / Literature: A list of relevant literature is available on the class web site.</td>
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<td></td>
<td>Prerequisites / notice: Basic knowledge about geology and glaciers/permafrost from corresponding courses at ETH/uzh or from the related lecture notes.</td>
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<tr>
<td>701-1315-00L</td>
<td>Biogeochemistry of Trace Elements</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>A. Voegelin, M. E. L. Winkel</td>
</tr>
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<td></td>
<td>The course addresses the biogeochemical classification and behavior of trace elements, including key processes driving the cycling of important trace elements in aquatic and terrestrial environments and the coupling of abiotic and biotic transformation processes of trace elements. Examples of the role of trace elements in natural or engineered systems will be presented and discussed in the course.</td>
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</tbody>
</table>
Objective: The students are familiar with the chemical characteristics, the environmental behavior and fate, and the biogeochemical reactivity of different groups of trace elements. They are able to apply their knowledge on the interaction of trace elements with geosphere components and on abiotic and biotic transformation processes of trace elements to discuss and evaluate the behavior and impact of trace elements in aquatic and terrestrial systems.

Content: (i) Definition, importance and biogeochemical classification of trace elements. (ii) Key biogeochemical processes controlling the cycling of different trace elements (base metals, redox-sensitive and chalcophile elements, volatile trace elements) in natural and engineered environments. (iii) Abiotic and biotic processes that determine the environmental fate and impact of selected trace elements.

Lecture notes: Selected handouts (lecture notes, literature, exercises) will be distributed during the course.

Prerequisites / notice: Students are expected to be familiar with the basic concepts of aquatic and soil chemistry covered in the respective classes at the bachelor level (soil mineralogy, soil organic matter, acid-base and redox reactions, complexation and sorption reactions, precipitation/dissolution reactions, thermodynamics, kinetics, carbonate buffer system).

This lecture is a prerequisite for attending the laboratory course "Trace elements laboratory".

<table>
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<tbody>
<tr>
<td>701-1341-00L</td>
<td>Water Resources and Drinking Water</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>S. Hug, M. Berg, F. Hammes, U. von Gunten</td>
</tr>
<tr>
<td>701-1346-00L</td>
<td>Carbon Mitigation</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>N. Gruber</td>
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</table>

Minor in Global Change and Sustainability

<table>
<thead>
<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-0015-00L</td>
<td>Seminar on Transdisciplinary Research for Sustainable Development</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>C. E. Pohl, M. Stauffacher</td>
</tr>
<tr>
<td>701-1551-00L</td>
<td>Sustainability Assessment</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>P. Krüttli, C. E. Pohl</td>
</tr>
</tbody>
</table>
The lecture contains concepts, physics and components of building technologies for the efficient and sustainable energy supply and demand.

1. Introduction

Lecturers: A. Steinfeld, D. Reichelt, W. A. Koepell


The course is structured as follows:
- Selected scientific articles & book chapters
- Scenarios for the development of world primary energy consumption are introduced. Students know the potential and limitations of energy conversion chains, their interaction with architecture and urban design. The time series focuses on the physical principles and technical components of relevant systems for an efficient and sustainable energy supply and demand. A special focus is on the interrelation of supply systems and architectural design and construction. The lecture series focuses on the physical principles and technical components of relevant systems for an efficient and sustainable energy supply and demand. A special focus is on the interrelation of supply systems and architectural design and construction. Learning and practicing methods of calculating demand and supply allows identifying parameters relevant for design.

Content

<table>
<thead>
<tr>
<th>Topic</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>Energy and Climate Systems I</td>
<td>The lecture series focuses on the physical principles and technical components of relevant systems for an efficient and sustainable energy supply and demand. A special focus is on the interrelation of supply systems and architectural design and construction. Learning and practicing methods of calculating demand and supply allows identifying parameters relevant for design.</td>
</tr>
<tr>
<td>Renewable Energy Technologies I</td>
<td>Scenarios for the development of world primary energy consumption are introduced. Students know the potential and limitations of energy conversion chains, primary energy sources and availability of raw materials. Methods for the assessment of energy chains, potential and technology of renewable energies: Biomass (heat, electricity, biofuels), solar energy (low temp. heat, solar thermal and photovoltaic electricity, solar chemistry), Wind and ocean energy, heat pumps, geothermal energy, energy from waste, CO2 sequestration. Scenarios for renewable energy for reducing CO2 emissions, and their contribution towards a future sustainable energy system that respects climate protection goals.</td>
</tr>
</tbody>
</table>

Lecture notes

The Slides from the lecture serve as lecture notes and are available as download.

Literature

A list of relevant literature is available at the chair.

<table>
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<tr>
<td>051-0551-00L</td>
<td>Energy- and Climate Systems I</td>
<td>W</td>
<td>2 credits</td>
<td>A. Schluter</td>
</tr>
<tr>
<td>227-0731-00L</td>
<td>Power Market I - Portfolio and Risk Management</td>
<td>W</td>
<td>6 credits</td>
<td>D. Reichelt, G. A. Koepell</td>
</tr>
<tr>
<td>529-0193-00L</td>
<td>Renewable Energy Technologies I</td>
<td>W</td>
<td>4 credits</td>
<td>A. Wokaun, A. Steinfeld</td>
</tr>
</tbody>
</table>

Prerequisites / notice

1 excursion per semester, 2 case studies, guest speakers for specific topics.

Course Moodle: https://moodle-app2.let.ethz.ch/course/view.php?id=2196
The course gives an introduction to methods and tools for analysis of energy consumption, energy production and energy flows. Both larger energy system analysis

Prerequisites / notice

Fundamentals of chemistry, physics and thermodynamics are a prerequisite for this course.

Topics are available to carry out a Project Work (Semesterarbeit) on the contents of this course.

227-1631-00L Energy System Analysis  W 4 credits  3G  G. Hug, S. Hellweg, F. Noembrini, A. Schüler

Abstract

The course provides an introduction to the methods and tools for analysis of energy consumption, energy production and energy flows. Environmental aspects are included as well as economical considerations. Different sectors of the society are discussed, such as electric power, buildings, and transportation. Models for energy system analysis planning are introduced.

Objective

The purpose of the course is to give the participants an overview of the methods and tools used for energy systems analysis and how to use these in simple practical examples.

Content

The course gives an introduction to methods and tools for analysis of energy consumption, energy production and energy flows. Both larger systems, e.g. countries, and smaller systems, e.g. industries, homes, vehicles, are studied. The tools and methods are applied to various problems during the exercises. Different conventions of energy statistics used are introduced.

The course provides also an introduction to energy systems models for developing scenarios of future energy consumption and production. Bottom-up and Top-Down approaches are addressed and their features and applications discussed.

The course contains the following parts:

- Part I: Energy flows and energy statistics
- Part II: Environmental impacts
- Part III: Electric power systems
- Part IV: Energy in buildings
- Part V: Energy in transportation
- Part VI: Energy systems models

Lecture notes

Handouts

Literature


Seminars and Colloquia

Number Title Type ECTS Hours Lecturers
651-4095-01L Colloquium Atmosphere and Climate 1 O 1 credit 1K H. Joos, C. Schär, D. N. Bresch, N. Gruber, R. Knutti, U. Lohmann, T. Peter, S. I. Seneviratne, H. Wernli, M. Wild

Abstract

The colloquium is a series of scientific talks by prominent invited speakers assembling interested students and researchers from around Zürich. Students take part of the scientific discussions.

Objective

The students are exposed to different atmospheric science topics and learn how to take part in scientific discussions.

651-4095-02L Colloquium Atmosphere and Climate 2 O 1 credit 1K H. Joos, C. Schär, D. N. Bresch, N. Gruber, R. Knutti, U. Lohmann, T. Peter, S. I. Seneviratne, H. Wernli, M. Wild

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Objective

The students are exposed to different atmospheric science topics and learn how to take part in scientific discussions.

651-4095-03L Colloquium Atmosphere and Climate 3 O 1 credit 1K H. Joos, C. Schär, D. N. Bresch, N. Gruber, R. Knutti, U. Lohmann, T. Peter, S. I. Seneviratne, H. Wernli, M. Wild

Abstract

The colloquium is a series of scientific talks by prominent invited speakers assembling interested students and researchers from around Zürich. Students take part of the scientific discussions.

Objective

The students are exposed to different atmospheric science topics and learn how to take part in scientific discussions.

701-1211-01L Master's Seminar: Atmosphere and Climate 1 O 3 credits 2S H. Joos, O. Stebler, F. Tummon, M. A. Wüest

Abstract

In this seminar, the process of writing a scientific proposal will be introduced. The essential elements of a proposal, including the peer review process, will be outlined and class exercises will train scientific writing skills. Knowledge exchange between class participants is promoted through the preparation of a master thesis proposal and evaluation of each other's work.

Objective

Training scientific writing skills.

Content

In this seminar, the process of writing a scientific proposal will be introduced. The essential elements of a proposal, including the peer review process, will be outlined and class exercises will train scientific writing skills. Knowledge exchange between class participants is promoted through the preparation of a master thesis proposal and evaluation of each other's work.

Prerequisites / notice

Attendance is mandatory.

701-1211-02L Master's Seminar: Atmosphere and Climate 2 O 3 credits 2S H. Joos, O. Stebler, F. Tummon, M. A. Wüest

Abstract

In this seminar scientific project management is introduced and applied to your master project. The course concludes with a presentation of your project including an overview of the science and a discussion of project management techniques applied to your thesis project.

Objective

Apply scientific project management techniques to your master project.
In this seminar scientific project management is introduced and applied to your master project. The course concludes with a presentation of your project including an overview of the science and a discussion of project management techniques applied to your thesis project. Attendance is mandatory.

**701-1213-00L Introduction Course to Master Studies Environment and Climate**

**Objective**

The aims of this course are i) to welcome all students to the master program and to ETH, ii) to acquaint students with the faculty teaching in the field of atmospheric and climate science at ETH and at the University of Bern, iii) that the students get to know each other and iv) to assess needs and discuss options for training and education of soft-skills during the Master program and to give an overview of the study options in general.

**Laboratory and Field Courses**

*The course in the category «lab and field work» are only offered in spring semester.*

**Master's Thesis**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>651-4275-00L</td>
<td>Master's Thesis</td>
<td>O</td>
<td>30</td>
<td>64D</td>
<td>Supervisors</td>
</tr>
</tbody>
</table>

Only students who fulfill the following criteria are allowed to begin with their master thesis:

- a. successful completion of the bachelor programme;
- b. fulfilling of any additional requirements necessary to gain admission to the master programme.

The master thesis is under the supervision of a professor teaching in the module courses of the master programme. Please refer to the web page linked here for instructions and guidelines how to register for the master thesis (http://www.iac.ethz.ch/education/master/curriculum/maste r_thesis/)

**Course Units for Additional Admission Requirements**

*The courses below are only available for MSc students with additional admission requirements.*

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-0412-AAL</td>
<td>Climate Systems</td>
<td>E-</td>
<td>3</td>
<td>6R</td>
<td>R. Knutti</td>
</tr>
</tbody>
</table>

Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Introduction of the most important components of the climate systems and their interactions.

Students have a basic understanding of the global energy balance, radiation budget, boundary, layer, atmosphere, ocean, biosphere, land-surface coupling, cryosphere, carbon cycle, climate variability, climate of the past and anthropogenic climate change, and they are able to apply this to solve simple quantitative problems and answer qualitative questions.

Copies of the slides are provided in electronic form.

A comprehensive list of references is provided in the class. Two books are particularly recommended:


Teaching: Reto Knutti, several keynotes to special topics by other professors

Course taught in German, slides in English.

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-0471-AAL</td>
<td>Atmospheric Chemistry</td>
<td>E-</td>
<td>3</td>
<td>6R</td>
<td>D. W. Brunner, M. Ammann</td>
</tr>
</tbody>
</table>

Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

This is a self-study course targeted at Master students who did not follow the bachelor course "atmospheric chemistry" or similar. The course provides a general introduction into atmospheric chemistry.

The learning target of this lecture is a general overview on the most important processes of atmospheric chemistry and the various problems of the anthropogenic change in the structure of Earth's atmosphere.

- Origin and properties of the atmosphere: structure, large scale dynamics, UV radiation
- Thermodynamics and kinetics of gas phase reactions: enthalpy and free energy of reactions, rate laws, mechanisms of bimolecular and termolecular reactions.
- Tropospheric photochemistry: Photolysis reactions, photochemical C3 formation, role and budget of HOx, dry and wet deposition
- Aerosols and clouds: chemical properties, primary and secondary aerosol sources
- Multiphase chemistry: heterogeneous kinetics, solubility and hygroscopicity, N2O5 chemistry, SO2 oxidation, secondary organic aerosols
- Air quality: role of planetary boundary layer, summer- versus winter-smog, environmental problems, legislation, long-term trends
- Stratospheric chemistry: Chapman cycle, Brewer-Dobson circulation, catalytic ozone destruction cycles, polar ozone hole, Montreal protocol
- Global aspects: global budgets of ozone, methane, CO and NOx, air quality - climate interactions

Basic courses in chemistry and physics are expected.
Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract
The fundamental background of cloud and precipitation formation (including thermodynamics and aerosol physics) and their relevance for climate are discussed.

Objective
The students can appreciate the processes leading to cloud and precipitation formation and their importance for climate.

Content
Moist processes/thermodynamics; aerosol physics; cloud formation; precipitation processes, storms; importance of aerosols and clouds for climate; measurements of clouds (radar and satellites)

Lecture notes
Powerpoint slides and script will be made available

Literature
Rogers and Yau, A Short Course in Cloud Physics, Pergamon Press, 1989; Wallace and Hobbs, Atmospheric Science: An Introductory Survey, Elsevier, 2006

701-0473-AAL Weather Systems
Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract
Satellite observations; analysis of vertical soundings; geostrophic and thermal wind; cyclones at mid-latitude; global circulation; north-atlantic oscillation; atmospheric blocking situations; Eulerian and Lagrangian perspective; potential vorticity; Alpine dynamics (storms, orographic wind); planetary boundary layer

Objective
Introduction to basic aspects of atmospheric dynamics. Focus is given to the global-scale atmospheric circulation, synoptic-scale processes (in particular low-pressure systems), and the influence of mountains on the atmospheric flow.

Content
Satellite observations; analysis of vertical soundings; geostrophic and thermal wind; cyclones at mid-latitude; global circulation; north-atlantic oscillation; atmospheric blocking situations; Eulerian and Lagrangian perspective; potential vorticity; Alpine dynamics (storms, orographic wind); planetary boundary layer

Lecture notes
Lecture notes and slides

Literature
Atmospheric Science, An Introductory Survey
John M. Wallace and Peter V. Hobbs, Academic Press

701-0461-AAL Numerical Methods in Environmental Sciences
Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract
This lecture imparts the mathematical basis necessary for the development and application of numerical models in the field of Environmental Science. The lecture material includes an introduction into numerical techniques for solving ordinary and partial differential equations, as well as exercises aimed at the realization of simple models.

Objective
This lecture imparts the mathematical basis necessary for the development and application of numerical models in the field of Environmental Science. The lecture material includes an introduction into numerical techniques for solving ordinary and partial differential equations as well as exercises aimed at the realization of simple models.

Content
Classification of numerical problems, introduction to finite-difference methods, time integration schemes, non-linearity, conservative numerical techniques, an overview of spectral and finite-element methods. Examples and exercises from a diverse cross-section of Environmental Science.

Lecture notes
Three obligatory exercises, each two hours in length, are integrated into the lecture. The implementation language is Matlab (previous experience not necessary: a Matlab introduction is given). Example programs and graphics tools are supplied.

Literature
List of literature is provided.

701-1901-AAL Systems Analysis
Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract
Self study course in Systems Analysis to fulfill requirements for enrollment into the master program. Topics covered include linear box models with one or several variables; non-linear box models with one or several variables; discrete-time models; and continuous models in space and time.

Objective
The aim of this course is to develop an understanding of the dynamical behavior of environmental systems and how this behavior can be captured and understood using mathematical concepts.

Lecture notes
For English Speaking students:

701-0106-AAL Mathematics V: Applied Deepening of Mathematics I - III
Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract
Selected mathematical topics are presented for later use in more specialised lectures. Part of the topics were already discussed in the lectures Mathematics I-III. Here, they should be shortly recapitulated and most importantly applied to practical problems. If necessary, new mathematical concepts and methods will be introduced in order to solve challenging and inspiring problems from practice.

Objective
The aim of this lecture is to prepare the students for the more specialised lectures. They should become more familiar with the mathematical background, the mathematical concepts and most of all with their application and interpretation.

Content
Practical examples from the following areas will be discussed: ordinary differential equations; eigenvalue problems from linear algebra; systems of linear and nonlinear differential equations; partial differential equations (diffusion, transport, waves).
### Atmospheric and Climate Science Master - Key for Type

<table>
<thead>
<tr>
<th></th>
<th>Courses outside the curriculum</th>
<th>W</th>
<th>Eligible for credits</th>
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</thead>
<tbody>
<tr>
<td>D</td>
<td>Suitable for doctorate</td>
<td>O</td>
<td>Compulsory</td>
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<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
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</table>

### Key for Hours

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
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<tbody>
<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
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</tbody>
</table>

**ECTS**
- European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
**Educational Science Teaching Certificate**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>851-0240-00L</td>
<td>Human Learning (EW1)</td>
<td>O</td>
<td>2</td>
<td>G</td>
<td>E. Stern</td>
</tr>
<tr>
<td></td>
<td>This lecture is only apt for students who intend to enrol in the programs “Teaching Diploma” or “Teaching Certificate”. It is about learning in childhood and adolescence.</td>
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<td></td>
<td>Abstract</td>
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<td></td>
<td>This course looks into scientific theories and also empirical studies on human learning and relates them to the school.</td>
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<td></td>
<td>Objective</td>
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<td></td>
<td>Anyone wishing to be a successful teacher must first of all understand the learning process. Against this background, theories and findings on the way humans process information and on human behaviour are prepared in such a manner that they can be used for planning and conducting lessons. Students additionally gain an understanding of what is going on in learning and behavioural research so that teachers are put in a position where they can further educate themselves in the field of research into teaching and learning.</td>
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<tr>
<td></td>
<td>Content</td>
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<td></td>
<td>Thematische Schwerpunkte: Lernen als Verhaltensänderung und als Informationsverarbeitung; Das menschliche Gedächtnis unter besonderer Berücksichtigung der Verarbeitung symbolischer Information; Lernen als Wissenskonstruktion und Kompetenzerwerb unter besonderer Berücksichtigung des Wissenstransfers; Lernen durch Instruktion und Erklärungen; Die Rolle von Emotion und Motivation beim Lernen; Interindividuelle Unterschiede in der Lernfähigkeit und ihre Ursachen; Intelligenztheorien, Geschlechtsunterschiede beim Lernen.</td>
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<td>Lecture notes</td>
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<td>Folien werden zur Verfügung gestellt.</td>
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<tr>
<td></td>
<td>Literature</td>
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<td></td>
<td>Prerequisites / notice</td>
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<td></td>
<td>This lecture is only apt for students who intend to enrol in the programs “Lehrdiplom” or “Didaktisches Zertifikat”. It is about learning in childhood and adolescence.</td>
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<tr>
<td>851-0240-22L</td>
<td>Coping with Psychosocial Demands of Teaching (EW4 W D2)</td>
<td>W</td>
<td>2</td>
<td>S</td>
<td>A. Deiglmayr, P. Greutmann, U. Markwalder</td>
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<td></td>
<td>Number of participants limited to 20.</td>
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<td>The successful participation in EW1 (“Human Learning”) and EW2 (“Designing Learning Environments for School”) is recommended, but not a mandatory prerequisite.</td>
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<td></td>
<td>Abstract</td>
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<tr>
<td></td>
<td>In this class, students will learn concepts and skills for coping with psychosocial demands of teaching</td>
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<td>Objective</td>
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<tr>
<td></td>
<td>Students possess theoretical knowledge and practical competences to be able to cope with the psychosocial demands of teaching.</td>
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<td></td>
<td>(1) They know the basic rules of negotiation and conflict management (e.g., mediation) and can apply them in the school context (e.g., in conversations with parents).</td>
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<td>(2) They can apply diverse techniques of classroom management (e.g., prevention of disciplinary problems in the classroom) and know relevant authorities for further information (e.g., legal conditions).</td>
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<tr>
<td>851-0240-16L</td>
<td>Colloquium on the Science of Learning and Instruction</td>
<td>W</td>
<td>1</td>
<td>K</td>
<td>E. Stern, P. Greutmann, further lecturers</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
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<tr>
<td></td>
<td>In the colloquium we discuss scientific projects concerning the teaching in mathematics, computer science, natural sciences and technology (STEM). The colloquium is conducted by the professorships participating in the Competence Center EduETH (ETH) and in the Institute for Educational Sciences (UZH).</td>
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<td></td>
<td>Objective</td>
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<td></td>
<td>Participants are exemplarily introduced to different research methods used in research on learning and instruction and learn to weigh advantages and disadvantages of these approaches.</td>
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<tr>
<td>851-0242-06L</td>
<td>Cognitively Activating Instructions in MINT Subjects</td>
<td>W</td>
<td>2</td>
<td>S</td>
<td>R. Schumacher</td>
</tr>
<tr>
<td></td>
<td>Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).</td>
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<tr>
<td></td>
<td>This course unit can only be enrolled after successful participation in, or during enrollment in the course “Human Learning (EW 1)”.</td>
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<tr>
<td></td>
<td>Abstract</td>
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<td></td>
<td>This seminar focuses on teaching units in chemistry, physics and mathematics that have been developed at the MINT Learning Center of the ETH Zurich. In the first meeting, the mission of the MINT Learning Center will be communicated. Furthermore, in groups of two, the students will intensively work on, refine and optimize a teaching unit following a goal set in advance.</td>
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<td>Objective</td>
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<tr>
<td></td>
<td>- Get to know cognitively activating instructions in MINT subjects</td>
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<td></td>
<td>- Get information about recent literature on learning and instruction</td>
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<td></td>
<td>Prerequisites / notice</td>
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<tr>
<td></td>
<td>Für eine reibungslose Semesterplanung wird um frühe Anmeldung und persönliches Erscheinen zum ersten Lehrveranstaltungstermin ersucht.</td>
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<tr>
<td>851-0242-07L</td>
<td>Human Intelligence</td>
<td>W</td>
<td>1</td>
<td>S</td>
<td>E. Stern, P. Edelsbrunner, B. Rütsche</td>
</tr>
<tr>
<td></td>
<td>Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport). Number of participants limited to 30. This course unit can only be enrolled after successful participation in, or during enrollment in the course “Human Learning (EW 1)”.</td>
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<tr>
<td></td>
<td>Abstract</td>
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<tr>
<td></td>
<td>The focus will be on the book “Intelligenz: Grosse Unterschiede und ihre Folgen” by Stern und Neubauer. Participation at the first meeting is obligatory. It is required that all participants read the complete book. Furthermore, in two meetings of 90 minutes, concept papers developed in small groups (5 - 10 students) will be discussed.</td>
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</tbody>
</table>
Objective
- Understanding of research methods used in the empirical human sciences
- Getting to know intelligence tests
- Understanding findings relevant for education

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0242-08L</td>
<td>Research Methods in Educational Science</td>
<td>W</td>
<td>1 credit</td>
<td>1S</td>
<td>P. Edelsbrunner, B. Rütsche, E. Stern, E. Ziegler</td>
</tr>
</tbody>
</table>

This course can only be enrolled after successful participation in, or during enrollment in the course "Human Learning (EW 1)".

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

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

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0240-03L</td>
<td>Introduction to Test Theory and Test Construction in Educational Contexts (University of Zürich)</td>
<td>W</td>
<td>4 credits</td>
<td>2S</td>
<td>University lecturers</td>
</tr>
</tbody>
</table>

Enrolment only possible with Teaching Diploma or DC matriculation.

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.

UZH Module Code: 200a968

Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

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

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

Content
Die konkreten Inhalte des Seminars ergeben sich aufgrund der Präferenzen der Teilnehmenden und der daraus abgeleiteten Themenübersicht für Vorträge und Seminararbeiten. Im Rahmen der Startveranstaltung wird eine Liste mit möglichen Themen abgegeben und erläutert. Schwerpunkte der Themenvorschläge sind:

- Testentwicklung
- Gütekriterien von Tests
- Aufgabenkonstruktion
- Datenauswertung
- Rasch-Modell
- Internationale Vergleichstests
- Zulassungsstests

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

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

Prerequisites / notice
Die Leistungsanforderungen richten sich im Umfang nach der Zahl zu erwerbender ECTS-Punkte, wobei 1 ECTS-Punkt einem Zeitaufwand von ca. 30 Arbeitsstunden entspricht. ETHZ-Studierende können im Rahmen dieser Veranstaltung 3 ECTS-Punkte erwerben. Dazu sind folgende Leistungen zu erbringen:

- Präsenz und aktive mündliche Mitarbeit in der Lehrveranstaltung (MA)
- Referat (RE)
- Schreiben einer schriftlichen Arbeit

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

Educational Science Teaching Diploma

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>851-0240-00L</td>
<td>Human Learning (EW1)</td>
<td>O</td>
<td>2 credits</td>
<td>2G</td>
<td>E. Stern</td>
</tr>
</tbody>
</table>

This lecture is only apt for students who intend to enrol in the programs "Teaching Diploma" or "Teaching Certificate". It is about learning in childhood and adolescence.

Abstract
This course looks into scientific theories and also empirical studies on human learning and relates them to the school.

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

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

Lernformen:
Theorien und wissenschaftliche Konstrukte werden zusammen mit ausgewählten wissenschaftlichen Untersuchungen in Form einer Vorlesung präsentiert. Die Studierenden vertiefen nach jeder Stunde die Inhalte durch die Bearbeitung von Aufträgen in einem elektronischen Lernzettelbuch, über die Bedeutung das Gelernte für den Schulalltag soll reflektiert werden. Ausgewählte Tagebuchbeiträge werden zu Beginn jeder Vorlesung thematisiert.

Lecture notes
Folien werden zur Verfügung gestellt.

Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

Data: 06.03.2019 12:57 Autumn Semester 2016 Page 145 of 1571
851-0242-01L  
**Coping with Psychosocial Demands of Teaching (EW4)**  
Enrolment possible with Teaching Diploma matriculation, except for students of Sport Teaching Diploma, who complete the sport-specific course unit EW4.

**Abstract**  
Students learn and practice techniques and skills for coping with psychosocial demands of teaching.

**Objective**  
(1) They know the basic rules of negotiation and conflict management (e.g., mediation) and can apply them in the school context (e.g., in conversations with parents).  
(2) They can apply diverse techniques of classroom management (e.g., prevention of disciplinary problems in the classroom) and know relevant authorities for further information (e.g., legal conditions; crisis intervention).  
(3) They know stress coping strategies to prevent burnout (e.g., psychosocial support) and are familiar with relevant institutions.

**Content**  
Major themes:  
- counseling and counselling techniques  
- conflict management and mediation  
- classroom management  
- supporting students in a psychological crisis  
- preventing stress and burnout

Forms of learning  
Theoretical foundations will be taught in workshops which contain different means of activation and interaction such as group work, panel discussions, and individual work. Subsequently, this knowledge will be transferred and applied in different school-relevant situations by means of role plays, discussing of cases and video sequences, as well as reflections of practical experiences.

851-0238-01L  
**Support and Diagnosis of Knowledge Acquisition Processes (EW3)**  
Enrolment only possible with matriculation in Teaching Diploma (except for students of Sport Teaching Diploma, who complete the sport-specific course unit EW3) and for students who intend to enrol in the "Teaching Diploma".

**Prerequisites**  
Successful participation in 851-0240-00L "Human Learning (EW1)".

**Abstract**  
In this seminar students learn advanced techniques to support and to diagnose knowledge acquisition processes in school.

**Objective**  
(1) You have a deep understanding about the cognitive mechanisms of knowledge acquisition.  
(2) You have a basic understanding about psychological test theory and can appropriately administer tests.  
(3) You know various techniques of formative assessment and can apply these to uncover students' misconceptions.

**Content**  
For a rebunglosen Semesterplanung wird um persönliches Erscheinen zum ersten Lehrveranstaltungstermin ersucht.

851-0240-15L  
**Designing Educational Environments in Physical Education (EW2 Sport)**  
Compulsory course requirements for EW2 Sport: This course is required to be taken prior to EW4 Sport "Outdoor Education: Concepts and Practice" (851-0242-02L).

**Abstract**  
Students learn principles of teaching beyond classroom and regular PE-Lessons:  
- Planning and organizing camps and events  
- Teaching the "Ergänzungsfach Sport"  
- Long-term-curricula in PE

As a practical part students design the Outdoor event in EW4 of the following term

**Objective**  
Students know  
- how to plan events and camps  
- to assess curricula critically and to use them properly  
- how to combine theoretical and practical issues in the 'Ergänzungsfach'

**Content**  
1. LV Semestereinführung  
2. LV Planung Outdoor-Weekend  
3. LV Auswertung Outdoor-Event  
4. LV Planung Event  
5. LV Event-Präsentationen / Schlussveranstaltung

**Prerequisites**  
Prerequisites:

- EW2 is compulsory requirement for EW4 Sport

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**Literature**  

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

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851-0240-19L  
**Effective Learning Environments (EW 9)**  
This is a mandatory course for students of the teacher's diploma for secondary schools, who have not completed the course 851-0238-01L. "Unterstützung und Diagnose von Wissenswerterprozessen" (EW 3) until the end of spring semester 2014 (except for students of Sport Teaching Diploma, who have completed the sport-specific course units EW2-4). The successful completion of ALL modules relevant for the teacher's diploma is required for participation in this course.

**Abstract**  
The students have to read the book "Lernwirksam unterrichten" from Felten/Stern and they have to answer the questions addressed on http://www.lvil.ethz.ch/studium/lehre/ew-5.html. In individual or small-group sessions, Elisbeth Stern and the students will discuss how insights from learning research can inform classroom practice.
The seminar focuses on teaching units in chemistry, physics and mathematics that have been developed at the MINT Learning Center of R. Schumacher. The course is targeted at advanced students who have taken an interest in gathering practical research experience in the field of Learning Human Intelligence, P. Edelsbrunner.

In teams of two, participants in this seminar conduct their own research project. Each team is advised by one of the researchers serving as lecturers in this course. During the first half the semester, relevant methodological knowledge and skills are practiced during plenary meetings and in students’ independent reading (e.g. generating and testing research questions, designing experiments, and analyzing data in the field of Learning and Instruction).

The successful completion of both course no. 851-0240-00L „Menschliches Lernen (EW 1)” and course no. 851-0239-01L „Unterstützung und Diagnose von Wissenserwerbsprozessen (EW 3)” is a necessary prerequisite for this course.

The course is targeted at advanced students who have taken an interest in gathering practical research experience in the field of Learning & Instruction. In teams of two, students conduct their own research projects (planning, conducting, analyzing, interpreting, and presenting research); thus, the course requires a high amount of self-directed working. Students are personally advised, and supported in their research project, by one of the researchers serving as lecturers in this course.

Learning goals include:
- Participants can illustrate and explain basic methods and concepts for research in the fields of Learning and Instruction, e.g. with the help of practical examples.
- Participants can generate testable research questions for a topic relevant in the fields of Learning and Instruction.
- Participants can design and conduct a study that is relevant for answering their research question.
- Participants can summarize and evaluate the main results from a study in the field of learning and Instruction, with regard to the research question being asked.

This course unit can only be enrolled after successful participation in, or during enrollment in the course “Human Learning (EW 1)”.

This seminar focuses on teaching units in chemistry, physics and mathematics that have been developed at the MINT Learning Center of the ETH Zurich. In the first meeting, the mission of the MINT Learning Center will be communicated. Furthermore, in groups of two, the students will intensively work on, refine and optimize a teaching unit following a goal set in advance.

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

This course unit can only be enrolled after successful participation in, or during enrollment in the course “Human Learning (EW 1)”.

For a smooth semester planning, an early registration and personal attendance at the first teaching date is necessary. It is required that all participants read the complete book. Furthermore, in two meetings of 90 minutes, concept papers developed in small groups (5 - 10 students) will be discussed.

This seminar will begin with a review of the literature on the teaching and learning of nature of science and scientific inquiry. It focuses on the development of adequate and functional understandings of nature of science and scientific inquiry.

Student teachers will develop an understanding of the concepts of nature of science and scientific inquiry. They will design a variety of instructional materials for teaching students about these concepts.
### Compulsory Elective Courses Teaching Diploma

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<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>851-0237-01L</td>
<td>Vocational Schools as Sites of Teaching and Learning W I: Teaching Structure (University of Zürich)</td>
<td>W</td>
<td>3</td>
<td>2S</td>
<td>University lecturers</td>
</tr>
</tbody>
</table>

**Abstract**

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.

**Objective**

- Formulating learning objectives at different levels, and implementing and monitoring these.
- Steering tuition in terms of content and method to fit in with the objectives.
- Formulating examination questions and assignments on the basis of the learning objectives set out in the curriculum and the teaching given.
- Selectively deploying different examination types and procedures/structuring selected learning contents logically in terms of the subject matter and learning process (from the concrete to the abstract, from the simple to the complex) and implementing these with different didactic visual aids.

**Content**

In der Veranstaltung werden die Rahmen- und Schullehrpläne der Berufsmaturität (alle Richtungen) analysiert und deren Fachinhalt in Übungen und Hospitalien didaktisch umgesetzt. Der Unterricht an der Berufsmaturität wird im Hinblick auf die Herausforderung "Viel-Stoff-wenig-Zeit" erarbeitet.

**Lecture notes**

Von den Dozierenden.

**Literature**

Unterrichten an Berufsfachschulen: Berufsmaturität. hep Verlag Bern


G. Steiner (2007): Der Kick zum effizienten Lernen. hep Verlag

Rahmen- und Schullehrpläne der Berufsmaturität

Die Lehrveranstaltung ist seit September 2008 vom Bundesamt für Berufsbildung und Technologie akkreditiert.

| 851-0237-02L | Vocational Schools as Sites of Teaching and Learning W II: Providing Encouragement & Support (UZH) | W    | 3    | 2S    | University lecturers    |

**Abstract**

The module "vocational schools as sites of teaching and learning: providing encouragement and support for apprentices" aims to provide teachers at VET and professional baccalaureate institutions with ways of dealing with learners problems, particularly in connection with their being fed up with school, with job-seeking, school-to-work transition, or continuing education.

**Objective**

- Die spezielle Situation der Berufsschülernenden in ihrer Doppelbelastung Beruf und Schule wahrnehmen und pädagogisch berücksichtigen können.
- Die Übertrittsthematik in Bezug auf die Leistungsorientierung kennen: Mit Konflikten, Störungen und allgemein schwierigen Situationen im BM-Unterricht lösungsorientiert umgehen können.
- Die Formen des betrieblichen Lernens kennen und diese für den Unterricht nutzbar machen.
- Krisenentwicklungen diagnostizieren und fördernde Massnahmen ergreifen.
- Wesentliche Aspekte eines förder- und unterstützungssorientierten Unterrichtsmanagements kennen.
- Rollensicherheit als Lehrperson finden und deren Grenzen definieren.
- Einblicke in die konkrete Ausbildungs situation der Berufsschülerenden gewinnen.

**Content**

- Positionierung des Berufsfachschullenachts innerhalb des dualen (trialen) Systems.
- Berufsmaturität: Entwicklung von Kernkompetenzen für die Wirtschaft?
- "Verakademisierung" der Berufsbildung?
- Lernenden-Porträt: Die Umwelt des Berufsschülerenden - Entwicklungschancen und Problemkreise im Zusammenhang mit der Ausbildungs situation.
- Sozialisations- und Lernprozesse im beruflichen Umfeld / Führungsverständnis im Umgang mit Jugendlichen an Berufsfachschulen.
- Konfliktmanagement I: Wahrnehmungsinstrumente und Interventionssstrategien, Konfliktprävention und niederschwelliges Konfliktsmanagement.
- Konfliktmanagement II: Der ressourcenorientierte Ansatz im Umgang mit Störungen.
- Das lösungsorientierte Konfliktgespräch in schulischen Kontext / Beratung und Coaching: Beratungssituationen im Kontext des Unterrichtsaltags.
- Rollenverständnis und Rollengrenzen.
- Berufsschülerenderechtes Unterrichtsmanagement.
- Mobbing in der Schule.
- Konzepte und Praxis der betrieblichen Betreuung und Förderung.
- Jugendkriminalität und Jugendgewalt.
- Jugendkrisen und Krisenintervention.

**Lecture notes**

Handouts vom Dozenten und Sammlung von Arbeitsmaterialien auf dem BSCW-Server.

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Data: 06.03.2019 12:57  Autumn Semester 2016  Page 148 of 1571
Introduction to Test Theory and Test Construction in Educational Contexts (University of Zürich)

Enrolment only possible with Teaching Diploma or DC matriculation.

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.

UZH Module Code: 200a968

Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

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

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

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

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

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

Prerequisites / notice
Die Leistungsanforderungen richten sich im Umgang nach der Zahl zu erwerbender ECTS-Punkte, wobei 1 ECTS-Punkt einem Zeitaufwand von ca. 30 Arbeitsstunden entspricht. ETHZ-Studierende können im Rahmen dieser Veranstaltung 3 ECTS-Punkte erwerben. Dazu sind folgende Leistungen zu erbringen:
- Präsenz und aktive mündliche Mitarbeit in der Lehrveranstaltung (MA)
- Referat (RE)
- Schreiben einer schriftlichen Arbeit

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

Colloquium on the Science of Learning and Instruction

Abstract
In the colloquium we discuss scientific projects concerning the teaching in mathematics, computer science, natural sciences and technology (STEM). The colloquium is conducted by the professorships participating in the Competence Center EducETH (ETH) and in the Institute for Educational Sciences (UZH).

Objective
Participants are exemplarily introduced to different research methods used in research on learning and instruction and learn to weigh advantages and disadvantages of these approaches.

Cognitively Activating Instructions in MINT Subjects

Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).

This course unit can only be enrolled after successful participation in, or during enrollment in the course "Human Learning (EW 1)".

Abstract
This seminar focuses on teaching units in chemistry, physics and mathematics that have been developed at the MINT Learning Center of the ETH Zurich. In the first meeting, the mission of the MINT Learning Center will be communicated. Furthermore, in groups of two, the students will intensively work on, refine and optimize a teaching unit following a goal set in advance.

Objective
- Get to know cognitively activating instructions in MINT subjects
- Get information about recent literature on learning and instruction

Prerequisites / notice
Für eine reibungslose Semesterplanung wird um frühe Anmeldung und persönliches Erscheinen zum ersten Lehrveranstaltungstermin ersucht.

Human Intelligence

Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).

Number of participants limited to 30.

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

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

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

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

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

851-0242-09L Student Research Projects: Practical Research on Learning and Instruction
Number of participants limited to 20.

Abstract
In teams of two, participants in this seminar conduct their own research project. Each team is advised by one of the researchers serving as lecturers in this course. Basic conceptual and methodological issues are the topic of a series of plenary meetings; however, the major part of the work is done in small-group meetings with the advising researcher, and in self-directed research projects.

Objective
The course is targeted at advanced students who have taken an interest in gathering practical research experience in the field of Learning & Instruction. In teams of two, students conduct their own research projects (planning, conducting, analyzing, interpreting, and presenting research); thus, the course requires a high amount of self-directed working. Students are personally advised and supported in their research project, by one of the researchers serving as lecturers in this course. During the first half the semester, relevant methodological knowledge and skills are practiced during plenary meetings and in students’ independent reading (e.g. generating and testing research questions, designing experiments, and analyzing data in the field of Learning and Instruction)

Learning goals include:
- Participants can illustrate and explain basic methods and concepts for research in the fields of Learning and Instruction, e.g. with the help of practical examples.
- Participants can generate testable research questions for a topic relevant in the fields of Learning and Instruction.
- Participants can design and conduct a study that is relevant for answering their research question.
- Participants can summarize and evaluate the main results from a study in the field of learning and instruction, with regard to the research question being asked.

851-0250-05L Introduction to "Nature of Science" and "Scientific Inquiry"
Enrolment only possible with matriculation in Teaching Diploma (excluding Teaching Diploma Sport).
Number of participants limited to 20.

Abstract
This seminar will begin with a review of the literature on the teaching and learning of nature of science and scientific inquiry. It focuses on the development of adequate and functional understandings of nature of science and scientific inquiry.

Objective
Student teachers will develop an understanding of the concepts of nature of science and scientific inquiry. They will design a variety of instructional materials for teaching students about these concepts.

851-0594-00L International Environmental Politics
Particularly suitable for students of D-ITET, D-USYS

Abstract
This course focuses on the conditions under which cooperation in international environmental politics emerges and the conditions under which such cooperation is effective and/or efficient. Based on theories of international political economy and theories of government regulation various examples of international environmental politics are discussed: the management of international water resources, the problem of unsafe nuclear power plants in eastern Europe, political responses to global warming, the protection of the stratospheric ozone layer, the reduction of long-range transboundary air pollution in Europe, the prevention of pollution of the oceans, etc.

The course is open to all ETH students. Participation does not require previous coursework in the social sciences.

After passing an end-of-semester test (requirement: grade 4.0 or higher) students will receive 3 ECTS credit points. The workload is around 90 hours (meetings, reading assignments, preparation of test).

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

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

Literature
Assigned reading materials and slides will be available at http://www.ib.ethz.ch/teaching.html (select link 'Registered students, please click here for course materials' at top of that page). Log in with your nethz name and password. Questions concerning access to course materials can be addressed to Mike Hudecheck (Mike.Hudecheck@student.ethz.ch).
The lecture explores various strands in philosophy of science in a critical way, focusing on the notion of rationality in science, especially with regards to environmental research. It addresses the significance and limits of empirical, mathematical and logical methods, as well as problems and ethical issues raised by the use of science in society.

**Objective**

Students learn to engage with problems in the philosophy of science and to relate them to natural and environmental sciences, thus developing their skills in critical thinking about science and its use. They know the most important positions in philosophy of science and the objections they face. They can identify, structure and discuss issues raised by the use of science in society.

**Content**

1. Core differences between classical Greek and modern conceptions of science.
2. Classic positions in the philosophy of science in the 20th century: logical empiricism and critical rationalism (Popper); the analysis of scientific concepts and explanations.
3. Objections to logical empiricism and critical rationalism, and further developments: What is the difference between the natural sciences, the social sciences and the arts and humanities? What is progress in science (Kuhn, Fleck, Feyerabend)? Is scientific knowledge relativistic? What is the role of experiments and computer simulations?
4. Issues raised by the use of science in society: The relation between basic and applied research; inter- and transdisciplinary; ethics and accountability of science.

**Lecture notes**

A list of introductory literature and handbooks will be distributed to the students.

**Literature**

A list of literature will be distributed to the students together with the reader.

**Prerequisites**

None
corresponding module directly at UZH.
UZH Module Code: 090MaDgU

Enrolment only possible with matriculation in Teaching Diploma or TC at ETH or in Teaching Diploma at UZH.

Mind the enrolment deadlines at UZH: http://www.uzh.ch/studies/application/mobilitaet_en.html

Abstract
Students are familiarised with the subjects taught at high-school level I (the first three years of the full-length high school, or the first year of the reduced-length high school). The central contents of geometry, arithmetic and algebra, and also written mathematical problems are explained.

Objective
In the teaching given at high-school level I (the first three years of the full-length high school or the first year of the reduced-length high school), central concepts and approaches adopted in mathematics are introduced and observed in greater depth. These include variables, function, proof. This calls for a careful didactic analysis on the part of the teacher, requiring them to study and reflect on the prerequisites for the pupils and the requirements in terms of mathematics and cognitive psychology.

Content
Beispiele von Schülerarbeiten geben in diesem Seminar einen Einblick in die mathematische Denkwelt der Schülerinnen und Schüler.
Vielfältige Aufgaben zum Einsatz im Unterricht werden vorgestellt, selber gelöst und diskutiert.

- Arithmetik und Algebra: Zahlbereiche, Form und Inhalt in der Algebra
- Geometrie: Konstruieren-Berechnen-Beweisen, dynamische Geometrie (Geogebra).
- Sachrechnen: Funktionsbegriff, mathematische Modellierung.
- Aktuelle mathematikdidaktische Aspekte wie Lernprozesse, Grundvorstellungen, Kompetenzen, offene Aufgaben.

Lecture notes
Zahlreiche begleitende Unterlagen werden abgegeben.

Prerequisites / notice
Seminar mit Übungen

Educational Science for Teaching Diploma and TC - Key for Type

<table>
<thead>
<tr>
<th>Key for Hours</th>
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<tbody>
<tr>
<td>V lecture</td>
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<tr>
<td>G lecture with exercise</td>
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<tr>
<td>U exercise</td>
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<tr>
<td>S seminar</td>
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<tr>
<td>K colloquium</td>
</tr>
<tr>
<td>P practical/laboratory course</td>
</tr>
<tr>
<td>A independent project</td>
</tr>
<tr>
<td>D diploma thesis</td>
</tr>
<tr>
<td>R revision course / private study</td>
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</table>

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
## Generally Accessible Seminars and Colloquia

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
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<td>101-1187-00L</td>
<td>Colloquium in Structural Engineering</td>
<td>E-</td>
<td>0 credits</td>
<td>2K</td>
<td>B. Stojadinovic, E. Chatzi, M. Fontana, A. Frangi, W. Kaufmann, B. Sudret, T. Vogel</td>
</tr>
</tbody>
</table>

### Abstract

Professors from national and international universities, technical experts from the industry as well as research associates of the institute of structural engineering (IBK) are invited to present recent research results and specific projects from the practice. This colloquium is addressed to members of universities, practicing engineers and interested persons in general.

### Objective

Learn about recent research results in structural engineering.

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<tr>
<td>101-1387-00L</td>
<td>Colloquia in Geotechnics</td>
<td>E-</td>
<td>0 credits</td>
<td></td>
<td>A. Puzrin, G. Anagnostou, I. Anastasopoulos</td>
</tr>
</tbody>
</table>

### Abstract

The Institute for Geotechnical Engineering invites distinguished speakers from research and practice, nationally and internationally. The colloquia are directed towards staff and students from Universities as well as engineers and scientists working in industry. Details can be obtained from www.igt.ethz.ch by following Events & Public Events. Some colloquia are available via webcast.

### Objective

Learn about recent research results in geotechnics.

### Key for Type

- **O**: Compulsory
- **W+**: Eligible for credits and recommended
- **W**: Eligible for credits
- **E-**: Recommended, not eligible for credits
- **Z**: Courses outside the curriculum
- **Dr**: Suitable for doctorate

### Key for Hours

- **V**: lecture
- **G**: lecture with exercise
- **U**: exercise
- **S**: seminar
- **K**: colloquium
- **P**: practical/laboratory course
- **A**: independent project
- **D**: diploma thesis
- **R**: revision course / private study

### ECTS

- European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
Mechanics 1: Kinematics and Statics

2V+2U

Linear Algebra and Numerical Analysis

O
5 credits, Hours

E. Mazza

Complex numbers.

V. C. Gradinaru

Mathematics as a tool to solve engineering problems. Mathematical formulation of technical and scientific problems.

M. Hirt

Type Grundlagen: Lage eines materiellen Punktes; Geschwindigkeit; Kinematik starrer Körper, Translation, Rotation, Kreiselung, ebene... The course covers the basic concepts of computer programming.

O
Die Vorlesung folgt weitgehend... M.h. Akka Ginosar

Übungsblätter

Mathematical tools for the engineer

O

Die Vorlesung folgt weitgehend...

O

M.h. Akka Ginosar

Übungsblätter

Analysis I

O
7 credits
5V+2U
M.h. Akka Ginosar

Lecture notes

Klaus Dürrschnabel, "Mathematik für Ingenieure - Eine Einführung mit Anwendungs- und Alltagsbeispielen", Springer; online verfügbar unter:


Literature

Neben Klaus Dürrschnabel, "Mathematik für Ingenieure - Eine Einführung mit Anwendungs- und Alltagsbeispielen", Springer sind auch die folgenden Bücher/Skripte empfehlenswert und decken den zu behandelnden Stoff ab:

Tilo Arens et al., "Mathematik", Springer; online verfügbar unter:


Meike Akveld, "Analysis 1", vdf:


Urs Stammbach, "Analysis III" (erhältlich im ETH Store);
https://people.math.ethz.ch/~stammb/analysisskript.html

Lecture notes


Objective

To acquire basic knowledge of Linear Algebra and Numerical Methods. Enhanced capability for abstract and algorithmic thinking based on mathematical concepts and models. Ability to select appropriate numerical linear algebra methods, to apply them properly and to implement them efficiently in MATLAB.

Literature

K. Nipp, D. Stoffer, Lineare Algebra, VdF Hochschulverlag ETH

G. Strang, Lineare Algebra, Springer

Abstract

Introduction to Linear Algebra and Numerical Analysis with emphasis on both abstract concepts and algorithms.

Content

1. Linear systems of equations
2. Vector and matrix calculus
3. Subspaces and bases
4. The Euclidean space Rn
5. Numerical linear algebra with MATLAB
6. Linear mappings [optional]
7. Diagonalization (eigenproblems)

Computer Science I

O
5 credits
3V+1U
M. Hirt

Lecture notes

G. Strang, "Introduction to Linear Algebra" (erhältlich im ETH Store);

Meike Akveld, "Analysis 1", vdf;

Tilo Arens et al., "Mathematik", Springer; online verfügbar unter:

Urs Stammbach, "Analysis III" (erhältlich im ETH Store);
https://people.math.ethz.ch/~stammb/analysisskript.html

Literature

K. Nipp, D. Stoffer, Lineare Algebra, VdF Hochschulverlag ETH

G. Strang, Lineare Algebra, Springer

Abstract

The course covers the basic concepts of computer programming.

Objective

Basic understanding of programming concepts. Students will be able to write and read simple programs and to modify existing programs.

Content

Variablen, Typen, Kontrollanweisungen, Prozeduren und Funktionen, Scoping, Rekursion, dynamische Programmierung, vektorisierte Programmierung, Effizienz.

As Lernsprachen werden Pascal und Matlab verwendet.

Written session examination in "Mechanics 1" and "Mechanics 2" for D-MAVT Students, Students in Human Movement Sciences and Sport and all other Students, who take "Mechanics 1" and "Mechanics 2":

Part 1: 20 minutes: Neither notes nor calculators allowed right afterwards:


This course gives an overview of the basic concepts of geology and petrography and shows some links to the application of these concepts. The course consists of lectures and exercises in groups. The lectures cover all aspects of the dynamic earth, from the history of the earth, to the formation of rocks, mountains, and oceans, and the degradation processes shaping the uppermost earth's crust.

This class introduces students to basic features of the legal system. Questions of constitutional and administrative law, contract law, tort law, corporate law, as well as litigation are covered.

This course focuses on the Swiss Code of Obligations (contracts, torts) and on Property Law (ownership, mortgage and easements). In addition, the course will provide a short overview of Civil Procedure and Enforcement.

**Abstract**

This class introduces students to basic features of the legal system. Questions of constitutional and administrative law, contract law, tort law, corporate law, as well as litigation are covered.

**Objective**

Introduction to fundamental questions of public and private law which serves as a foundation for more advanced law classes.

**Content**

1. Public Law
   - Constitutional law: sources of law, organization of the state, fundamental rights. Administrative law: administrative decisions, organization of the administration, enforcement of administrative decisions, procedural law, basics of police, environmental and zoning law.

**Literature**

- Boillod, J.-P.: Manuel de droit, éd Slatkine, Genève
- Nef, Urs Ch.: Le droit des obligations à l'usage des ingénieurs et des architectes, trad. Bovay, J., éd. Payot, Lausanne
- Boillot, J.-P.: Manuel de droit, éd Slatkine, Genève

**Prerequisites / notice**

- Le cours de droit civil et le cours de droit public (2e sem.) sont l'équivalent des cours “Recht I” et “Recht II” en langue allemande et des cours de droit civil et de droit des obligations, disponibles auprès de la plupart des librairies.

- Sont indispensables:
  - le Code civil et le Code des obligations;
  - Sont conseillés:
  - Nef, Urs Ch.: Le droit des obligations à l'usage des ingénieurs et des architectes, trad. Bovay, J., éd. Payot, Lausanne
  - Boillot, J.-P.: Manuel de droit, éd Slatkine, Genève

**Optional Colloquia**

**Compulsory Courses 3. Semester**

**Examination Block 1**

**Optional Colloquia**

**Number**

151-0501-02L

**Title**

Mechanics 1: Kinematics and Statics (Colloquium)

**Type**

Z

**ECTS**

0

**Hours**

1K

**Lecturers**

E. Mazza

**Abstract**

Basics: Position of a material point, velocity, kinematics of rigid bodies, forces, reaction principle, mechanical power

Statics: Groups of forces, moments, equilibrium of rigid bodies, reactions at supports, parallel forces, center of gravity, statics of systems, principle of virtual power, trusses, frames, forces in beams and cables, friction

**Objective**

The understanding of the fundamentals of Statics for engineers and their application in simple settings.

**Content**

Basics: Position of a material point; velocity; kinematics of rigid bodies; translation, rotation, planar motion; forces, action-reaction principle, internal and external forces, distributed forces; mechanical power.

Statics: equivalence and reduction of groups of forces; rest and equilibrium; basic theorem of statics; kinematic and static boundary conditions, applications to supports and clamps of rods and beams; procedures for determination of forces at supports and clamps; parallel forces and centre of gravity; statics of systems, solution using basic theorem and using the principle of virtual power, statically indeterminate systems; statically determinate truss structures, ideal truss structures, nodal point equilibrium, methods for truss force determination; friction, static friction, sliding friction, friction at joints and supports, rolling resistance; forces in cables; beam loading, force and moment vector.

**Lecture notes**

Übungsblätter

**Literature**

Sayir, M.B., Dual J., Kaufmann S., Ingenieurmechanik 1: Grundlagen und Statik, Teubner

**Compulsory Courses 3. Semester**

**Number**

401-0243-00L

**Title**

Analysis III

**Type**

O

**ECTS**

3

**Hours**

2V+1U

**Lecturers**

M. Larsson

**Abstract**

This course is based on the book Dynamic Earth from Press & Siever

This course gives an overview of the basic concepts of geology and petrography and shows some links to the application of these concepts. The course consists of lectures and exercises in groups. The lectures cover all aspects of the dynamic earth, from the history of the earth, to the formation of rocks, mountains, and oceans, and the degradation processes shaping the uppermost earth's crust.
We will model and solve scientific problems with partial differential equations. Differential equations which are important in applications will be classified and solved. Elliptic, parabolic and hyperbolic differential equations will be treated. The following mathematical tools will be introduced: Laplace and Fourier transforms, Fourier series, separation of variables, methods of characteristics.

Learning to model scientific problems using partial differential equations and developing a good command of the mathematical methods that can be applied to them. Knowing the formulation of important problems in science and engineering with a view toward civil engineering (when possible). Understanding the properties of the different types of partial differential equations arising in science and in engineering.

Classification of partial differential equations

Study of the Heat equation general diffusion/parabolic problems using the following tools:
- Separation of variables
- Fourier series
- Fourier transform
- Laplace transform

Study of the wave equation and general hyperbolic problems using similar tools and the method of characteristics.

Study of the Laplace equation and general elliptic problems using similar tools and generalizations of Fourier series.

Accompanying material will be posted on the course website throughout the semester.

We will loosely follow the following books:

- Stanley J. Farlow - Partial Differential Equations for Scientists and Engineers (a Dover reprint and can be bought for less than 20 CHF)
- Chapters 11 and 12 of E. Kreyszig, Advanced Engineering Mathematics.

Two good sources in German are:

- Norbert Hungerbühler, "Einführung in die partiellen Differentialgleichungen"
- http://www.math.ethz.ch/u/felder/Teaching/PDG.

Analysis I and II, in particular, knowing how to solve ordinary differential equations is an important prerequisite.

This course will cover the basic topics in Physics and will show/display/explain with a variety of experiments the most important physical effects. The course will address classical as well as modern physics, and the interpret between basic research and applications.


The course teaches the basics of hydromechanics, relevant for civil and environmental engineers.

Familiarization with the basics of hydromechanics of steady state flows

Properties of water, hydrostatics, stability of floating bodies, continuity, Euler equation of motion, Navier-Stokes equations, similarity, Bernoulli principle, momentum equation for finite volumes, potential flows, ideal fluids vs. real fluids, boundary layer, pipe flow, open channel flow, flow measurements, demonstration experiments in the lecture hall

The course provides Bachelor students of mechanical engineering with fundamental knowledge of kinematics and dynamics of mechanical systems. By studying motion of a single particle, systems of particles and rigid bodies, we introduce essential concepts such as work and energy, equations of motion, and forces and torques. Further topics include stability of equilibria and vibrations. Examples presented in the lectures and weekly exercise lessons help students learn basic techniques that are necessary for advanced courses and work on engineering applications.

Kinematics, dynamics and oscillations: Motion of a single particle - Motion of systems of particles - 2D and 3D motion of rigid bodies

This course will cover the basic topics in Physics and will show/display/explain with a variety of experiments the most important physical effects. The course will address classical as well as modern physics, and the interpret between basic research and applications.

Properties of water, hydrostatics, stability of floating bodies, continuity, Euler equation of motion, Navier-Stokes equations, similarity, Bernoulli principle, momentum equation for finite volumes, potential flows, ideal fluids vs. real fluids, boundary layer, pipe flow, open channel flow, flow measurements, demonstration experiments in the lecture hall

This course will cover the basic topics in Physics and will show/display/explain with a variety of experiments the most important physical effects. The course will address classical as well as modern physics, and the interpret between basic research and applications.

Properties of water, hydrostatics, stability of floating bodies, continuity, Euler equation of motion, Navier-Stokes equations, similarity, Bernoulli principle, momentum equation for finite volumes, potential flows, ideal fluids vs. real fluids, boundary layer, pipe flow, open channel flow, flow measurements, demonstration experiments in the lecture hall

Data: 06.03.2019 12:57 Autumn Semester 2016 Page 156 of 1571
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<thead>
<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
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<tr>
<td>101-0113-00L</td>
<td>Theory of Structures I</td>
<td>O</td>
<td>5 credits</td>
<td>3V+2U</td>
<td>S. Zweidler</td>
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<tr>
<td>Abstract</td>
<td>Introduction, statically determinate beams and frames, stresses and deformations, application of the principle of virtual work, statically indeterminate beams and frames (force method).</td>
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<tr>
<td>Objective</td>
<td>Understanding the response of elastic beam and frame structures</td>
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<tr>
<td>Ability to correctly apply the equilibrium conditions</td>
<td>Ability to determine elastic deformations</td>
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<tr>
<td>Ability to apply the force (flexibility) method for statically indeterminate structures</td>
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<tr>
<td>Content</td>
<td>Introduction</td>
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<tr>
<td>Reactions, internal forces and moments</td>
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<tr>
<td>Arches and cables</td>
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<td>Trusses</td>
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<td>Influence lines</td>
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<tr>
<td>Stresses and deformations</td>
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<tr>
<td>Principle of virtual work</td>
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<td>Flexure and axial force, shear, torsion</td>
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<tr>
<td>Deflections, work equation</td>
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<tr>
<td>Statically indeterminate systems</td>
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Compulsory Courses 5. Semester

Examination Block 3

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<th>Number</th>
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<tbody>
<tr>
<td>101-0315-00L</td>
<td>Geotechnical Engineering</td>
<td>O</td>
<td>5 credits</td>
<td>4G</td>
<td>A. Puzrin</td>
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<tr>
<td>Abstract</td>
<td>The course explores the fundamental principles of Geomechanics and Geotechnical Engineering, with the following objectives:</td>
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<tr>
<td>- Recognition of the basic consequences of the ground construction;</td>
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<tr>
<td>- Understanding of the important fundamental concepts of Soil mechanics and Geotechnical Engineering;</td>
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<tr>
<td>- Independent analysis of the basic geotechnical problems.</td>
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<tr>
<td>Objective</td>
<td>The course explores the fundamental principles of Geomechanics and Geotechnical Engineering, with the following objectives:</td>
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<tr>
<td>- Recognition of the basic consequences of the ground construction;</td>
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<tr>
<td>- Understanding of the important fundamental concepts of Soil mechanics and Geotechnical Engineering;</td>
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<tr>
<td>- Independent analysis of the basic geotechnical problems.</td>
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<tr>
<td>Content</td>
<td>Overview of stability problems; Bearing capacity of shallow and deep foundations; Soil-foundation interaction; Analysis and design of shallow and deep foundations; Earth pressure on retaining structures; Analysis and design of retaining walls; Excavations: dewatering, analysis and design; Soil improvement; Safety considerations.</td>
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<tr>
<td>Lecture notes</td>
<td>Examples</td>
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<td>Exercises</td>
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<tr>
<td>101-0135-01L</td>
<td>Steel Structures II</td>
<td>O</td>
<td>4 credits</td>
<td>3G</td>
<td>M. Fontana</td>
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<tr>
<td>Abstract</td>
<td>Theoretical basic knowledge and detailing of plate girders, trusses and composite beams and columns. Local load introduction, design structural analysis stability and detailing of buildings. A global approach including aspects of structural safety, architecture, use and durability is given. The course includes practical examples and exercises done by the students to enhance their knowledge.</td>
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<tr>
<td>Objective</td>
<td>Students know the theoretical basis and the detailing of strutural steel elements. They understand how to cope with local load introduction and redirection. They know the basics of design, detailing and dimensioning of steel structures for buildings, respecting aspects of safety, architecture, use, durability and flexibility etc.</td>
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<tr>
<td>Content</td>
<td>After having attended Steel structures I and II students are able to design, detail and dimension the structure of common steel buildings.</td>
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<tr>
<td>Basics of dimensioning of plate girders, trusses and composite beams and columns (structural modeling, detailing and selection of material). Load introduction and redirection, detailing. Design, detailing and dimensioning of steel and steel concrete composite structures including roof and façades. Interaction of different building elements including bracing and global stability of steel structures)</td>
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<tr>
<td>Lecture notes</td>
<td>Autography on plate girders, trusses, load introduction and redirection, steel concrete composite elements. Copies of presentations.</td>
<td></td>
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<td></td>
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<tr>
<td>Literature</td>
<td>Dubas, P.; Gehri, E.; Stahlbochbach, Springer-Verlag Berlin, 1988</td>
<td></td>
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<tr>
<td>- Stahlbaukalender, Ernst &amp; Sohn, Berlin</td>
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<tr>
<td>Prerequisites / notice</td>
<td>The content of steel structures I is a prerequisite</td>
<td></td>
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<tr>
<td>101-0415-01L</td>
<td>Railway Infrastructures (Transportation II)</td>
<td>O</td>
<td>3 credits</td>
<td>2G</td>
<td>U. A. Weidmann</td>
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<tr>
<td>Abstract</td>
<td>Fundamentals of railroad technology and interactions between track and vehicles, network development and infrastructure planning, planning of rail infrastructure, planning and design of railway stations, construction and dimensioning of tracks, approval and beginning service on complex infrastructure facilities, special issues of maintenance.</td>
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<tr>
<td>Objective</td>
<td>Teaches the basic principles of public transport network and topology design, geometrical design, dimensioning and construction as well as the maintenance of rail infrastructures. Teaches students to recognize the interactions between the infrastructure design and the production processes. Provides the background for Masters degree study.</td>
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<tr>
<td>Content</td>
<td>(1) Fundamentals: Infrastructures of public transport systems; interaction between track and vehicles; passengers and goods as infrastructure users; management and financing of networks; railway standards and norms. (2) Infrastructure planning: Planning processes and decision levels in network development and infrastructure planning, planning of railway tracks and rail topologies; planning of the passenger parts of stations. (3) Infrastructure design: Fundamentals of the layout of a line; track geometry; switches and crossings; design of station platforms. (4) Construction of railway infrastructures: Assembly and evolution of the railway track; elements of the railway track; dimensioning of the track; track stability. (5) Approval and beginning service on complex infrastructure facilities: Definitions and limitations; fundamentals of the legal situation; test and approval processes; processes of putting railway systems into operation. (6) Maintenance of railway infrastructures: Fundamentals of infrastructure maintenance; kinds of deprivations; supervision methods; steps of infrastructure maintenance; estimation of maintenance need; methods to minimize maintenance costs.</td>
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<tr>
<td>Lecture notes</td>
<td>Course notes will be provided in German. Slides are made available some days before each lecture.</td>
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<tr>
<td>Literature</td>
<td>References to technical literature will be included in the course script. An additional list of literature will be given during the course.</td>
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</tbody>
</table>
Systems Engineering

Abstract

- to gain competency in methods used to plan and analyse systems
- to gain the ability to formulate, analyse and solve complex problems
- to gain competency in the methods used for the evaluation of multiple solutions

Content

- Introduction
- System development
- System analysis
- Networks
- Decision theory
- Economic analysis
- Cost-benefit analysis

Lecture notes

Script and transparencies as well as additional material via Moodle.

The transparencies will be provided via Moodle two days before the respective class.

Hydrology

Abstract

The course introduces the students to engineering hydrology. It covers first physical hydrology, that is the description and the measurement of hydrological processes (precipitation, interception, evapotranspiration, runoff, erosion, snow), and it introduces then the basic mathematical models of the single processes and of the rainfall-runoff transformation, thereby including flood analysis.

Objective

Know the main features of engineering hydrology. Apply methods to estimate hydrological variables for dimensioning hydraulic structures and managing water resources.

Content

Der hydrologische Kreislauf: globale Wasserressourcen, Wasserbilanz, räumliche und zeitliche Dimension der hydrologischen Prozesse.


Interzeption: Messung und Schätzung.

Evaporation and Evapotranspiration: Prozesse, Messung und Schätzung, potentielle und effektive Evapotranspiration, Energiebilanzmethode, empirische Methoden.

Infiltration: Messung, Horton-Gleichung, empirische und konzeptionelle Methoden, F-index und Prozentuale Methode, SCS-CN Methode.


Schnee und Eis: Schneeeigenschaften und -messungen Schätzung des Schneeschmelzprozesses durch die Energiebilanzmethode, Abfluss aus Schneeschmelze, Temperatur-Index- und Grad-Tag-Verfahren.


Prerequisites / notice

Ein internes Skript steht zur Verfügung (kostenpflichtig, nur Herstellungskosten)

Literature


Prerequisites / notice

Vorbereitende zu Hydrologie I sind die Vorlesungen in Statistik. Der Inhalt, der um ein Teil der Übungen zu behandeln und um ein Teil der Vorlesungen zu verstehen notwendig ist, kann zusammengefasst werden, wie hintereinander es beschrieben wird:


Examination Block 4

<table>
<thead>
<tr>
<th>Number</th>
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<tr>
<td>101-0125-00L</td>
<td>Structural Concrete I</td>
<td>O</td>
<td>5</td>
<td>4</td>
<td>W. Kaufmann</td>
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Abstract

- Contents: Introduction, historical development of structural concrete, materials and material behaviour (cement, concrete, reinforcing steel, prestressing steel), linear members (axial force, flexure and axial force, compression members and columns, shear, bending and shear, torsion and combined actions), strut-and-tie models and simple stress fields, detailing, basic aspects of membrane elements.

Objective

- Understanding the materials concrete and reinforcing steel and understanding their interaction;
- Knowing elementary models and ability to apply them to practical problems;
- Ability to correctly dimension and detail simple structures.

Content

Introduction, historical development of structural concrete, materials and material behaviour (cement, concrete, reinforcing steel, prestressing steel), linear members (axial force, flexure and axial force, compression members and columns, shear, bending and shear, torsion and combined actions), strut-and-tie models and simple stress fields, detailing.
Introduction into the basic and practical knowledge of important building materials and testing methods.

**4 credits**

- Introduction of material testing equipment, with various examples of experiments on metals (tensile behaviour, hardness, bending and impact loading).
- Theoretical background and practical aspects of concrete technology; mixture design, casting and setting; determination of mechanical properties.
- Properties of bricks and mortar; individual materials and the composite brickwork. Parameters like strength, Youngs modulus, water absorption and thermal conductivity are determined.
- Understanding the characteristic properties of wood: anisotropy, hygroscopic behaviour, shrinkage and swelling, and effect of size on strength. Introduction to test-methods for wood and wood-products.
- Introduction into the basics of scanning electron microscopy: practical exercises with the Environmental Scanning Electron Microscope (ESEM).
- Introduction to fundamentals of Finite Element Methods and their application in examples.
- Introduction to durability of building materials and building structures: assessment of potentials for detecting and locating corrosion of steel reinforcement in concrete.

Methodology:
Excursion with mission, lectures, autonomous work, poster session, role playing, workshop, exemplary plenary review.

**Additional Compulsory Courses**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0007-01L</td>
<td>Project Work Conceptual Design</td>
<td>O</td>
<td>3 credits</td>
<td>3S</td>
<td>T. Vogel</td>
</tr>
<tr>
<td>Abstract</td>
<td>A structure to be designed serves as a mean to practice the holistic approach of conceptual design by working in parallel and iteratively on different levels of detailing. Both, requirements and scope of action, are identified by the students and serve as basis for a solution. The task group organizes itself to solve complex tasks.</td>
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</table>

**Bachelor’s Thesis**

For each topic a script will be provided, that can be downloaded under www.ifb.ethz.ch/education

**Bachelor Studies (Programme Regulations 2010)**

**Übrige obligatorische Fächer**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0615-00L</td>
<td>Materials III</td>
<td>O</td>
<td>4 credits</td>
<td>4P</td>
<td>R. J. Flatt, I. Burgert, P. Lura, H. Richner, F. Wittel</td>
</tr>
</tbody>
</table>

*Only for Civil Engineering BSc, Programme Regulations 2014.*
Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
101-0006-00L | Bachelor’s Thesis | O | 10 credits | 20D | Lecturers

Abstract: The Bachelor Programme concludes with the Bachelor Thesis. This project is supervised by a professor. Writing up the Bachelor Thesis encourages students to show independence and to produce structured work.

Objective: Encourages students to show independence, to produce scientifically structured work and to apply engineering working methods. The contents base upon the fundamentals of the Bachelor Programme. Students can choose from different subjects and tasks. The thesis consists of both a written report and an oral presentation.

The entire course programs of ETH Zurich and the University of Zurich are open to the students to individual selection.

Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
101-0185-01L | CAD for Civil Engineers | W | 2 credits | 2G | T. Vogel, K.H. Hamel

Abstract: Introduction to computer aided design and drafting in 2D and 3D with examples from structural engineering.

Objective: Having followed the course, students are able to develop a 2D-structure (formwork drawing) and they know the principle of a reinforcement module. They have also got an introduction to a 3D program (reinforcement in 3D).

They are therefore better prepared for:
- the bachelor thesis in the 6th semester,
- an eventual internship between bachelor and master course,
- the project works in the master course,
- the master thesis.

Above all they practice spatial sense and acquire contextual knowledge as future superiors of draftsmen and designers.

Prerequisites / notice: Specialbewilligung der Dozierenden notwendig. Für Studierende im 5. Semester während 10 Wochen gemäss speziellem Programm; Arbeit ausschliesslich am eigenen Laptop. Die rechtzeitige Installation der Software ist Bedingung für die Teilnahme. Eine Anleitung zur Installation wird ausgegeben.
Civil Engineering Master

1. Semester

Seminar Work

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>101-0007-00L</td>
<td>Conceptual Design</td>
<td>O</td>
<td>4</td>
<td>3S</td>
<td>T. Vogel, H. Figi, H. Schnetzer</td>
</tr>
</tbody>
</table>

Abstract
Procurement of consistent procedures to solve typical problems of civil engineering. Consolidation of the knowledge of the bachelor courses; integration of bachelors of other universities. Practice of the holistic approach of conceptual design, parallel and iterative operations on varying levels of detailing. Integration of different fields of knowledge and experiences.

Objective
Procurement of consistent procedures to solve typical problems of civil engineering. Consolidation of the knowledge of the bachelor courses; integration of bachelors of other universities. Practice of the holistic approach of conceptual design, parallel and iterative operations on varying levels of detailing. Integration of different fields of knowledge and experiences.

Content
Basic tools:
- Literature research, quotations
- Technical report and presentations
- Basics of graphical representation

Elements of the design process:
- Service criteria and respective agreement
- Design requirements and design boundary conditions
- Design alternatives
- Preliminary dimensioning
- Cost-effectiveness
- Optimization
- Detailing

Exemplary consolidations:
- Geotechnical basics of retaining walls
- Conceptual design and shaping of retaining walls
- Drainage of structures
- Case study conceptual bridge design

Implementation with a planning tutorial:
- Presentation of the objects
- Survey and inventory
- Design options
- Intermediate review
- Final presentation

Lecture notes
Lecture notes, partially as download
http://www.vogel.ibk.ethz.ch/studium/downloads.html

Literature
Normen

Weiterführende Literatur

Major Courses

Major in Construction and Maintenance Management

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0579-00L</td>
<td>Infrastructure Maintenance Processes</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>B. T. Adey</td>
</tr>
</tbody>
</table>

Does not take place this semester.
101-0579-00L "Infrastructure Maintenance Processes" will be offered from FS17 on with new title 101-0579-00L "Infrastructure Management 2: Evaluation Tools".

Abstract
This course provides an introduction to the tools that can be used to evaluate infrastructure. In particular tools:
- to measure the level of service being obtained from infrastructure,
- to predict slow changes in infrastructure over time, and
- to predict fast changes in infrastructure over time. fits of monitoring.

Objective
to equip students with tools to be used to evaluate infrastructure and the level of service being provided from infrastructure

Content
Introduction
Levels of service
Reliability of infrastructure
Availability and maintainability of infrastructure
Mechanistic-empirical models
Regression analysis
Event trees
Fault trees
Markov chains
Neural networks
Bayesian networks
Conclusion

Lecture notes
All necessary materials (e.g. transparencies and hand-outs) will be distributed before class.
"Design and Building Process MBS" is a brief manual for prospective architects and engineers covering the competencies and the principles of heat and mass transport, hygro-thermal performance, durability of the building envelope and interaction with indoor and outdoor climates, applications.

Objective
The students will acquire in the following fields:
- Indoor and outdoor climate and driving forces.
- Hygrothermal properties of building materials.
- Building envelope solutions and their construction.
- Hygrothermal performance and durability.

Content
Principles of heat and mass transport, hygro-thermal performance, durability of the building envelope and interaction with indoor and outdoor climates, applications.

529-0193-00L Renewable Energy Technologies I
The lectures Renewable Energy Technologies I (529-0193-00L) and Renewable Energy Technologies II (529-0191-01L) can be taken independently from one another.

Abstract
Scenarios for world energy demand and CO2 emissions, implications for climate. Methods for the assessment of energy chains. Potential and technology of renewable energies: Biomass (heat, electricity, biofuels), solar energy (low temp. heat, solar thermal and photovoltaic electricity, solar chemistry). Wind and ocean energy, heat pumps, geothermal energy, energy from waste. CO2 sequestration.

Objective
Scenarios for the development of world primary energy consumption are introduced. Students know the potential and limitations of renewable energies for reducing CO2 emissions, and their contribution towards a future sustainable energy system that respects climate protection goals.

Content

Lecture notes
Lecture notes will be distributed electronically during the course.

Literature

Prerequisites / notice
- Fundamentals of chemistry, physics and thermodynamics are a prerequisite for this course.
- Topics are available to carry out a Project Work (Semesterarbeit) on the contents of this course.

066-0427-00L Design and Building Process MBS
“Design and Building Process MBS” is a brief manual for prospective architects and engineers covering the competencies and the responsibilities of all involved parties through the design and building process. Lectures on twelve compact aspects gaining importance in a increasingly specialised, complex and international surrounding.

Objective
Participants will come to understand how they can best navigate the design and building process, especially in relation to understanding their profession, gaining a thorough knowledge of rules and regulations, as well as understanding how involved parties’ minds work. They will also have the opportunity to investigate ways in which they can relate to, understand, and best respond to their clients’ wants and needs. Finally, course participants will come to appreciate the various tools and instruments, which are available to them when implementing their projects. The course will guide the participants, bringing the individual pieces of knowledge into a superordinate relationship.

Content
“Design and Building Process MBS” is a brief manual for prospective architects and engineers covering the competencies and the responsibilities of involved parties through the design and building process. Twelve compact aspects regarding the establishment building culture are gaining importance in an increasingly specialised, complex and international surrounding. Lectures on the topics of profession, service model, organisation, project, design quality, coordination, costing, tendering and construction management, contracts and agreements, life cycle, real estate market, and getting started will guide the participants, bringing the individual pieces of knowledge into a superordinate relationship. The course introduces the key figures, depicts the criteria of the project and highlights the provided services of the consultants. In addition to discussing the basics, the terminologies and the tendencies, the lecture units will refer to the studios as well as the praxis: Teaching-based case studies will compliment and deepen the understanding of the twelve selected aspects. The course is presented as a moderated seminar to allow students the opportunity for individual input: active collaboration between the students and their tutor therefore required.

101-0427-01L System and Network Planning
Public transports in the context of the transport systems; customer needs in the transport market; service planning processes for regular public transport services; long distance, regional and urban public transport service strategies; access to public transport and the last mile

Objective
Students will develop a basic knowledge of all stages of the public transport planning process from market demand to service planning; generic planning process; demarcation, analysis of the situation, setting of targets; design of public transport services; evaluation and optimization; system planning. (3) Public transport services: long distance service offers; suburban and urban service offers; regional and local service offers; access to public transport and the last mile

Content
(1) Fundamentals of system and network planning: Mobility and transport systems; public transport systems; customer needs versus supply characteristics of regular services. (2) System and network planning in public passenger services: Goals of the system and network planning; generic planning process; demarcation, analysis of the situation, setting of targets; design of public transport services; evaluation and optimization; system planning. (3) Public transport services: long distance service offers; suburban and urban service offers; regional and local service offers; access to public transport and the last mile

101-0520-00L Project Management: Project Execution to Closeout
The course will give Engineering students a comprehensive overview and enduring understanding of the techniques, processes, tool and terminology to manage the Project Triangle (time, cost Quality) and to organize, analyze, control and report a complex project from start of Project Execution to Project Completion. Responsibilities will be detailed in each phase of the execution.

Objective
A student after completing the course will have the understanding of the Project Management duties, responsibilities, actions and decisions to be done during the Execution phase of a complex project.
This course will provide both a theoretical background and a pragmatic project work (case studies) on current trends and developments of Construction Information Management.

### Main Content

- **Introduction to Construction Information Management**
- **Infrastructure Management 1: Process**
- **Project Management for Construction Projects**

### Objective

- The main content of the course is summarized in the following topics:
  - Project organization structures
  - Project scheduling
  - Resource management
  - Project estimating
  - Project financing
  - Risk management
  - Interpersonal skills

### Literature

- Relevant readings will be recommended throughout the course (and made available to the students via Moodle). There are no pre-requisites to enroll in this course.

### Prerequisites

- For **Project Management for Construction Projects**, prerequisite is course Project Management: Pre-Tender to Contract Execution number 101-0517-01 G, unless otherwise approved by the lecturer.

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### 101-0521-00L Project Management for Construction Projects

**W+** 3 credits 2S B. Garcia de Soto Lastra

**Abstract**

This course is designed to lay down the foundation of the different concepts, techniques, and tools for successful project management of construction projects.

**Objective**

The goal is that at the end of this course students should have a good understanding of the different project management knowledge areas, the phases required for successful project management, and the role of a project manager. To demonstrate this, students will work in groups in different case studies to apply the concepts, tools and techniques presented in the class.

**Content**

The main content of the course is summarized in the following topics:

- Project and organization structures
- Project scheduling
- Resource management
- Project estimating
- Project financing
- Risk management
- Interpersonal skills

**Lecture notes**

The slides for the class will be available for download from Moodle at least one day before each class. Copies of all necessary documents will be distributed at appropriate times.

**Literature**

Relevant readings will be recommended throughout the course (and made available to the students via Moodle). There are no pre-requisites to enroll in this course.

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### 101-0522-00L Introduction to Construction Information Management & Modelling

**W+** 3 credits 2S B. Garcia de Soto Lastra

**Abstract**

This course will provide both a theoretical background and a pragmatic project work (case studies) on current trends and developments of information modeling and management in the construction industry around the world and in Switzerland. The course will include external lecturers from engineering and construction companies in Switzerland.

**Objective**

Students enrolled in this course are expected to become familiar with current information modeling and management technologies and their applications to the construction industry, and to get a good understanding of new project delivery systems and technologies for integrated practice.

**Content**

The content of the course is summarized in the following topics:

- Introduction to information modeling and management technologies
- Integrated Project Delivery (IPD) (vs. traditional delivery methods)
- Information model execution plan
- Information modeling tools and parametric modeling
- Interoperability
- Standards and foundations
- Implications for engineers and the construction industry
- Implications for owners and facility managers
- Information Modeling and Prefabrication
- Construction Analysis and Planning (4D modeling)
- Quantity Takeoff and Cost Estimating (5D modeling)

**Lecture notes**

The slides for the class will be available for download from Moodle at least one day before each class. Copies of all necessary documents will be distributed at appropriate times.

**Literature**

Relevant readings will be recommended throughout the course and made available to the students via Moodle. There are no pre-requisites to enroll in this course.

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### 101-0509-00L Infrastructure Management 1: Process

**W+** 3 credits 2S B. T. Adey

**Abstract**

The course provides an introduction to the steps included in the infrastructure management process. The lectures are given by a mixture of external people in German and internal people in English.

**Objective**

Upon completion of the course, students will

- understand the steps required to manage infrastructure effectively,
- understand the complexity of these steps, and
- have an overview of the tools that they can use in each of the steps.

**Content**

- The infrastructure management process and guidelines
- Knowing the infrastructure - Dealing with data
- Establishing goals and constraints
- Establishing organization structure and processes
- Making predictions
- Selecting strategies
- Developing programs
- Planning interventions
- Conducting impact analysis
- Reviewing the process

**Lecture notes**

Appropriate reading / and study material will be handed out during the course. Transparencies will be handed out at the beginning of each class.

**Literature**

Appropriate literature will be handed out when required.

**Prerequisites**

The courses will be given half in English and half in German. Students should have a minimum of level B2 in both to register for the course.
### Major in Geotechnical Engineering

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0317-00L</td>
<td>Tunnelling I</td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>G. Anagnostou, E. Pimentel</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>Basic aspects of design and analysis of underground structures. Conventional tunnel construction methods. Auxiliary measures (ground improvement and drainage, forepoling, face reinforcement), Numerical analysis methods.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>Basic aspects of design and analysis of underground structures. Conventional tunnel construction methods. Auxiliary measures (ground improvement and drainage, forepoling, face reinforcement), Numerical analysis methods.</td>
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<tr>
<td><strong>Content</strong></td>
<td>Numerical analysis methods in tunnelling.</td>
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<td></td>
<td>Conventional excavation methods (full face, top heading and bench, side drift method, ...)</td>
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<td></td>
<td>Auxiliary measures:</td>
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<td>- Injections</td>
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<td>- Jet grouting</td>
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<td>- Ground freezing</td>
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<td>- Drainage</td>
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<td>- Forepoling</td>
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<td></td>
<td>- Face reinforcement</td>
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<tr>
<td><strong>Lecture notes</strong></td>
<td>Autographiblätter</td>
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<tr>
<td><strong>Literature</strong></td>
<td>Empfehlungen</td>
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</tbody>
</table>

#### Theoretical and Experimental Soil Mechanics [W+ 6 credits 4G]

**Prerequisites:** Mechanics I, II and III.

*The number of participants is limited to 60 due to the existing laboratory equipment! Students with major in Geotechnical Engineering have priority. Registrations will be accepted in the order they are received.*

**Abstract**
Overview of soil behaviour
Explanation of typical applications: reality, modelling, laboratory tests with transfer of results to the practical examples
Consolidation theory and typical applications in practice
Triaxial & direct shear tests: consolidation & shear, drained & undrained response
Plasticity theory & Critical State Soil Mechanics, Cam Clay
Application of plasticity theory

**Objective**
Extend knowledge of theoretical approaches that can be used to describe soil behaviour to enable students to carry out more advanced geotechnical design and to plan the appropriate laboratory tests to obtain relevant parameters for coupled plasticity models of soil behaviour.
A further goal is to give students the wherewithal to be able to select an appropriate constitutive model and set up insitu stress conditions in preparation for subsequent numerical modelling (e.g. with finite elements).

**Content**
Overview of soil behaviour
Discussion of general gaps between basic theory and soil response
Stress paths in practice & in laboratory tests
Explanation of typical applications: reality, modelling, laboratory tests with transfer of results to the practical examples
Consolidation theory for incremental and continuous loading oedometer tests and typical applications in practice
Triaxial & direct shear tests: consolidation & shear, drained & undrained response
Plasticity theory & Critical State Soil Mechanics, Cam Clay
Application of plasticity theory

**Lecture notes**
Printed script with web support
Exercises

**Literature**
http://geotip.igt.ethz.ch/

**Prerequisites / notice**
Lectures will be conducted as Problem Based Learning within the framework of a case history
Virtual laboratory in support of 'hands-on' experience of selected laboratory tests

Pre-requisites: Basic knowledge in soil mechanics as well as knowledge of advanced mechanics
Laboratory equipment will be available for 60 students. First priority goes to those registered for the geotechnics specialty in the Masters, 2nd year students then first year students, doctoral students qualifying officially for their PhD status and then 'first come, first served'.

#### Design and Construction in Geotechnical Engineering [W 4 credits 3G]

**Abstract**
This lecture deals with the practical application of the knowledge gained in the fundamental lectures from the Bachelor degree.
The basics of planning and design of geotechnical structures will be taught for the main topics geotechnical engineers are faced to in practice.

**Objective**
Transfer of the fundamental knowledge taught in the Bachelor degree to practical application.
Ability to plan and design geotechnical structures based on the state of the art.

**Content**
Introduction to Swisscode SIA
Foundations and settlements
Pile foundations
Excavations
Slopes
Soil nailing
Reinforced geosystems
Ground improvement
River levees

**Lecture notes**
Script in the form of chapters and powerpoint overheads with web support (http://geotip.igt.ethz.ch)
Exercises

**Literature**
relevant literature will be stated during the lectures

**Prerequisites / notice**
Pre-condition: Successful examinations (pass) in the geotechnical studies (soil mechanics and ground engineering, each 5 credits) in the Bachelor degree of Civil Engineering (ETH), or equivalent for new students.

The lecture contains at least one presentation from practice

#### Forensic Geotechnical Engineering [W 3 credits 2G]

**Prerequisites:** successful participation in "Geotechnical Engineering" (101-0315-00L) or an equivalent course.

**Abstract**
In this course selected famous geotechnical failures are investigated with the following purpose: (a) to deepen understanding of the geotechnical risks and possible solutions; (b) to practice design and analysis methods; (c) to learn the techniques for investigation of failures; (d) to learn the techniques for mitigation of the failure damage.
Objective

In this course selected famous geotechnical failures are investigated with the following purpose: (a) to deepen understanding of the geotechnical risks and possible solutions; (b) to practice design and analysis methods; (c) to learn the techniques for investigation of failures; (d) to learn the techniques for mitigation of the failure damage.

Content

Failure due to the loading history
Failure due to the creeping landslides
Failure due to excessive settlements
Failure due to the leaning instability
Failure due to tunnelling
Bearing capacity failure
Excavation failure

Lecture notes

Lecture notes

Literature


Prerequisites / notice

The course is given in the first MSc semester.
Prerequisite: Basic knowledge in Geotechnical Engineering (Course content of "Bauordnung" or similar lecture).

★★★★ Major in Structural Engineering

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0187-00L</td>
<td>Structural Reliability and Risk Analysis</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>B. Sudret</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
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<td></td>
<td>Structural reliability aims at quantifying the probability of failure of systems due to uncertainties in their design, manufacturing and environmental conditions. Risk analysis combines this information with the consequences of failure in view of optimal decision making. The course presents the underlying probabilistic modelling and computational methods for reliability and risk assessment.</td>
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<td></td>
<td>Objective</td>
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<td></td>
<td>The goal of this course is to provide the students with a thorough understanding of the key concepts behind structural reliability and risk analysis. After this course the students will have refreshed their knowledge of probability theory and statistics to model uncertainties in view of engineering applications. They will be able to analyze the reliability of a structure and to use risk assessment methods for decision making under uncertain conditions. They will be aware of the state-of-the-art computational methods and software in this field.</td>
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<tr>
<td>Literature</td>
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<tr>
<td>Prerequisites / notice</td>
<td>The course is given in the first MSc semester.</td>
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</table>
Content

Engineers are confronted every day to decision making under limited amount of information and uncertain conditions. When designing new structures and systems, the design codes such as SIA or Euro-codes usually provide a framework that guarantees safety and reliability. However, the level of safety is not quantified explicitly, which does not allow the analyst to properly choose between design variants and evaluate a total cost in case of failure. In contrast, the framework of risk analysis allows one to incorporate the uncertainty in decision making.

The first part of the course is a reminder on probability theory that is used as a main tool for reliability and risk analysis. Classical concepts such as random variables and vectors, dependence and correlation are recalled. Basic statistical inference methods used for building a probabilistic model from the available data, e.g. the maximum likelihood method, are presented.

The second part is related to structural reliability analysis, i.e. methods that allow one to compute probabilities of failure of a given system with respect to prescribed criteria. The framework of reliability analysis is first set up. Reliability indices are introduced together with the first order-second moment method (FORM) and the first order reliability method (FORM). Methods based on Monte Carlo simulation are then reviewed and illustrated through various examples. By-products of reliability analysis such as sensitivity measures and partial safety coefficients are derived and their links to structural design codes is shown. The reliability of structural systems is also introduced as well as the methods used to reassess existing structures based on new information.

The third part of the course addresses risk assessment methods. Techniques for the identification of hazard scenarios and their representation by fault trees and event trees are described. Risk is defined with respect to the concept of expected utility in the framework of decision making. Elements of Bayesian decision making, i.e. pre-, post and pre-post risk assessment methods are presented.

The course also includes a tutorial using the UQLab software dedicated to real world structural reliability analysis.

Lecture notes

Slides of the lectures are available online every week. A printed version of the full set of slides is proposed to the students at the beginning of the semester.

Literature


S. Marelli, R. Schöbi, B. Sudret, UQLab user manual - Structural reliability (rare events estimation), Report UQLab-V0.92-107.

Prerequisites / notice

Basic course on probability theory and statistics

101-0157-01L Structural Dynamics and Vibration Problems

Abstract

Fundamentals of structural dynamics are presented. Computing the response of elastic and inelastic single-DOF, continuous-mass and multiple-DOF structural systems subjected to harmonic, periodic, pulse, impulse, and random excitation is discussed. Practical solutions to vibration problems in flexible structures excited by humans, machinery, wind and explosions are developed.

Objective

- Explain the dynamic equilibrium of structures under dynamic loading.
- Model structural systems using single-degree-of-freedom, continuous-mass and multiple-degree-of-freedom models.
- Compute the dynamic response of structural system to harmonic, periodic, pulse, impulse and random excitation using time-history and response-spectrum methods.
- Apply structural dynamics principles to solve vibration problems in flexible structures excited by humans, machines, wind or explosions.
- Use dynamics of structures to identify the basis for structural design code provisions related to dynamic loading.

Content

This is a course on structural dynamics, an extension of structural analysis for loads that induce significant inertial forces and vibratory response of structures. Dynamic responses of elastic and inelastic single-degree-of-freedom, continuous-mass and multiple-degree-of-freedom systems subjected to harmonic, periodic, pulse, impulse, and random excitation are discussed. Theoretical background and engineering guidelines for practical solutions to vibration problems in flexible structures caused by humans, machinery, wind or explosions are presented. Laboratory demonstrations of single- and multi-degree-of-freedom system dynamic response and use of viscous and tuned-mass dampers are conducted.

Lecture notes

The electronic copies of the learning material will be uploaded to ILIAS and available through myStudies. The learning material includes: the lecture presentations, additional reading material, and exercise problems and solutions.

Literature


Prerequisites / notice

Knowledge of the fundamentals in structural analysis, and in structural design of reinforced concrete, steel and/or wood structures is mandatory. Working knowledge of matrix algebra and ordinary differential equations is required. Familiarity with Matlab and with structural analysis software is desirable.

051-0551-00L Energy- and Climate Systems I

Abstract

The lecture contains concepts, physics and components of building technologies for the efficient and sustainable energy supply and climatisation of buildings and their interaction with architecture and urban design. Using calculations, students learn to acquire relevant numbers and assess the performance of solutions.

Objective

The lecture series focuses on the physical principles and technical components of relevant systems for an efficient and sustainable climatisation and energy supply of buildings. A special focus is on the interrelation of supply systems and architectural design and construction. Learning and practicing methods of quantifying demand and supply allows identifying parameters relevant for design.

Content

1. Introduction
2. Heating and cooling
3. Active and passive ventilation
4. Electricity in buildings

Lecture notes

The Slides from the lecture serve as lecture notes and are available as download.

Literature

A list of relevant literature is available at the chair.

101-0177-00L Building Physics: Moisture and Durability

Abstract

Moisture transport and related degradation processes in building and civil engineering materials and structures; concepts of poromechanics and multiscale analysis; analysis of damage cases.

Objective

- Basic knowledge of moisture transport and related degradation processes in building and civil engineering materials and structures
- Introduction to concepts of poromechanics and multiscale analysis
- Application of knowledge by the analysis of damage cases
1. Introduction
Topics on Signal Processing and Identification
The students will be able to analyse digital signals and systems in time-, z-, and frequency domains, and create, implement, and identify

2. Moisture Transport
Description of moisture transport
Determination of moisture transport properties
Hysteresis
Transport in cracked materials
Damage and moisture transport in cracked media

3. Poromechanics
Moisture and mechanics: poro-elasticity
Poro-elasticity and salt crystallisation
Poro-elasticity and damage
Case studies

4. Multiscale analysis
Problem statement
Multiscale transport model
Multiscale coupled transport - damage model

### 101-0167-01L Fibre Composite Materials in Structural Engineering

<table>
<thead>
<tr>
<th>Topic</th>
<th>Credits</th>
<th>Type</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Lamina and Laminate Theory</td>
<td>W 3</td>
<td></td>
<td>M. Motavalli</td>
</tr>
<tr>
<td>2) FRP Manufacturing and Testing Methods</td>
<td>G 2G</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3) Design and Application ofExternally Bonded Reinforcement to Concrete, Timber, Masonry, and metallic Structures</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4) FRP Reinforced Concrete, All FRP Structures</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5) Measurement Techniques and Structural Health Monitoring</td>
<td></td>
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</tr>
</tbody>
</table>

**Objective**
At the end of the course, you shall be able to

1) Design advanced FRP composites for your structures,

2) To consult owners and clients with necessary testing and SHM techniques for FRP structures,

3) Continue your education as a PhD student in this field.

**Content**
Fibre Reinforced Polymer (FRP) composites are increasingly being used in civil infrastructure applications, such as reinforcing rods, tendons and FRP profiles as well as wraps for seismic upgrading of columns and repair of deteriorated structures. The objective of this course is on one hand to provide new generation of engineering students with an overall awareness of the application and design of FRP reinforcing materials for internal and external strengthening (repair) of reinforced concrete structures. The FRP strengthening of other structures such as metallic, timber and masonry will also be shortly discussed. On the other hand the course will provide guidance to students seeking additional information on the topic. Many practical cases will be presented analysed and discussed. An ongoing structural health monitoring of these new materials is necessary to ensure that the structures are performing as planned, and that the safety and integrity of structures is not compromised. The course outlines some of the primary considerations to keep in mind when designing and utilizing structural health monitoring technologies. During the course, the students will have the opportunity to design FRP strengthened concrete beams, apply the FRP by themselves, and finally test their samples up to failure.

**Lecture notes**
1) Power Point Printouts
2) Handouts

**Literature**

### 101-0190-06L Topics on Signal Processing and Identification

<table>
<thead>
<tr>
<th>Topic</th>
<th>Credits</th>
<th>Credits</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>In this course some fundamental topics on digital signal processing will be reviewed. This includes an introduction to digital signals in time, frequency and z-domain, as well as sampling theory and digital filter design. We will then discuss the state space model of dynamic systems and introduce methods of identification of such systems, with an emphasis on using data from mobile sensors.</td>
<td>W 2</td>
<td>2V</td>
<td>S. Pakzad</td>
</tr>
</tbody>
</table>

**Objective**
The students will be able to analyse digital signals and systems in time-, z-, and frequency domains, and create, implement, and identify digital systems. The examples and sample data are measured from civil structures.

### 101-0637-01L Wood and Wood Composites

<table>
<thead>
<tr>
<th>Topic</th>
<th>Credits</th>
<th>Credits</th>
<th>Authors</th>
</tr>
</thead>
</table>

**Objective**

- Characteristic properties of wood as a anisotropic and porous material and their consideration in structural timber design, History, ecology, structure of timber, drying, material properties, influence of moisture and creep, grading, Durability.
- Material properties and field of applications of solid timber, glued laminated timber and wood composites.

- Fire safety and fire design.

**Lecture notes**
Power Point slides. Further literature.


**Prerequisites / notice**
Die Vorlesung ist mit einer halbtägigen Auskunft verbunden.

Voraussetzungen: Grundkenntnisse der Baustoffkunde
Transport Planning Methods

The goal of the course is to obtain a good understanding of some of the most fundamental mathematical optimization techniques used to solve linear programs and basic combinatorial optimization problems. The students will also practice applying the learned models to transport planning problems. Examples of such planning problems are the estimation of traffic volumes, prediction of estimated utilization of new public transport lines, and evaluation of effects (e.g. change in emissions of a city) triggered by building new infrastructure and changes to operational regulations.

To cope with the forecasting problem it is first divided into sub-problems. Then, these are solved using various algorithms like iterative proportional fitting, shortest path algorithms and the method of successive averages.

The course is composed of a lecture part, providing the theoretical knowledge, and a applied part, in which students develop their own models. This part takes place in form of a tutorial and consists in the development of a computer program. The programming part is closely guided and particularly suitable for students with little programming experience.

Literature


This course provides the basic concepts of high level programming languages to students without previous programming training. The main Java concepts explained in the course are:

1) Types, Variables, Operators
2) Methods, Conditionals, Loops, Arrays
3) Objects and Classes
4) Access control, Class scope, Packages, Java API
5) Design, Debugging, Interfaces
6) Inheritance, Exceptions, File I/O

MATSim, will be used for several exercises.

The main Java concepts explained in the course are:

1) Types, Variables, Operators
2) Methods, Conditionals, Loops, Arrays
3) Objects and Classes
4) Access control, Class scope, Packages, Java API
5) Design, Debugging, Interfaces
6) Inheritance, Exceptions, File I/O

MATSim will be introduced on a basic level and its basic functionalities will be explained. Weekly exercises will be focused on building Java knowledge through various examples using the MATSim environment.

We will also use English papers.
Prerequisites / notice
Information: Enrolment of Hydraulic Engineering II is not recommended without having attended Hydraulic Engineering (101-0206-00L) previously since Hydraulic Engineering II is strongly based on Hydraulic Engineering (101-0206-00L).

<table>
<thead>
<tr>
<th>Code</th>
<th>Course Name</th>
<th>Credits</th>
<th>Type</th>
<th>Instructor(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0267-01L</td>
<td>Numerical Hydraulics</td>
<td>3</td>
<td>2G</td>
<td>M. Holzner</td>
</tr>
</tbody>
</table>

Abstract
In the course Numerical Hydraulics the basics of numerical modelling of flows are presented.

Objective
The goal of the course is to develop the understanding of the students for numerical simulation of flows to an extent that they can later use commercial software in a responsible and critical way.

Content
The basic equations are derived from first principles. Possible simplifications relevant for practical problems are shown and their applicability is discussed. Using the example of non-steady state pipe flow numerical methods such as the method of characteristics and finite difference methods are introduced. The finite volume method as well as the method of characteristics are used for the solution of the shallow water equations. Special aspects such as wave propagation and turbulence modelling are also treated.

All methods discussed are applied practically in exercises. This is done using programs in MATLAB which partially are programmed by the students themselves. Further, some generally available softwares such as Hydraulic Systems and HEC RAS for non-steady flows are used.

Lecture notes
Lecture notes, powerpoints shown in the lecture and programs used can be downloaded. They are also available in German.

Literature
Given in lecture

<table>
<thead>
<tr>
<th>Code</th>
<th>Course Name</th>
<th>Credits</th>
<th>Type</th>
<th>Instructor(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>102-0237-00L</td>
<td>Hydrology II</td>
<td>3</td>
<td>2G</td>
<td>P. Burlando, S. Fatichi</td>
</tr>
</tbody>
</table>

Abstract
The course presents advanced hydrological analyses of rainfall-runoff processes. The course is given in English.

Objective
Tools for hydrological modelling are discussed at the event and continuous scale. The focus is on the description of physical processes and their modelisation with practical examples.

Content

Lecture notes
Parts of the script for "Hydrology I" are used. Also available are the overhead transparencies used in the lectures. The semester project consists of a two part instruction manual.

Literature
Additional literature is presented during the course.

<table>
<thead>
<tr>
<th>Code</th>
<th>Course Name</th>
<th>Credits</th>
<th>Type</th>
<th>Instructor(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>102-0455-01L</td>
<td>Groundwater I</td>
<td>3</td>
<td>2G</td>
<td>M. Willmann</td>
</tr>
</tbody>
</table>

Abstract
The course provides an introduction into quantitavie analysis of groundwater flow and transport. It is focussed on formulating flow and transport problems in groundwater, which are to be solved analytically or numerically.

Objective
a) Students understand the basic concepts of flow and contaminant transport processes and boundary conditions in groundwater.
b) Students are able to formulate simple practical flow and transport problems.
c) Students are able to understand and apply simple analytical solutions to simple flow and transport problems.
d) Students are able to use simple numerical codes to adequately solve simple flow (and transport) problems.

Content
Introduction, aquifers, groundwater use, sustainability, porosity.
Properties of porous media.
Exercises: Groundwater use, porosity, grain size analysis.
Flow properties, Darcy's law, filter.
Flow equations, stream function.
Exercises: Darcy's law.
Analytical solutions, confined aquifers, steady-state flow.
Exercises: Head isolines.
Use of superposition principles, transient flow, freee surface flow.
Exercises: Analytical solutions to flow problems.
Finite difference solutions to flow problems I.
Exercises: Analytical solutions to flow problems.
Finite difference solutions to flow problems II.
Exercises: Finite difference formulations to flow problems.
Transport processes.
Exercises: Computer workshop using PMWIN.
Analytical solutions to transport problems I.
Exercises: Computer workshop using PMWIN.
Analytical solutions to transport problems II.
Exercises: Analytical solutions to transport problems.
Path lines, groundwater protection.
Exercises: Analytical solutions to transport problems.
Groundwater remediation, groundwater management.
Exercises: Groundwater remediation.

Lecture notes
Folien auf Internet unter www.ihw.ethz.ch/GWH/education/index
Altes Skript auf Internet www.ihw.ethz.ch/GWH/education/index
Weitere Texte auf Internet www.ihw.ethz.ch/GWH/education/index
Didaktische Software auf Internet unter www.ihw.ethz.ch/GWH/education/index
This lecture is focused on current issues of materials research from various fields. It provides an overview on various directions of research.


H. J. Herrmann, *Opportunities and limitations of concrete technology.*

ECTS

Introduction to Computational Physics (for Civil Engineers)

M. Bäuml, *G. R. Bezzola*

This course offers an introduction to computer simulation methods for physics problems and their implementation on PCs and supercomputers of vector supercomputers and parallel processors, as well as an overview of existing libraries for numerical simulation methods (predominantly in ++C). In addition, an introduction to the programming of vector supercomputers and parallel processors is given.

Lecture notes: "River Engineering" (in German, 470 pages, including list of references)

The students shall
- be capable of describing the interrelation between discharge, sediment transport and channel evolution quantitatively
- know the fundamentals and be able to apply the approaches and methods to treat river engineering problems associated with flood control and river restoration

Content

1. Mechanics and failure of fibre reinforced materials
2. Cyclic failure of asphalt (Fatigue)
3. Fracture mechanics and size effects in concrete
4. Transport and degradation in porous building materials
5. Mechanics and failure of fibre reinforced materials
6. Wood: from the tree to the beam (multi scale approaches)
7. Plasticity
8. Rheology
9. Foam (e.g. polymers)
10. Foam (e.g. polymers)
11. Gluing and coating (surfaces)
12. Asbestos, nano particles and hazardous substances
13. Biomimetics in Constructions

Prerequisites / notice

Lecture notes contain a comprehensive list of references for further reading.

Literature

Based on the lecture 'Werkstoffe I' students receive deep concrete technology training. A comprehensive knowledge of the most important properties of conventional concrete and the current areas of research in concrete technology will be presented. The course covers various topics.

The content of the course is:
- concrete components
- concrete properties
- concrete mix design
- production, transport, casting
- demoulding, curing and additional protective measures
- durability
- standards
- high performance concretes
  1. high strength and ultra high strength concrete
  2. fiber reinforced concrete
  3. self compacting concrete
  4. shotcrete
  5. light weight concrete
  6. low shrinkage concrete
- low heat concrete for mass structures
- frost and wear resistant concrete
- concrete for low and high ambient temperatures

Lecture notes
Slides provided for download.

### 101-0177-00L Building Physics: Moisture and Durability

<table>
<thead>
<tr>
<th>Abstract</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture transport and related degradation processes in building and civil engineering materials and structures; concepts of poromechanics and multiscale analysis; analysis of damage cases.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Basic knowledge of moisture transport and related degradation processes in building and civil engineering materials and structures</td>
</tr>
<tr>
<td>- Introduction to concepts of poromechanics and multiscale analysis</td>
</tr>
<tr>
<td>- Application of knowledge by the analysis of damage cases</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Introduction</td>
</tr>
<tr>
<td>Moisture damage: problem statement</td>
</tr>
<tr>
<td>Durability</td>
</tr>
<tr>
<td>2. Moisture Transport</td>
</tr>
<tr>
<td>Description of moisture transport</td>
</tr>
<tr>
<td>Determination of moisture transport properties</td>
</tr>
<tr>
<td>Hysteresis</td>
</tr>
<tr>
<td>Transport in cracked materials</td>
</tr>
<tr>
<td>Damage and moisture transport in cracked media</td>
</tr>
<tr>
<td>3. Poromechanics</td>
</tr>
<tr>
<td>Moisture and mechanics: poro-elasticity</td>
</tr>
<tr>
<td>Poro-elasticity and salt crystallisation</td>
</tr>
<tr>
<td>Poro-elasticity and damage</td>
</tr>
<tr>
<td>Case studies</td>
</tr>
<tr>
<td>4. Multiscale analysis</td>
</tr>
<tr>
<td>Problem statement</td>
</tr>
<tr>
<td>Multiscale transport model</td>
</tr>
<tr>
<td>Multiscale coupled transport - damage model</td>
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</tbody>
</table>

### 101-0648-00L Metallic Materials and Corrosion

<table>
<thead>
<tr>
<th>Abstract</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metals in civil engineering (steels, high strength steel, Al-alloys, stainless steels). Mechanisms to improve the mechanical properties, plastic deformation (dislocations), mechanical tests. Corrosion, stress corrosion. The goal is the understanding of the relation between chemical composition, microstructure and mechanical properties and durability (corrosion) of metallic materials. Case studies.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Objective</th>
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</thead>
<tbody>
<tr>
<td>Knowledge and comprehension of the fundamentals of material science of metallic materials such as the relation between chemical composition, microstructure and properties of metallic materials. Ability to critically select the appropriate materials for application in civil engineering (fixation elements, reinforcement for concrete structures, high-strength steels).</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fundamentals of metallic materials, cristal structure of metallic materials, defects, solidification,</td>
</tr>
<tr>
<td>Properties of metallic materials, physical (electrical, magnetic), mechanical (strength, deformation, fracture), chemical (corrosion resistance),</td>
</tr>
<tr>
<td>Most important alloys (steels, aluminium alloys, stainless steels)</td>
</tr>
<tr>
<td>Examples of application</td>
</tr>
</tbody>
</table>

Lecture notes
Lecture notes (in german) are distributed at the beginning of the course. Reprints for selected topics.

Literature

**3. Semester**

**3. Major Courses**

**3.3. Major in Construction and Maintenance Management**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0549-00L</td>
<td>Selected Topics on Legal Aspects in Civil Engineering</td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>H. Briner, D. Trümpy</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Abstract</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic knowledge in public and private law of civil engineering. Examples of the subjects treated: space management, protection of the environment, legal procedures, standards for building technology and contracts.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part 1: The students shall acquire basic knowledge of the public law concerning civil engineering: space management, conception of buildings, protection of the environment, procedures</td>
</tr>
<tr>
<td>Part 2: The students shall acquire basic knowledge of the private law concerning civil engineering</td>
</tr>
</tbody>
</table>
Content

Teil 1: Jede Lektion behandelt für ein bestimmtes Stadium des Projekts ein Thema des öffentlichen Baurechts wie Bau- und Zonenordnungen, Quartierpläne, Umweltverträglichkeitsprüfungen, Baubewilligungsverfahren etc., Teil 2: Grundzüge des privaten Baurechts wie Abnahme und Genehmigung von Bauwerken, Vollmacht des Architekten / Ingenieurs zu Rechtshandlungen namens des Bauherrn, Mängelprüfung im Bauwesen, Mehrheit ersatzpflichtiger Baubeteiligter, Generalunternehmensvorschriften Haftung der Baumaterialverkäufer, Bauhandwerkerbundrecht, Grundzüge der SIA-Norm 118, Baukonsortial, technische Normen, internationale Bauverträge, Architekten / Ingenieure als Gerichtsexperten, Aspekte des Bauzivilprozesses

Lecture notes

D. Trümpy; Tafeln zu den Grundzügen des schweizerischen Bauvertragsrechts (Vorlesungsunterlage)
H. Briner: Tafeln zu den Grundzügen des öffentlichen Raumplanungs-, Bau- und Umweltrechts (Vorlesungsunterlage)

Literature

- Stöckli P./Siegenthaler Th. (Hrsg.) Die Planeinverträge, Schulthess 2013
- Gaucher Peter, Werkvertrag, 5. Auflage, Schulthess 2011

Prerequisites / notice

Die Teilnehmer sollen stets ein Exemplar der SIA-Norm 118, der SIA-LHO 103 sowie die Gesetzesausgaben von OR und ZGB bei sich haben.

101-0577-00L An Introduction to Sustainable Development in the Built Environment 0 3 credits 2G G. Habert

Abstract

This year the UN Conference in Paris will shape future world objectives to tackle climate change.
This course provides an introduction to the notion of sustainable development when applied to our built environment.

In order to address current challenges of climate change mitigation and resource depletion, students will learn a holistic approach of sustainable development. Ecological, economical and social constraints will be presented and students will learn about methods for argumentation and tools for assessment (i.e. life cycle assessment).

For this purpose an overview of sustainable development is presented with an introduction to the history of sustainability and its today definition, as well as the role of cities, urbanisation and material resources (i.e. energy, construction material) in social economic and environmental aspects.

The course aims to promote an integral view and understanding of sustainability and describing different spheres (social/cultural, ecological, economical, and institutional) that influence our built environment.

Students will acquire critical knowledge and understand the role of involved stakeholders, their motivations and constraints, learn how to evaluate challenges, identify deficits and define strategies to promote a more sustainable construction.

After the course students should be able to define the relevance of specific local, regional or territorial aspects to achieve coherent and applicable solutions toward sustainable development.

The course offers an environmental, socio-economic and socio-technical perspective focussing on buildings, cities and their transition to resilience with sustainable development. Students will learn on theory and application of current scientific pathways towards sustainable development.

The following topics give an overview of the themes that are to be worked on during the lecture.

- Overview on the history and emergence of sustainable development
- Overview on the current understanding and definition of sustainable development
- Case Study 1: Sustainable construction, the role of construction industry (national/international)
- Case Study 2: Cities, forms of settlements
- Case Study 3: Material resources, scenarios, energy, construction materials, urban metabolism
- Case Study 4: Buildings, heating/cooling, consumers, prosumers and other stakeholder, cooperations
- Method 1: Life cycle assessment (planning, construction, operation/use, deconstruction)
- Method 2: Economics for sustainable construction
- Method 3: Construction, flexibility, modularity
- Synthesis 1: Climate Change mitigation and adaptation in cities
- Synthesis 2: Transition to sustainable development

Lecture notes

All relevant information will be online available before the lectures. For each lecture slides of the lecture will be provided.

101-0587-00L Workshop on Sustainable Building Certification W+ 3 credits 2G D. Kellenberger

Abstract

Building labels are used to certify buildings and neighbourhoods in term of sustainability. Many different labels have been developed and can be used in Switzerland (LEED, DGNB, SNBS, Minergie). In this course the differences between the certification labels and its application on 3 emblematic case study buildings will be discussed.

Objective

After this course, the students are able to understand and use the different certification labels. They have a clear view of what the labels take into consideration and what they don't.

Content

Three buildings case study will be presented.

Different certification schemes, including LEED (American standard), DGNB (German Standard with Swiss adaptation), SNBS, MINERGIE-ECO and 2000-Watt-Society (Swiss standards) will be presented and explained by experts.

After this overall general presentation and in order to have a closer look to specific aspects of sustainability, students will work in groups and assess during one or two weeks this specific criteria on one of the case studies presented before. This practical hands on the label will end with a presentation and a discussion where we will highlight differences between the labels.

The slides from the presentations will be made available.

101-0439-00L Introduction to Economic Analysis - A Case Study Approach with Cost Benefit Analysis in Transport W 6 credits 4G K. W. Axhausen, R. Schubert

Data: 06.03.2019 12:57 Autumn Semester 2016 Page 173 of 1571
### Major in Geotechnical Engineering

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0329-00L</td>
<td>Tunnelling III</td>
<td>W</td>
<td>4</td>
<td>2G</td>
<td>G. Anagnostou, E. Pimentel, M. Ramoni</td>
</tr>
<tr>
<td>101-0339-00L</td>
<td>Environmental Geotechnics</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>L. M. Plötze</td>
</tr>
<tr>
<td>101-0359-00L</td>
<td>Physical Modelling in Geotechnics</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>to be announced</td>
</tr>
</tbody>
</table>

**Abstract**
- The course presents cost benefit analysis and related evaluation methods in transport and introduces the survey methods used to derive the monetary values of non-market goods.
- Familiarity with the essential methods of project appraisal
- Cost-Benefit-Analysis; multi-criteria analysis; European guidelines; stated response methods; travel cost approach and others; Valuation of travel time savings; valuation of traffic safety

**Objective**
- The lecture gives a deeper insight into track geometry, the interaction between track and vehicles as well as in construction and dimensioning of the track. Methods for the diagnosis of the state of the track and its forcast are shown. State-of-the-art maintenance strategies and technologies are presented.
- Track geometry including calculation and measuring as well as related data systems; interaction between track and vehicles, vehicle dynamics, stress; track construction including special features of railway bridges and tunnels; track diagnostics and forcast; track maintenance and related methods

**Content**
- The slides will be made available.
- A list with related technical literature will be handed out.
- The lecture Railway Infrastructures (Transportation II) is recommended.

**Literature**

**Lecture notes**
- Handouts

**Prerequisites / notice**
- Prerequisite: BSc course "Tunnelling", MSc courses "Tunnelling I" and "Tunnelling II".
From:- Foundations (shallow and deep), bridge abutments, reinforced soils, soil nailing & anchorages, tunnels & deep excavations, earthquake effects, dynamic problems, environmental geomechanics, transport processes, dams, embankments & slopes, cold regions engineering.

Prerequisites / notice
A simple soil structure interaction boundary value problem will be selected (e.g., foundation, embankment, slope) as the exercise topic, which will modelled, in various forms, throughout the course. A predictive (class A) numerical analysis will be carried out by the students, followed by a centrifuge test on the same geometry to validate the numerical calculations. Subsequently a Class C2 numerical analysis will be conducted, calibrated by the physical modelling event.

#### 101-0367-00L Geotechnical Engineering in Transportation

**Abstract**
Road design criteria, technology of road construction materials, geotechnical testing methods in laboratory and in situ, planning, monitoring and interpretation of soil field tests, soil classification for traffic construction, compaction of road structures and dams, frost characteristics of soil materials, soil stabilization

**Objective**
Aim of the course is to teach students the most important aspects of the road structure, its building and design methods. An essential part of the course is devoted to understand the influence of the insitu conditions; soil, underground, climate, water, as well as of the characteristics of building materials and of road surface on the durability of the pavement.

**Content**
Road design criteria, technology of road construction materials, geotechnical testing methods in laboratory and in situ, planning, monitoring and interpretation of soil field tests, soil classification for traffic construction, compaction of road structures and dams, frost characteristics of soil materials, soil stabilization

**Lecture notes**
Autographie, Uebungsblietter, Handouts as indicated in the course

**Literature**
Handout notes, Example worksheets

http://geotip.igt.ethz.ch

**Prerequisites / notice**
In den Vorlesungen und Übungen werden verschiedene Demonstrationsmaterialien verwendet.

Voraussetzungen: Grundlagenkenntnisse in "Bodenmechanik/Grundbau" sowie in "Projektierung von Verkehrsanlagen"

### Major in Structural Engineering

#### 101-0119-00L Structural Masonry

**Abstract**
Knowledge of the engineering properties of materials for masonry construction. Technical understanding of the structural behaviour of load-bearing masonry structures subjected to in-plane forces and combined actions. Develop a technical competence for design procedures for load-bearing masonry structures by means of exercises.

**Objective**
Knowledge of the engineering properties of materials for masonry construction. Technical understanding of the structural behaviour of load-bearing masonry structures subjected to in-plane forces and combined actions. Develop a technical competence for design procedures for load-bearing masonry structures by means of exercises.

**Content**
Historical Development of Masonry Construction
Detailing and Execution
Construction Materials
Structural Behaviour and Modelling
Structural Analysis and Dimensioning
Reinforced Masonry
Seismic Behaviour

**Lecture notes**
Lecture notes

"Mauerwerk; Bemessungsbeispieler zur Norm SIA 266", SIA Dokumentation D0257, 2015
"Mauerwerk", Norm SIA 266, 2015
"Mauerwerk - Ergänzende Festlegungen", Norm SIA 266/1, 2015

**Prerequisites / notice**
Structural Concrete III

#### 101-0129-00L Existing Structures

**Abstract**
Treatment of the topic primarily from the perspective of a consulting engineer dealing with a single object. Elaboration of a systematic procedure for respective projects. Consolidation for concrete structures and extension to other construction methods.

Uncovering of interfaces between owners, architects, contractors and specialists.

**Objective**
Treatment of the topic primarily from the perspective of a consulting engineer dealing with a single object. Elaboration of a systematic procedure for respective projects. Consolidation for concrete structures and extension to other construction methods.

Uncovering of interfaces between owners, architects, contractors and specialists.

**Content**
Systematics of existing structures, examination (condition survey, condition examination, recommendation of remedial measures), non-destructive testing methods, natural stone masonry, strengthening methods (esp. plate bonding)

**Lecture notes**
Lecture notes

Normen SIA 269, 269/1 bis 269/6, SIA-Dokumentationen D 0239 und D 0240 der Einführungskurse

#### 101-0149-00L Plate and Shell Structures

**Abstract**
Basic load bearing behaviour of plate and shell structures; knowledge of typical applications of different materials, ability to reasonably interpret and check results of numerical calculations; establish access to technical literature.

**Objective**
Comprehension of basic load bearing behaviour of plate and shell structures; knowledge of typical applications of different materials, ability to reasonably interpret and check results of numerical calculations; establish access to technical literature.
Content

- In-plane loaded plates (cartesian and polar coordinates)
- Kinematics of in-plane loaded plates
- Folded plate structures
- Thin plates with small deflections
- Circular plates
- Thin plates with large deflections
- Geometry of curved surfaces
- Shells (basics, membrane theory, bending theory, form finding)

Lecture notes

Autographie "Flächentragwerke"

Literature

Empfohlen:

101-0159-00L  Method of Finite Elements II

<table>
<thead>
<tr>
<th>W</th>
<th>3 credits</th>
<th>2G</th>
<th>E. Chatzi</th>
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</table>

Abstract

Basic theoretical and procedural concepts of the method of finite elements (FE) for the analysis of nonlinear & dynamic systems are introduced. Kinematic and material nonlinear effects and the dynamic analysis of structures in terms of modal and time domain analysis are described.

The course is complemented by Homework Sessions using computing tools and FE software such as MATLAB, ABAQUS & ANSYS.

Objective

Basic theoretical and procedural concepts of the method of finite elements (FE) for the analysis of nonlinear & dynamic systems are introduced. Kinematic and material nonlinear effects and the dynamic analysis of structures in terms of modal and time domain analysis are described.

The course is complemented by Homework Sessions using computing tools and FE software such as MATLAB, ABAQUS & ANSYS.

Content

Introduction to finite element nonlinear analysis in structural engineering.

Formulation and solution of nonlinear problems.

Nonlinear constitutive relations.

Dynamic finite element analysis.

Solution of eigen value problems.

Practical application of the finite element nonlinear and/or dynamic analysis

Problem solution using MATLAB, ABAQUS and ANSYS

Lecture notes

Handouts, Course Script available on http://www.ibk.ethz.ch/ibk/ibk/ch/education/feml/index_EN

Literature

Course Script available on http://www.ibk.ethz.ch/ibk/ibk/ch/education/feml/index_EN

Useful Reading:
"Nonlinear Finite Elements of Continua and Structures" by T. Belytschko, W.K. Liu, and B. Moran.


101-0169-00L  Timber Structures II

<table>
<thead>
<tr>
<th>W</th>
<th>3 credits</th>
<th>2G</th>
<th>A. Frangi, R. Jockwer, R. Steiger</th>
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</thead>
</table>

Prerequisite: Timber Structures I (101-0168-00L)

Abstract

Basic knowledge of structural timber design including material behaviour especially anisotropy, moisture and long duration effects and their consideration in structural analysis and detailing. Design, detailing and structural analysis of timber roof structures, buildings and bridges.

Objective

Comprehension and application of basic structural timber design including material behaviour especially anisotropy, moisture and long duration effects and their consideration in structural analysis and detailing. Design, detailing and structural analysis of timber roof structures, buildings and bridges.

Content

Field of application of timber structures; Timber as building material (wood structure, physical and mechanical properties of wood and wood-based products); Durability; Principles of design and dimensioning; Connections (dowels, nails, screws, glued connections); Timber components and assemblies (mechanically jointed beams, trusses); Design and detailing of timber roof structures, buildings and bridges.

Lecture notes

Autography Timber Structures

Copies of lecture slides

Literature

Timber design tables HBT 1, Lignum (2012)
Swiss Standard SIA 265 (2012)
Swiss Standard SIA 265/1 (2009)

101-0189-00L  Seismic Design of Structures II

<table>
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<tr>
<th>W</th>
<th>3 credits</th>
<th>2G</th>
<th>B. Stojadinovic</th>
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Prerequisites / notice

Timber Structures I

Abstract

The following advanced topics are covered: 1) behavior and non-linear response of structural systems under earthquake excitation; 2) seismic behavior and design of moment frame, braced frame, shear wall and masonry structures; 3) fundamentals of seismic isolation; and 4) assessment and retrofit of existing buildings. These topics are discussed in terms of performance-based seismic design.

Objective

After successfully completing this course the students will be able to:

1. Use the knowledge of nonlinear dynamic response of structures to interpret the design code provisions and apply them in seismic design structural systems.
2. Explain the seismic behavior of moment frame, braced frame and shear wall structural systems and successfully design such systems to achieve the performance objectives stipulated by the design codes.
3. Determine the performance of structures under earthquake loading using modern performance assessment methods and analysis tools.

Content

This course completes the series of two courses on seismic design of structures at ETHZ. Building on the material covered in Seismic Design of Structures I, the following advanced topics will be covered in this course: 1) behavior and non-linear response of structural systems under earthquake excitation; 2) seismic behavior and design of moment frame, braced frame and shear wall structures; 3) fundamentals of seismic isolation; and 4) assessment and retrofit of existing buildings. These topics will be discussed from the standpoint of performance-based design.

Lecture notes

The electronic copies of the learning material will be uploaded to ILIAS and available through myStudies. The learning material includes the lecture presentations, additional reading, and exercise problems and solutions.

Literature

Earthquake Engineering: From Engineering Seismology to Performance-Based Engineering, Yousef Borzorgnia and Vitelmo Bertero, Eds., CRC Press, 2004


Prerequisites / notice

ETH Seismic Design of Structures I course, or equivalent. Students are expected to understand the seismological nature of earthquakes, to characterize the ground motion excitation, to analyze the response of elastic single- and multiple-degree-of-freedom systems to earthquake excitation, to use the concept of response and design spectrum, to compute the equivalent seismic loads on simple structures, and to perform code-based seismic design of simple structures. Familiarity with structural analysis software, such as SAP2000, and general-purpose numerical analysis software, such as Matlab, is expected.
The electronic copies of the learning material will be uploaded to ILIAS and available through myStudies. This will include the lecture notes, additional reading, and exercise problems and solutions. There is no textbook for this course.

**Literature**

- Earthquake Engineering: From Engineering Seismology to Performance-Based Engineering, Yousef Borzorgnia and Vitelmo Bertero, Eds., CRC Press, 2004

**Software**

- Bispec: software for unidirectional and bidirectional dynamic time-history and spectral seismic analysis of a simple dynamic system.
- OpenSees: Open System for Earthquake Engineering Simulation, is an object-oriented, open-source software framework.

**Prerequisites / notice**

ETH Seismic Design of Structures I course (101-0188-00), or equivalent. Students are expected to understand the seismological nature of earthquakes, to characterize the ground motion excitation, to analyze the response of elastic single- and multiple-degree-of-freedom systems to earthquake excitation, to use the concept of response and design spectrum, to compute the equivalent seismic loads on simple structures, and to perform code-based seismic design of simple structures.

**References**

- Norm SIA 261: Einwirkungen auf Tragwerke (Actions on Structures), Schweizerischer Ingenieur- und Architekten-Verein, Zürich, 2003

**Prerequisites / notice**

Die Vorlesung ist mit einer halbtägigen Exkursion verbunden.

**Voraussetzungen:** Grundkenntnisse der Baustoffkunde
Lecture notes


101-0469-00L

Road Safety

W  6 credits  4G  H. Schüller, M. Deublein

Abstract
The collection and the methods of statistical and geographical analysis of road accidents are important fundamentals of this course. Safety Aspects in design of urban roads are discussed and measures for improving the safety situation are presented. Procedures of infrastructure safety management for administrations and police are another topic.

Objective
Imparting knowledge about road safety and the event of accident, presenting possibilities to increase road safety

Content
Accident origin, collection of road accidents, statistical (descriptive and multivariate, accident prediction models) and geographical analysis of road accidents, risk analysis and rehabilitation measures, road safety instruments for infrastructure with focus on road safety audit, Swiss and international transport policy

Literature

Further literature: will be presented during the course

101-0419-00L

Railway Construction and Maintenance

W  4 credits  4G  U. Weidmann, P. Güldenapfel, M. Kohler, M. J. Manhart, further speakers

Abstract
Track geometry including calculation and measuring as well as related data systems; interaction between track and vehicles, vehicle dynamics, stress; track construction including special features of railway bridges and tunnels; track diagnostics and forecast; track maintenance and related methods

Objective
The lecture gives a deeper insight into track geometry, the interaction between track and vehicles as well as in construction and dimensioning of the track. Methods for the diagnosis of the state of the track and its forecast are shown. State-of-the-art maintenance strategies and technologies are presented.

Content
Track geometry including calculation and measuring as well as related data systems; interaction between track and vehicles, vehicle dynamics, stress; track construction including special features of railway bridges and tunnels; track diagnostics and forecast; track maintenance and related methods

Literature
A list with related technical literature will be handed out.

Prerequisites / notice
The lecture Railway Infrastructures (Transportation II) is recommended.

101-0479-00L

Safety and Reliability of Railway Systems

W  3 credits  3G  U. Weidmann, A. Bomhauer-Beins, O. Fink, M. Montigel

Abstract
Railway safety policies and safety concepts, command and control technologies for railways, optimization systems, European Train Control System, reliability availability maintainability safety (RAMS) of railway systems.

Objective
The students comprehend the main principles of safety, reliability and optimization for railway systems and understand the basic concepts of command and control technologies for railways.

Content
Railway safety strategies
- Safety in public transport
- Safety relevant characteristic of railway transport
- Safety requirements for railway transport
- Safety concepts

Command and control technologies for railway systems
- operational command/control systems
- dispatching
- operational control systems
- concepts of optimization

RAMS for railway systems
- accident investigation methods
- RAMS standards for railways
- risk analysis and hazard control
- RAMS methods
- design principles for availability and safety
- maintenance strategies
- Life Cycle Costs (LCC)
- Human Factor
- safety in long railway tunnels

Lecture notes
The slides will be provided in German.

Literature
References will be included in the lecture notes. An additional list of literature will be given during the course.

Prerequisites / notice
some of the tutorials will be held at the IVTs Railway Operation Laboratory. The lecture Systems Dimensioning and Capacity is recommended.

101-0449-00L

Management, Marketing, Quality

W  6 credits  4G  U. A. Weidmann

Does not take place this semester.

Abstract
Transport and administrative policy, international and national regulation, business management of public transport companies, marketing, advertising and pricing; quality management

Lecture notes
The slides will be made available.

Literature
The slides will be provided in German.

Prerequisites / notice
Does not take place this semester.
### Objective
Comprehension of the transport and administrative policy as well as of the regulation of public transport companies. To develop a full understanding of the three important public transport system operations management processes: (1) Business management; (2) Marketing; (3) Quality control. The course will teach essential working techniques in each of these processes.

### Content
1. Transport and administrative policy: Goals of the state related to public transports, governmental activities in public transport, regulation.
2. Business management in public transport enterprises: goals of public transport companies, goals of the business management; management of public transport on the different management levels, business organization. (3) Marketing, advertising and pricing: Fundamentals and goals; marketing strategies and concepts in public transports; marketing tools; putting marketing into action. (4) Quality control: Quality in transport systems; goals of quality management; structuring quality control measures; collecting quality data in an operating service; use of quality control systems for service optimization.

### Lecture notes
References to technical literature will be included in the course script. An additional list of literature will be given during the course.

### Literature
Lectures System and Network Planning as well as Systems Dimensioning and Capacity recommended.

### Prerequisites / notice
Course notes will be provided in German. Slides will be made available.

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### 101-0579-00L Infrastructure Maintenance Processes

**Objective**
- to equip students with tools to be used to evaluate infrastructure and the level of service being provided from infrastructure

**Content**
- Introduction
- Levels of service
- Reliability of infrastructure
- Availability and maintainability of infrastructure
- Mechanistic-empirical models
- Regression analysis
- Event trees
- Fault trees
- Markov chains
- Neural networks
- Bayesian networks

**Lecture notes**
All necessary materials (e.g. transparencies and hand-outs) will be distributed before class.

**Literature**
Appropriate reading material will be assigned when necessary.

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### 101-0509-00L Infrastructure Management 1: Process

**Objective**
- to understand the steps required to manage infrastructure effectively,
- to understand the complexity of these steps, and
- to have an overview of the tools that they can use in each of the steps.

**Content**
- The infrastructure management process and guidelines
- Knowing the infrastructure - Dealing with data
- Establishing goals and constraints
- Establishing organization structure and processes
- Making predictions
- Selecting strategies
- Developing programs
- Planning interventions
- Conducting impact analysis
- Reviewing the process

**Lecture notes**
Appropriate reading / and study material will be handed out during the course. Transparencies will be handed out at the beginning of each class.

**Literature**
Appropriate literature will be handed out when required.

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### 103-0417-02L Theory and Methodology of Spatial Planning

**Objective**
- to develop an overview of the three important public transport system operations management processes: (1) Business management; (2) Marketing; (3) Quality control. The course will teach essential working techniques in each of these processes.

**Content**
- Only for master students, otherwise a special permission by the lecturer is required.

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### 101-0491-00L Agent Based Modeling in Transportation

**Objective**
- The objective of this course is to make the students familiar with agent-based models and in particular with the software MATSim. They will learn the pros and cons of this type of approach versus traditional transport models and will learn to use the simulation. They will design a policy study and run simulations to evaluate the impacts of the proposed policies.

**Abstract**
The main topics of the lecture are:
1. Introduction to the agent-based paradigm and overview on existing agent-based models in transportation, including MATSim
2. Learn how to setup MATSim for policy analysis
3. Learn about the interfaces available to enhances the software (includes Java programming)
4. Create, run and analyse a policy study
Basics in physical glaciology

In this course the students will first learn some microscopic simulation concepts and then complete a traffic engineering project with the software Vissim. The course introduces basics of microscopic traffic simulation, including model development, calibration, validation, data analysis, and understanding of the models behind and logically evaluating results. The final goal is to make valid and concrete engineering proposals based on the simulation model.

Additional relevant readings, mostly scientific articles, will be recommended throughout the course.

101-0492-00L Simulation of Traffic Operations

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<tr>
<td>101-0492-00L</td>
<td>Simulation of Traffic Operations</td>
<td>W</td>
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<td>H. He</td>
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Abstract: The course introduces basics of microscopic traffic simulation, including model development, calibration, validation, data analysis, identification of strategies for improving traffic performance, and evaluation of such strategies. The modelling software used is VISSIM.

Objective: The objective of this course is to introduce basic concepts in microscopic traffic simulation and conduct a realistic traffic engineering project from beginning to end. The students will first familiarize themselves with microscopic traffic simulation models. They will then use a simulation for modeling and analyzing the traffic operations. The emphasis is not only on building the simulation model, but also understanding of the models behind and logically evaluating results. The final goal is to make valid and concrete engineering proposals based on the simulation model.

Content: In this course the students will first learn some microscopic simulation concepts and then complete a traffic engineering project with microscopic traffic simulator VISSIM.

Microscopic simulation concepts will include:
1) Car following models
2) Lane change models

Specific tasks for the project will include:
1) Building a model with the simulator VISSIM in order to replicate and analyze the traffic conditions measured/observed.
2) Calibrating and validating the simulation model.
3) Redesigning/Extending the model to improve the traffic performance.

Prerequisites / notice: There are no strict preconditions in terms of which lectures the students should have previously attended. However, it is expected that the students have some experience with some high level programming language (i.e. C, C++, Fortran or Java). If this is not the case, attending the additional java exercises (101-0491-00U) is strongly encouraged.

101-0249-00L Selected Topics on Hydraulic Engineering

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<tr>
<td>101-0249-00L</td>
<td>Selected Topics on Hydraulic Engineering</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>R. Boes, I. Albayrak</td>
</tr>
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</table>

Abstract: The lecture focuses on selected topics in hydraulic engineering, water management and aquatic ecology relating to hydropower and flood protection projects.

Objective: to deepen knowledge on special aspects in hydraulic engineering and to understand the procedures and the planning sequence of hydropower projects.

Content: Different selected topics in hydraulic engineering will be focused on, e.g. dam safety, possible problems at reservoirs like sedimentation or natural hazards by impulse waves, the hydraulics of river flows, spillways and intake structures at dams and weirs, hydropower and ecology like fish-ecological aspects at low-head hydropower plants and eco-hydraulics like flow-vegetation interaction. Another focus will be put on typical approaches and procedures in the planning process of hydropower projects.

Prerequisites / notice: Students need to know some basic road transport concepts. The course Road Transport Systems (Verkehr III), or simultaneously taking the course Traffic Engineering is encouraged. The course Transport Simulation (101-0438-00 G) and previous experience with VISSIM is helpful but not mandatory.

101-0289-00L Applied Glaciology

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<tr>
<td>101-0289-00L</td>
<td>Applied Glaciology</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>M. Funk, A. Bauder, D. Farinotti</td>
</tr>
</tbody>
</table>

Abstract: We will explain the fundamentals of physics of glaciers which are necessary for treating applied problems. We will go into climate-glacier interactions, flow of glaciers, lake ice and hydrology of glaciers.

Objective: To understand the fundamental physical processes in glaciology.
To learn some basic numerical modelling techniques for glacier flow.
To identify glaciological hazards and to learn some assessment and mitigation possibilities.

Content: Basics in physical glaciology
- Dynamics of glaciers: deformation of glacier ice, role of water in glacier motion, reaction of glaciers to climate changes, glacier calving, surges
- Ice falls, ice avalanches
- Glacier floods
- Lake ice and bearing capacity

Prerequisites / notice: There are no strict preconditions in terms of which lectures the students should have previously attended. However, it is expected that the students have some experience with some high level programming language (i.e. C, C++, Fortran or Java). If this is not the case, attending the additional java exercises (101-0491-00U) is strongly encouraged.

101-1249-00L Hydraulics of Engineering Structures

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<tr>
<td>101-1249-00L</td>
<td>Hydraulics of Engineering Structures</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>H. Fuchs, I. Albayrak, L. Schmocker</td>
</tr>
</tbody>
</table>
Abstract
Hydraulic fundamentals are applied to hydraulic structures for wastewater, flood protection and hydropower. Typical case studies from engineering practice are further described.

Objective
Understanding and quantification of fundamental hydraulic processes with particular focus on hydraulic structures for wastewater, flood protection and hydropower

Content
1. Introduction & Basic equations
2. Losses in flow & Maximum discharge
3. Uniform flow & Critical flow
4. Hydraulic jump & Stilling basins
5. Backwater curves
6. Weirs/End overfalls & Venturi
7. Mobile discharge measurements & Culverts/restrictors/inverted siphons
8. Fall manholes & Vortex drop
9. Conjunctions & Shock waves at abrupt wall deflections
10. Air/water flows and bottom outlets
11. Driftwood retention racks
12. Vegetated flows - Introduction
13. Vegetated flows - Application
14. Summary & questions/preparations for examination

Lecture notes
Text books

Literature

Exhaustive references are contained in the suggested text book.

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<tr>
<th>Course Code</th>
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<tr>
<td>102-0215-00L</td>
<td>Urban Water Management II</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>M. Maurer, P. Stauffer</td>
</tr>
</tbody>
</table>

Abstract

Objective
Consolidation of the basic procedures for design and operation of technical networks in water engineering.

Content
- Demand Side Management versus Supply Side Management
- Optimierung von Wasserverteilnetzen
- Druckstösse
- Kalkausfällung, Korrosion von Leitungen
- Hygiene in Verteilsystemen
- Siedlungshydrologie: Niederschlag, Abflussbildung
- Instationäre Strömungen in Kanalisationen
- Stofftransport in der Kanalisation
- Einleitbedingungen bei Regenwetter
- Versickerung von Regenwasser
- Generelle Entwässerungsplanung (GEP)

Lecture notes
Written material and copies of the overheads will be available.

Prerequisites / notice
Prerequisite: Introduction to Urban Water Management

重大在材料和工程力学

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<tr>
<td>101-0619-00L</td>
<td>Mechanics of Building Materials</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>F. Wittel</td>
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</tbody>
</table>

Abstract
Material models comprise our knowledge on the physical behavior of materials. Based on a short introduction to solid mechanics, 3D material laws for elastic, visco-elastic behavior, plasticity and damage mechanics are discussed. We focus on material laws for concrete, metals, wood and other composites, how to obtain parameters from mechanical tests and their application in FEM calculations.

Objective
This introductory course aims to bridge the gap between phenomenological, qualitative comprehension of processes in building materials, their characterization in mechanical testing and the ability to apply those for practical design purposes via constitutive models.

Upon completion of the course you should be able to:
- classify different material behavior (e.g. linear/non-linear elastic, elasto-plastic, creep) with respect to types of constitutive material models (total /incremental strain models, damage / plasticity models, linear visco-elasticity),
- review how incremental strain models (e.g. elasto-plastic) are algorithmically implemented in Finite Element software (UMat of Abaqus),
- formulate the main approach and assumptions to the most import models for building materials and discuss their limitations,
- propose experimental campaigns for obtaining relevant material parameters for non-linear material models.

Content
- Introduction to constitutive models for materials
- Fundaments of mechanics of materials
- Cauchy-, hyper- and hypoelastic material descriptions
- Constitutive Models for Concrete (non-linear elastic)
- Introduction to metal and concrete plasticity
- Introduction to ABAQUS UMAT Programming
- Damage continuum mechanics
- Linear visco-elastic materials

Lecture notes
Will be provided during the lecture.

101-0639-01L | Science and Engineering of Glass and Natural Stone in Construction | W | 3 credits | 2G | F. Wittel, T. Wangler |

Abstract
The course offers an overview of relevant practical issues and present technological challenges for glass and natural stones in constructions. Students gain a good knowledge of the basics of glasses and natural stones, their potential as engineering materials and learn to apply them in the design of civil engineering constructions and to evaluate concepts.

Data: 06.03.2019 12:57 Autumn Semester 2016 Page 181 of 1571
Glass is increasingly used in constructions to ease the construction process, as functional insulation barrier, even for structural applications of impressive size. While everyone has experienced the innovation potential of glass in the last decade, products from natural stone suffer from an unjustified traditional image that often originates from a lack of understanding of the material and its combination with other materials. Culturally important structures often are made from natural stone and their conservation demands an understanding of their deterioration mechanisms, the concepts of which can be applied to other civil engineering materials. Designers and engineers need the knowledge to reconcile materials and system behavior with the entire processing, handling, integration and life time in mind.

In this module students are provided with a broad fundamental as well as practice-oriented education on glass and natural stone in civil engineering applications. Present and future construction and building concepts demand for such materials with optimized properties. Based on the fundamentals from the Bachelor course in materials by the end of this module, you should be able to:

- recognize and choose specific applications from the broad overview you were provided with,
- relate processing technologies to typical products and building applications and recognize (and explain typical damage related to wrong material choice or application,
- explain the nature of glassy and crystalline materials and interpret their physical behavior against this background,
- explain the major deterioration mechanisms in natural stone and how this relates to durability,
- analyze material combinations and appraise their application in future products as well as integration in existing constructions,
- summarize with appropriate guidance publications on a related topic in an oral presentation and short report.

**Objective**

**Abstract**

The course focuses on durability of RC structures, in particular the corrosion of steel in concrete. The main emphasis lies on understanding the mechanisms, design and execution aspects related to durability of new and existing structures. New methods and materials for preventative measures, condition assessment and repair techniques are treated with lectures and practice related exercises.

Understand the mechanism of deterioration of RC structures, in particular reinforcement corrosion.

Know the relevant parameters affecting durability of reinforced concrete, in particular cover depth, concrete quality, moisture, and the ways to control durability

Understand the current approaches for design for durability (exposure classes, prescriptive) and be aware of their limitations

Know the future performance-based models for durability design and the difficulties in defining input parameters (such as critical chloride content).

Know and understand different ways to improve durability of RC structures (e.g. stainless steel reinforcement)

Know the particular problems with post-tensioned structures and ways to overcome them (electrically isolated tendons).

Know and understand the non-destructive methods for inspection and condition assessment (especially half-cell potential mapping) and be aware of the limitations

Know and understand repair methods such as conventional repair, electrochemical methods (in particular cathodic protection)

Be aware of differences in performance of the new blended cements (especially CEM II with limestone) respect to the traditional Portland cement and the possible future problems for durability.

**Content**

Lecture 1: An introduction to science and engineering of glass and natural stone in construction (FW/TW)

Lecture 2: Glass chemistry including historical development of glass composition, use of raw materials, melts, chemical stability and corrosion. (FW)

Lecture 3: Geology and mineralogy of stones used in construction. Formation processes, chemistry, crystal structure. (TW)

Lecture 4: Microscopic models for glassy materials. Physics of glass transition. From microscopic physical models to thermodynamics, rheology and mechanics of glassy materials. (FW)

Lecture 5: Stone properties and behavior: microstructure, density, porosity, mechanical properties (TW)

Lecture 6: Glass physics: Optical properties (transmission, reflection, emission, refraction, polarization and birefringence, testing methods); Mechanical properties (density, thermal, mechanical, electric properties, glass testing) (FW)

Lecture 7: Stone properties and durability: transport, moisture and thermal cycling (FW)

Lecture 8: Forming and processing of glass: (plate and molded glass, drawing, slumping, profiling etc.; Processing: Cutting, mechanical processing, tempering, gluing, bending, laminating of glass Surface treatments: coating, sputtering, enameling, printing, etching, chemical pre-stressing.) (FW)

Lecture 9: Durability: Salt crystallization, freezing, biodeterioration (FW)

Lecture 10: Glass products for civil engineering applications: (Molded glasses, fiber glass, foam glass, plate glass); construction glass (insulation glass, structural glass, protective glass, intelligent glass, codes); (FW)

Lecture 11: Conservation: Consolidation, cleaning, and other treatments (TW). Practical aspects (guest lecturer)

Lecture 12: Glass in constructions. (modelling, application and regulation, typical damage in glass) (FW)

Lecture 13: Student presentations; exam questions (FW/TW)

Will be handed out in the lectures

Werkstoffe II script (download via the IFB homepage). Rest will be handed out in the lectures

Werkstoffe I/II of the bachelor studies or equivalent introductory materials lecture.
Reinforced concrete combines the good compressive strength of concrete with the high tensile strength of steel and has proven to be successful in terms of structural performance and durability. However, there are instances of premature failure of reinforced concrete and prestressed concrete components due to corrosion of the reinforcing steel with very high economic implications of such damage. This course focuses on the chloride and carbonation induced corrosion of steel in concrete, presenting transport mechanisms and electrochemical concepts. The main emphasis lies on design and execution aspects related to durability of new and existing structures. New methods and materials for preventative measures, condition assessment and repair techniques are discussed. This course is a point of reference for engineers and materials scientists involved in research and practice of corrosion protection, rehabilitation and maintenance of reinforced concrete structures and components.

Content of the course in detail:

Lecture 1
Administrative issues, literature, what do students expect to learn? Introduction (economic relevance of durability, transition from building to maintenance). Fundamentals of corrosion and durability / Passivity and pitting corrosion

Lecture 2
Reinforced concrete / Corrosion protection / Degradation mechanism corrosion (chlorides/carbonation) / electrochemical mechanism / controlling parameters / cracks and spalling on surface, danger of localized corrosion

Lecture 3
Other degradation mechanisms: sulphate attack, ASR, frost attack
Various examples, frequency of occurrence of individual deterioration mechanisms

Lecture 4
Service life: initiation stage & propagation stage. Durability design: prescriptive approach, constructive detailing, importance of moisture for almost all degradation mechanisms. Performance based approach, simple diffusion approach for chloride ingress, Critical chloride content (influencing parameters)

Lecture 5
Stainless steel as reinforcing steel for concrete / different types of stainless steels / mechanical properties / corrosion resistance, passivity / coupling with black reinforcing steel / examples of application / life-cycle-costs

Lecture 6
Inspection and condition assessment I: visual inspection / destructive testing (chloride profiles, carbonation depth, thin section analysis, etc.)

Lectures 7
Inspection and condition assessment II: non-destructive testing (potential mapping, cover depth measurement, resistivity measurement). Potential mapping: measurement principle / effect of carbonated cover zone / effect of moisture / examples

Lecture 8
Post-tensioned structures / problem with existing structures: no NDT method / approach for protection (multiple barrier) / new systems with polymer ducts / electrically isolated tendons / fib guidelines / Swiss guideline / Monitoring techniques / Applications

Lecture 9
Repair methods I: conventional repair / coatings / inhibitors / limitations

Lecture 10
Repair methods II: electrochemical repair methods (ECR, ER, CP) / principles / electrochemical chloride removal (theory and examples) / electrochemical realalkalization (theory and examples) / when can these methods be applied ? / cost aspects

Lecture 11
Repair methods III: cathodic protection (theory, technical solutions, anode systems, etc and applications). Monitoring of CP.

Lecture 12
New cements, issue of CO2 reduction. Effects of fly ash, slag, limestone on workability, diffusion coefficient, resistivity, pH (including a discussion of the pozzolanic reaction and it's consequences with respect to pH buffering Portlandite reserve). Discuss products on the Swiss market.

Lecture 13
Summary of most important points of this course given by the students. Open discussion about durability design, use of new cements, new materials and repair methods. Expected consequences for practice ? Course evaluation and time for asking questions.

Lecture notes
The course is based on the book
Slides of the lectures will be distributed in advance
Special hand outs and reprints for particular topics will be distributed

Literature


Prerequisites / notice
Students are encouraged to actively participate during the lectures. Students are expected to work on all the exercises (four). For one exercise a detailed written solution of the exercise has to be delivered (after the discussion).

Students should have passed the exams on Werkstoffe I and II.

101-0669-00L Bituminous Materials  W  3 credits  2G  M. Partl
Abstract
Introduction into special aspects of the mechanical and chemo-physical properties as well as the structure and application of bituminous materials for road and waterproofing application considering also new R&D trends

Objective
Introduction into special aspects of the mechanical and chemo-physical properties as well as the structure and application of bituminous materials for road and waterproofing application considering also new R&D trends

Content
Basics of mechanical behavior: Viscosity, rheological models, viscoelasticity, time-temperature superposition, fatigue, viscoplasticity.
Bituminous binders: Tar-related issues, bitumen, natural asphalt, polymer modified bitumen, technological tests, mechanical-physical properties, binder classification, bitumen emulsions, foam bitumen.
Asphalt pavements: material structure and concepts, production, mixture testing and characterization, mixture types, recycling
Waterproofing membranes: tack- coats, structure of polymer modified waterproofing membranes, production, typical tests, system-related properties, construction and application
**Lecture notes**  Script, handed out during lecture  
The lecture comprises two written exercises and one literature exercise with short presentation that are requested to be done.

<table>
<thead>
<tr>
<th>Lecture notes</th>
<th>Prerequisites / notice</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>101-0689-00L</strong></td>
<td>Shrinkage and Cracking of Concrete: Mechanisms and Impact on Durability</td>
</tr>
</tbody>
</table>

**Abstract**  
Concrete is generally viewed as a durable construction material. However, the long-term performance of a concrete structure can be greatly compromised by early-age cracking. This course will explain how shrinkage of concrete leads to cracking and how control of shrinkage allows increasing the expected durability of a concrete structure.

**Objective**  
This course will begin with a brief introduction about hydration and microstructure development in cement paste and concrete. The students will learn the main causes of cracking at early ages, namely plastic, drying, thermal and autogenous shrinkage, with special emphasis on the driving mechanisms. The importance of concrete curing, especially in the first few days after casting, will be explained. Building on the knowledge of the driving forces of shrinkage, the way of action of shrinkage-reducing admixtures will be clarified and different applications illustrated. As an extension of external curing, the students will become familiar with internal water curing by means of saturated lightweight aggregate and superabsorbent polymer.

Most concrete members are restrained by adjacent structures. When shrinkage is restrained, cracks may develop. The students will learn how to apply different criteria for assessing concrete cracking and how to retrieve the mechanical properties of the concrete, especially stiffness and creep, relevant for the calculations.

In addition to macroscopic cracks, microcracking may occur in the cement paste due to inner restraint offered by the aggregates. Both macroscopic cracks and diffuse microcracking within a concrete may facilitate the ingress of harmful substances (e.g., chloride and sulfate ions) into the concrete; these may react with the concrete or with the reinforcement and create further deterioration. The students will acquire an understanding of the mechanisms of transport through cracked concrete, with special focus on experimental evidence and on techniques able to visualize the transport process and follow it in time.

As a final outcome of the course, the students will be able to estimate the impact of cracking on the expected durability of concrete structures and to implement different types of measures to reduce the extent of cracking.

**Content**  
Concrete is generally viewed as a long-lasting construction material. However, the durability of a concrete structure can be jeopardized by shrinkage-induced cracking. In addition to being unsightly, cracks have the potential to act as weak planes for further distress or as conduits for accelerated ingress of aggressive agents that may reduce durability.

Advances in concrete technology over the past decades have led to the practical use of concrete with a low water to binder ratio and with different types of mineral and organic admixtures. Another recent development is self-compacting concrete, which avoids concrete vibration and reduces labor during placing. Unfortunately, these concretes are especially prone to cracking at an early age, unless special precautions are taken. Proper curing becomes in this case the key to achieve better performance in various environmental and load conditions.

**Lecture notes**  For each lecture, lecture notes will be provided. In addition, one or two research papers for each lecture will be indicated as supportive information.

**Literature**  Copies of one to two research papers relevant to the topic of each lecture will be provided to the students as supportive information.

**Prerequisites / notice**  A basic knowledge of concrete technology is preferable.

<table>
<thead>
<tr>
<th>Lecture notes</th>
<th>Prerequisites / notice</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>151-0353-00L</strong></td>
<td>Mechanics of Composite Materials</td>
</tr>
</tbody>
</table>

**Abstract**  
The course Mechanics of Composite Materials is dedicated to modeling problems following from the complex mechanical behavior of these anisotropic material structures. and modeling of continuous fibre reinforced composites. Participants will be able to design parts for the mechanical, automotive and aerospace industry.

**Objective**  
Understanding of the mechanical properties of fiber reinforced composites with regard to analysis and design of lightweight structures for mechanical, transportation and aerospace applications.

**Content**  
1. Introduction and Elastic Anisotropy  
2. Laminate Theory  
3. Thick-Walled Laminates and Interlaminar Stresses  
4. Edge Effects at Multidirectional Laminates  
5. Micromechanics  
6. Failure Hypotheses and Damage Prediction  
7. Fatigue Response  
8. Joining and Bonding Techniques  
9. Sandwich Designs

**Lecture notes**  Manuscript and handouts in printed form and as PDF-files: http://www.structures.ethz.ch/education/master/intro/compulsory/mechanics

**Literature**  The lecture material is covered by the script and further literature is referenced in there.

<table>
<thead>
<tr>
<th>Lecture notes</th>
<th>Prerequisites / notice</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>151-0833-00L</strong></td>
<td>Principles of Nonlinear Finite-Element-Methods</td>
</tr>
</tbody>
</table>

**Abstract**  
Most problems in engineering are of nonlinear nature. The nonlinearities are caused basically due to the nonlinear material behavior, contact conditions and instability of structures. The principles of the nonlinear Finite-Element-Method (FEM) will be introduced in the scope of this lecture for treating such problems.
The goal of the lecture is to provide the students with the fundamentals of the non linear Finite Element Method (FEM). The lecture focuses on the principles of the nonlinear Finite-Element-Method based on explicit and implicit formulations. Typical applications of the nonlinear Finite-Element-Methods are simulations of:

- Crash
- Collapse of structures
- Materials in Biomechanics (soft materials)
- General forming processes

Special attention will be paid to the modeling of the nonlinear material behavior, thermo-mechanical processes and processes with large plastic deformations. The ability to independently create a virtual model which describes the complex non linear systems will be acquired through accompanying exercises. These will include the Matlab programming of important model components such as constitutive equations.

### Content

- Fundamentals of continuum mechanics to characterize large plastic deformations
- Elasto-plastic material models
- Updated-Lagrange (UL), Euler and combined Euler-Lagrange (ALE) approaches
- FEM implementation of constitutive equations
- Element formulations
- Implicit and explicit FEM methods
- FEM formulations of coupled thermo-mechanical problems
- Modeling of tool contact and the influence of friction
- Solvers and convergence
- Modeling of crack propagation
- Introduction of advanced FE-Methods

### Prerequisites

Lecture notes: yes


### Prerequisites / Notice

If we will have a large number of students, two dates for the exercises will be offered.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
<th>Type</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0637-10L</td>
<td>Structures of Wood and Function</td>
<td>3</td>
<td>W</td>
<td>I. Burgert, E. R. Zürcher</td>
</tr>
<tr>
<td>101-0637-20L</td>
<td>Fundamentals of Wood Elaboration and Woodmachining</td>
<td>3</td>
<td>W</td>
<td>I. Burgert, O. F. Kläusler</td>
</tr>
<tr>
<td>151-0735-00L</td>
<td>Dynamic Behavior of Materials and Structures</td>
<td>4</td>
<td>W</td>
<td>D. Mohr</td>
</tr>
<tr>
<td>151-0513-00L</td>
<td>Mechanics of Soft Materials and Tissues</td>
<td>4</td>
<td>W</td>
<td>A. E. Ehret</td>
</tr>
</tbody>
</table>
Abstract
An introduction to concepts for the constitutive modelling of highly deformable materials with non-linear properties is given in application to rubber-like materials and soft biological tissues. Related experimental methods for materials characterization and computational methods for simulation are addressed.

Objective
The objective of the course is to provide an overview of the wide range of non-linear mechanical behaviors displayed by soft materials and tissues together with a basic understanding of their physical origin, to familiarize students with appropriate mathematical concepts for their modeling, and to illustrate the application of these concepts in different fields in mechanics.

Content
Soft solids: rubber-like materials, gels, soft biological tissues
Non-linear continuum mechanics: kinematics, stress, balance laws
Mechanical characterization: experiments and their interpretation
Constitutive modeling: basic principles
Large strain elasticity: hyperelastic materials
Rubber-elasticity: statistical vs. phenomenological models
Biomechanics of soft tissues: composites, anisotropy, heterogeneity
Dissipative behavior: examples and the concept of internal variables.

Lecture notes
Accompanying learning materials will be provided or made available for download during the course.

Literature
Recommended text:
L.R.G. Treloar, The physics of rubber elasticity, 3rd ed., 2005

Prerequisites /
A good knowledge base in continuum mechanics, ideally a completed course in non-linear continuum mechanics, is recommended.

Projects

<table>
<thead>
<tr>
<th>Number</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0198-01L</td>
<td>W</td>
<td>Project on Construction Engineering</td>
<td>W</td>
<td>9 credits</td>
</tr>
<tr>
<td>101-0298-01L</td>
<td>W</td>
<td>Project on Hydraulic Engineering and Water Resources Management</td>
<td>W</td>
<td>9 credits</td>
</tr>
<tr>
<td>101-0398-01L</td>
<td>W</td>
<td>Project on Geotechnical Engineering</td>
<td>W</td>
<td>9 credits</td>
</tr>
<tr>
<td>101-0498-01L</td>
<td>W</td>
<td>Project on Transport Systems</td>
<td>W</td>
<td>9 credits</td>
</tr>
<tr>
<td>101-0598-01L</td>
<td>W</td>
<td>Project on Construction and Maintenance Management</td>
<td>W</td>
<td>9 credits</td>
</tr>
<tr>
<td>101-0698-01L</td>
<td>W</td>
<td>Project on Materials and Mechanics</td>
<td>W</td>
<td>9 credits</td>
</tr>
</tbody>
</table>

Electives

The entire course programs of ETH Zurich and the University of Zurich are open to the students to individual selection.

Electives ETH Zurich

Recommended Electives of Master Programme

<table>
<thead>
<tr>
<th>Number</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>051-0781-16L</td>
<td>W</td>
<td>Costruire correttamente/Constructing Correctly: Curve and Fold to Bear Loads and Forces</td>
<td>W</td>
<td>2 credits</td>
</tr>
</tbody>
</table>

Abstract
In line with the approach of P.L. Nervi's book, our study is based on factors that, outlined by him, are still today all the more relevant as a lesson for architecturally and structurally justified buildings. We will observe selected buildings both of our time and of the past for their space, architecture and construction, understand them and interpret them according to universal values of design.

Data: 06.03.2019 12:57  Autumn Semester 2016  Page 186 of 1571
The purpose of this course is to equip the students with methods and tools to tackle a broad range of problems. Following a Design Thinking: Human-Centred Solutions to Real World Challenges approach, students will work in teams to solve a set of design challenges that are organized as a one-week, a three-week, and a final six-week project in collaboration with an external project partner.

During the course, students will learn about different design thinking methods and tools. This will enable them to:
- Generate deep insights through the systematic observation and interaction of key stakeholders.
- Engage in collaborative ideation with a multidisciplinary (student) team.
- Rapidly prototype and iteratively test ideas and concepts by using various materials and techniques.

The students will work in multidisciplinary teams on a set of challenges that are organized as a one-week, a three-week, and a final six-week project with an external project partner. In this course, the students will learn about the different Design Thinking methods and tools that are needed to generate deep insights, to engage in collaborative ideation, rapid prototyping and iterative testing.

Design Thinking is a deeply human process that taps into the creative abilities we all have, but that get often overlooked by more conventional problem solving practices. It relies on our ability to be intuitive, to recognize patterns, to construct ideas that are emotionally meaningful as well as functional, and to express ourselves through means beyond words or symbols. Design Thinking provides an integrated way by incorporating tools, processes and techniques from design, engineering, the humanities and social sciences to identify, define and address diverse challenges. This integration leads to a highly productive collaboration between different disciplines.

For more information and the application visit: http://sparklabs.ch/ethz

Class attendance and active participation is crucial as much of the learning occurs through the work in teams during class. Therefore, attendance is obligatory for every session. Please also note that the group work outside class is an essential element of this course, so that students must expect an above-average workload.

The main objective of this course is to provide students with some basic tools to analyze transport policy decisions from an economic perspective. Can economics help us reduce road congestion problems? Should drivers be asked to pay for using urban roads? Should public transport tariffs depend on how roads are priced? How should the investment in transport infrastructure be financed? These are some of the questions that students should be able to tackle after completing the course.

For more information and the application visit: http://sparklabs.ch/ethz

Class attendance and active participation is crucial as much of the learning occurs through the work in teams during class. Therefore, attendance is obligatory for every session. Please also note that the group work outside class is an essential element of this course, so that students must expect an above-average workload.

The first part of the course will present some basic principles of transportation economics, applied to the main issues in urban transport policy (e.g. road pricing, public transport tariffs, investment in infrastructure etc.). The second part of the course will consider some case studies where we will apply the tools acquired in the first part to actual policy issues.

Objectives and content of the course will be outlined by him, and are still today all the more relevant as a lesson for architecturally and structurally justified buildings. His thoughts represent valuable criteria and indispensable tools for observation and carrying out investigations of the built environment.

Lessons learned from this can enrich the design work of today's and tomorrow's architects. All of these (see abstract) i.e. analyses, observances, hypotheses, groupings and cross-comparisons, will help the students in their careers to find their own strategies and approaches to design and to be aware of them. And so, according to the advice of Pier Luigi Nervi: "...At every stage of his training, the future architect should be constantly and methodically guided to search for essential elements in each problem, be it large or small. The study of the architectural works of the past should consist in the critical examination of their functional and structural solutions and of the relation between these and form, in order to show that form is a consequence and not a determinant of functional and structural needs." [P.L. Nervi: Costruire correttamente, Milano 1955; English version titled "Structures", 1956, p.28].

The main thread of this course, that runs over two semesters (*), are buildings of all ages that could be categorised under notions such as «most viewed», «most technically daring», «most unknown», «most discussed» or «most worthy of discussion», and carry instructive aspects of the teachings of Pier Luigi Nervi ("costruire correttamente"). In the lecture, these buildings will be investigated on-the-spot, described from the designers' point-of-view and will be commented on with reference to any redesign resulting from the interplay of architectural and structural concepts. Harmonies and discords should be discovered.

Occasionally there will be guest lectures. These people, who were directly involved with a certain building, will portray the emergence and development of the project.

In this sense, the course is also intended for civil / structural engineering students and presents a possible bridge between the two prospective project partners - architect and engineer.

(*) Begins in the autumn semester. Entry into the course in the spring is possible.

None for the time being.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Elective</th>
<th>Instructor(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-1065-00L</td>
<td>Design Thinking: Human-Centred Solutions to Real World Challenges</td>
<td>5</td>
<td>W</td>
<td>A. Cabello Llamas, F. Rittiner, S. Brusoni, C. Hölscher, M. Meboldt</td>
</tr>
<tr>
<td>363-1047-00L</td>
<td>Economics of Urban Transportation</td>
<td>3</td>
<td>2G</td>
<td>A. Russo</td>
</tr>
</tbody>
</table>
COURSE OUTLINE (preliminary):

1. Introduction
2. Travel demand:
   a. travel cost and value of time
   b. mode choice
3. Road congestion and first-best pricing
   a. Static congestion model
   b. Dynamic congestion models
   c. Examples: London Congestion Charge, Stockholm Congestion Charge
4. Second-best pricing
   a. Pricing roads with unpriced alternatives. Examples: tolled and toll-free highways
   b. Public transport: pricing with road congestion and with (or without) road tolls
   c. Induced demand
   d. Economies of scale/density in public transport
5. Investment in infrastructure: public transport and roads
   a. Roads: Investment with and without pricing
   b. Public transport: pricing with road congestion

Lecture notes

Course slides will be made available to students prior to each class.

Literature

SYLLABUS (preliminary):

Part 1 to 5: textbook: Small and Verhoef (The economics of urban transportation, 2007).

Part 6: Topics to be covered on research papers/case studies.

GESS Science in Perspective

Recommended GESS Science in Perspective (Type B) for D-BAUG.

see GESS Science in Perspective: Type A: Enhancement of Reflection Capability

see GESS Science in Perspective: Language Courses

Master’s Thesis

Number Title Type ECTS Hours Lecturers
101-0010-00L Master’s Thesis

Only students who fulfill the following criteria are allowed to begin with their master thesis:

a. successful completion of the bachelor programme;
b. fulfilling of any additional requirements necessary to gain admission to the master programme.

Abstract

The Master Programme concludes with the Master Thesis, which has to be done in one of the chosen Majors and has to be completed within 16 weeks. The Master Thesis is supervised by a professor and shall attest the students ability to work independently and to produce scientifically structured work.

Objective

To work independently and to produce a scientifically structured work.

Content

The topics of the Mastrer Thesis are published by the professors. The Topic can be set also in consultation between the student and the professor.

Civil Engineering Master - Key for Type

<table>
<thead>
<tr>
<th>Number</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
<td>E-</td>
<td></td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
<td></td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
<td></td>
<td>Suitable for doctorate</td>
</tr>
</tbody>
</table>

Key for Hours

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
<th>P</th>
<th>practical/laboratory course</th>
</tr>
</thead>
<tbody>
<tr>
<td>G</td>
<td>lecture with exercise</td>
<td>A</td>
<td>independent project</td>
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<tr>
<td>U</td>
<td>exercise</td>
<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>S</td>
<td>seminar</td>
<td>R</td>
<td>revision course / private study</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
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</tbody>
</table>

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
This course focuses on basic aspects of central nervous system physiology, including perception, motor control and cognitive functions.

**Electives**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0385-10L</td>
<td>Biomedical Imaging</td>
<td>W</td>
<td>6</td>
<td>5G</td>
<td>S. Kozerke, K. P. Prüssmann, M. Rudin</td>
</tr>
<tr>
<td>227-0386-00L</td>
<td>Biomedical Engineering</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>J. Vörös, S. J. Ferguson, S. Kozerke, U. Moser, M. Rudin, M. P. Wolf, M. Zenobi-Wong</td>
</tr>
<tr>
<td>227-1051-00L</td>
<td>Systems Neuroscience (University of Zurich)</td>
<td>W</td>
<td>6</td>
<td>2V+1U</td>
<td>D. Kiper</td>
</tr>
<tr>
<td>363-0301-00L</td>
<td>Work Design and Organizational Change</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>G. Grote</td>
</tr>
</tbody>
</table>

**Objective**

- To understand the basic concepts underlying X-ray imaging, computed tomography, single photon and positron emission tomography, magnetic resonance imaging, ultrasound and Doppler imaging techniques. The mathematical framework is developed to describe image encoding/decoding, point-spread function, transfer function, signal-to-noise ratio, contrast behavior for each of the methods. Matlab exercises are used to implement and study basic concepts.

- Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The focus is on learning the concepts that govern common medical instruments and the most important organs from an engineering point of view. In addition, the most recent achievements and trends of the field of biomedical engineering are also outlined.

- Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The course provides an overview of the various topics of the different tracks of the biomedical engineering master course and helps orienting the students in selecting their specialized classes and project locations.


- No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: INI415

- Mind the enrolment deadlines at UZH: http://www.uzh.ch/studies/application/mobilitaet_en.html

- This course focuses on basic aspects of central nervous system physiology, including perception, motor control and cognitive functions. Main emphasis sensory systems, with complements on motor and cognitive functions.

- Good work design is crucial for individual and company effectiveness and a core element to be considered in organizational change. Meaning of work, organization-technology interaction, and uncertainty management are discussed with respect to work design and sustainable organizational change. As course project, students learn and apply a method for analyzing and designing work in business settings.

- Know effects of work design on competence, motivation, and well-being
- Understand links between design of individual jobs and work processes
- Know basic processes involved in systematic organizational change
- Understand the interaction between organization and technology and its impact on organizational change
- Understand relevance of work design for company performance and strategy
- Know and apply methods for analyzing and designing work
Central aspects of Sport related pedagogy will be handled in these lectures. These aspects cover, amongst others, the subject and tasks of Sport related pedagogy.

On completion of this course students will be able to demonstrate:

- Work design: From Adam Smith to job crafting
- Effects of work design on performance and well-being
- Approaches to analyzing and designing work
- Modes of organizational change and change methods
- Balancing stability and flexibility in organizations as design criterium
- The organization-technology interaction and its impact on work design and organizational change
- Example Flexible working arrangements
- Strategic choices for work design

A list of required readings will be provided at the beginning of the course.

The course includes the completion of a course project to be conducted in groups of four students. The project entails applying a particular method for analyzing and designing work processes and is carried out by means of interviews and observations in companies chosen by the students.

Core texts for this course are:

- Physical Activities and Health
- Physical Activities and Health: Assessment and Measurement
- Physical Activity and Sedentary Behavior: Health Implications and Policy
- Physical Activity and Health: Challenges and Opportunities
- Physical Activity and Health: Concepts and Evidence


This course offers the fundamentals in theory and practice of entrepreneurship in new technology ventures. Main topics covered are success factors in the creation of new firms, including founding, financing and growing a venture.

This course provides theory-grounded knowledge and practice-driven skills for founding, financing, and growing new technology ventures.

A critical understanding of dos and don'ts is provided through highlighting and discussing real life examples and cases.

See course website: http://www.entrepreneurship.ethz.ch/sresources/courses/tech-entrepreneurship.html

Lecture slides and case material

Methods and Concepts in Human Systems and Motor Control

- Technology ventures are significantly changing the global economic picture. Technological skills increasingly need to be complemented by entrepreneurial understanding.
- This course offers the fundamentals in theory and practice of entrepreneurship in new technology ventures. Main topics covered are success factors in the creation of new firms, including founding, financing and growing a venture.
- This course provides theory-grounded knowledge and practice-driven skills for founding, financing, and growing new technology ventures.
- A critical understanding of dos and don'ts is provided through highlighting and discussing real life examples and cases.

The course will prepare students for experimental work as it is typically done during the master thesis. The goal is to gain hands-on experience with measurement and analysis methods relevant for Humans Systems Neuroscience and Motor control (for example peripheral nerve stimulation, electrical and magnetic brain stimulation, EEG, psychophysical paradigms etc.). Students will learn how to perform small scientific projects in this area. Students will work individually or in small groups and solve scientific problems which require them to perform measurements in human participants, extract relevant readouts from the data, apply appropriate statistics and interpret the results. They will also be required to write small essays and reports and they will get feedback on their writing throughout the course.

Students are required to have successfully completed the course "Neural control of movement and motor learning" and to have basic knowledge of applied statistics. Self-study material about applied statistics will be available at the beginning of the course and statistical knowledge will be tested (central element) in the second course week. Passing this test is a requirement for continuing the course. Students will have to solve scientific problems, requiring them to independently study scientific material, apply statistics and report their results in the form of written reports and essays. Assessments will be made on the basis of the completed theoretical and practical work that will be performed either in small groups or individually.

From the BSc-course the following book is recommended: ‘Essentials of strength training and conditioning’ T. Baechle, R. Earle (3rd Edition)


Selective journal articles from relevant journals such as Journal of Physical Activity and Health and Journal of Aging and Physical Activity will be made available at the beginning of the course.

From the BSc-course the following book is recommended: ‘Essentials of strength training and conditioning’ T. Baechle, R. Earle (3rd Edition)


Selective journal articles from relevant journals such as Journal of Physical Activity and Health and Journal of Aging and Physical Activity will be made available at the beginning of the course.

From the BSc-course the following book is recommended: ‘Essentials of strength training and conditioning’ T. Baechle, R. Earle (3rd Edition)

This lecture is intended as an introduction to sport psychology and imparts knowledge on selected areas of the subject.

The aim is to give a deepened insight on the normal development, of the nervous system based on molecular, cellular and biochemical insights of human movement sciences concerning wear, overstraining and regeneration of the musculoskeletal system form an important basis for ergonomic work design. The following topics will be covered: Muscle fatigue during the 8-hour day, use of the computer mouse, backaches, Tendinitis, nerve compression, epidemiology, prevention, rehabilitation, laws, measuring procedures.

Consolidated findings of movement sciences concerning deterioration, overload and regeneration of the musculoskeletal system are an important basis for an ergonomic working environment. The following topics are covered: Muscle fatigue during the 8-hour day, use of the computer mouse, backaches, Tendinitis, nerve compression, epidemiology, prevention, rehabilitation, laws, measuring procedures.

Select the topics of the lecture notes and are mentioned on OLAT.
Abstract
The course covers the structure, plasticity and regeneration of the adult nervous system (NS) with a focus on: sensory systems, cognitive functions, learning and memory, molecular and cellular mechanisms, animal models, and diseases of the NS.

Objective
The aim is to give a deepened insight into the structure, plasticity and regeneration of the nervous system based on molecular, cellular and biochemical approaches.

Content
The main focus is on the structure, plasticity and regeneration of the NS: biology of the adult nervous system; structural plasticity of the adult nervous system, regeneration and repair: networks and nerve fibers, regeneration, pathological loss of cells.

Lecture notes
ETH students: Lecture notes will be provided on Moodle https://moodle-app2.let.ethz.ch/course/view.php?id=694
Password will be provided at the beginning of the lecture.

Literature
UZH students: Lecture notes will be provided on OLAT: https://www.olat.uzh.ch/olat/dmz/
The lecture requires reading of book chapters, handouts and original scientific papers. Further information will be given in the individual lectures and are mentioned on Moodle / OLAT.

376-1665-00L
Training and Coaching I 145 W 3 credits 2G O. Buholzer

Abstract
The combining of training and coaching as in the example of sport analysis, which has an effect on youth training and athlete development

Objective
- To develop basics for a differentiate analyses of sports (model)
- To develop a profile of requirements for specific sports
- To develop competencies of training with youth and talents
- To develop the basics of talent training in theory and practice
- To observe athletes in case studies, make judgments and conclusion

Content
Das Modell der Sportartenanalyse
Die Relevanz der einzelnen Leistungsfaktoren
Das Modell der Wettkampfanalyse
Folgerungen für das Training und Coaching in der Sportart
Folgerungen für das Nachwuchstraining
Folgerungen für die Athletenauswahl, Athletenbeobachtung und -betreuung
Das Nachwuchs- und Talenttraining (Sichtung, Selektion, Förderung)
Projekte aus der Praxis (Talent- und Nachwuchstraining)
Praxisinput zum Thema Koordination, motorische Grundbedürfnisse, Kraft und Gesundheit
Praxisbeispiele erarbeiten und planen
Konkrete Athletenbeobachtung

Lecture notes
Die Skript- (Lektionsunterlagen) werden im Rahmen des Semesters abgegeben und auf Homepage veröffentlicht.

Prerequisites / notice

Literature
Struktur sportlicher Leistung (Modellsatz von Gundlach; (Trainingswissenschaften S. 45 - 49; Stiehler(Konzag/Döbler)

Leistungsdiagnostische Verfahren, Stiehler(Konzag/Döbler)
Training fundiert erklärt, Handbuch der Trainingslehre, Ingold Verlag 2006
Das sportliche Talent, W. Joch, Meyer&Meyer Verlag, 2002
Das neue Konditionstraining, Grosser/Starischka/Zimmermann, blv 2002

376-1717-00L
Practical Basics in Sports and Exercise Therapy 145 W 2 credits 2V B. Spörri Kälin, B. Keller

Abstract
Feasible from the 5th semester on.
Requirement: "Introduction of Exercise Therapy" passed.

Objective
Impart knowledge of practical basics of Sports and Exercise Therapy
The members are able to transform the knowledge from the previous courses in practical situations of Sports and Exercise Therapy. They learn basic aspects to design therapy lessons.

Content
communication/conversation with patients
psychoregulation: relaxation

Lecture notes
The courses "Introduction in Sports and Exercise Therapy" and has been completed successfully.

Prerequisites / notice

376-1720-00L
Application of MATLAB in the Human Movement Sciences 145 W 2 credits 2G R. van de Langenberg

Abstract
Students will learn to import, process and graphically present experimental data using the MATLAB computing environment. Both the data and the methods of analysis will be typical for experiments in Human Movement Science (i.e. kinematics, kinetics and electromyography).

Objective
Students will acquire the ability to independently load, plot, and process kinematic, kinetic and electromyographical data using the MATLAB computing environment.

Content
Drawbacks of Excel; Possibilities in MATLAB; Import of several data formats; Plot of one and more signals; Removing of an offset and filtering of data based on self-written functions; Normalisation and parametrisation of data; Reliability; Interpolation, Differentiation and Integration in MATLAB.

Literature
During the lecture, several electronically available MATLAB introductions are indicated. Course-specific scripts will be provided by the lecturer.

Prerequisites / notice
A Laptop with MATLAB installed (v2009 or higher) and wireless internet access is mandatory. Two students can share a laptop if necessary. A MATLAB student version can be obtained at Stud-IDES for free.

376-1722-00L
Spinal Cord Injury and Exercise 145 W 2 credits 2V C. Perret

Prerequisite: Anatomy and Physiology
Basics of Exercise Therapy:

- Fitt's law applied in manipulation tasks

Students learn the assessments to plan an exercise-therapy-treatment. The following issues will be discussed: Epidemiology and etiology of spinal cord injury; complications and consequences of spinal cord injury; trainability/exercise physiology and spinal cord injury; history and organisation of wheelchair sports; elite sport and spinal cord injury

Abstract

Intensive discussion concerning complications of a spinal cord injury and their consequences on trainability and exercise performance of persons sitting in a wheelchair. Overview on the clinical application of exercise testing as well as on the implementation of sport scientific findings to optimise performance of spinal cord injured subjects in rehabilitation and elite sports.

Objective

Knowledge of the pathophysiology and the concomitant complications of a spinal cord injury and the consequences for physical exercise and trainability during rehabilitation as well as in recreational and elite sport.

Content

The following issues will be discussed: Epidemiology and etiology of spinal cord injury; complications and consequences of spinal cord injury; trainability/exercise physiology and spinal cord injury; history and organisation of wheelchair sports; elite sport and spinal cord injury

Literature

General literature:

G.A. Züch, H. G. Koch
Paraplegie - ganzheitliche Rehabilitation
Karger-Verlag, 2006
ISBN 3-8055-7980-2

V. Goosery-Tolfrey
Wheelchair sport: A complete guide for athletes, coaches and teachers
Human Kinetics, 2010

Y.C. Vanlandeijick, W.R. Thompson
The Paralympic Athlete
Wiley-Blackwell, 2011
ISBN 978-1-4443-3404-3

Liz Broad
Sports Nutrition for Paralympic Athletes
CRC Press 2014

Prerequisites / notice

Voraussetzung: Vorlesung Anatomie/Physiologie besucht!

376-1177-00L  Human Factors I  W  2 credits  2V  M. Menozzi Jäcklli, R. Huang, M. Siegrist

Abstract

Every day humans interact with various systems. Strategies of interaction, individual needs, physical & mental abilities, and system properties are important factors in controlling the quality and performance in interaction processes. In the lecture, factors are investigated by basic scientific approaches. Discussed topics are important for optimizing people's satisfaction & overall performance.

Objective

The goal of the lecture is to empower students in better understanding the applied theories, principles, and methods in various applications. Students are expected to learn about how to enable an efficient and qualitatively high standing interaction between human and the environment, considering costs, benefits, health, and safety as well. Thus, an ergonomic design and evaluation process of products, tasks, and environments may be promoted in different disciplines. The goal is achieved in addressing a broad variety of topics and embedding the discussion in macroscopic factors such as the behavior of consumers and objectives of economy.

Content

- Physiological, physical, and cognitive factors in sensation and perception
- Body spaces and functional anthropometry, Digital Human Models
- Experimental techniques in assessing human performance and well-being
- Human factors and ergonomics in system designs, product development and innovation
- Human information processing and biological cybernetics
- Interaction among consumers, environments, behavior, and tasks

Literature

- Gavriel Salvendy, Handbook of Human Factors and Ergonomics, 4th edition (2012), is available on NEBIS as electronic version and for free to ETH students
- Further textbooks are introduced in the lecture
- Brouchures, checklists, key articles etc. are uploaded in ILIAS

376-1179-00L  Applications of Cybernetics in Ergonomics  W  1 credit  1U  M. Menozzi Jäckli

Abstract

Cybernetics systems have been studied and applied in various research fields, such as applications in the ergonomics domain. Research interests include the man-machine interaction (MMI) topic which involving the performance in multi-model interactions, quantification in gestalt principles in product development; or the information processing matter.

Objective

To learn and practice cybernetics principles in interface designs and product development.

Content

- Fitt's law applied in manipulation tasks
- Hick-Hyman law applied in design of the driver assistance systems - Vigilance applied in quality inspection
- Accommodation/vergence crosslink function
- Cross-link models in neurobiology- the ocular motor control system
- Human performance in optimization of production lines

Literature


376-1716-00L  Basics of Exercise Therapy  W  2 credits  2V  K. Marschall

Abstract

Number of participants limited to 30.

Possible from the 5th semester on.

Requirement:"Introduction of Exercise Therapy" passed.

Basics of Exercise Therapy:

A: diagnostic, anamnese, diagnostic of movement and function, assessments in exercise therapy, diagnostic of experience and behavior in relation to movement

B: biological-medical basics, pathophysiological Basics (internal, orthopedic and psychological deseases.

C: didactic knowledge, Reha-didactic

Objective

Students learn the assessments to plan an exercise-therapy-treatment. They are able to use them. They're able to integrate biological and medical basics.

Content

Grundlagen der Diagnostik, Anamnese, Bewegungsdagnostik, Funktionsdiagnostik
Sport- und Bewegungstherapeutische Testverfahren
Motorische Basisdiagnostik
Diagnostik bewegungsbezogenen Erlebens und Verhaltens
Biologisch-medicinische Grundlagen
Biomechanik (v.a. Gelenke), Pathophysiologische Grundlagen, Modelle der Methodik und Didaktik, Lektionsplanung

Lecture notes

wird vor Semesterbeginn elektronisch zur Verfügung gestellt
### 376-2017-00L Biomechanics of Sports Injuries and Rehabilitation

**Abstract**
This lecture introduces the basic principles of injury mechanics and rehabilitation focussing on sports injuries.

**Objective**
Within the scope of this lecture you will learn the basic principles of trauma biomechanics. Based on examples from sports, you will get to know different mechanisms that can possibly result in injury. Investigating the background and cause of injury should allow you to assess the injury risk for sports activities. Furthermore you should be able to develop measures to prevent such injury.

**Content**
This lecture deals with the basic principles of injury mechanics and rehabilitation. Mechanisms that can result in injury are presented. Furthermore possibilities to prevent injuries are discussed. Thercby the lecture focuses on sports injuries.

**Lecture notes**
Handouts will be made available.

**Literature**

**Prerequisites / notice**
A course work is required. The mark of this course work contributes to the final credits for this lecture. Details will be given during the first lecture.

### 752-6001-00L Introduction to Nutritional Science

**Abstract**
This course introduces basic concepts of micro- and macronutrient nutrition. Micronutrients studied include fat-soluble and water-soluble vitamins, minerals and trace elements. Macronutrients include proteins, fat and carbohydrates. Special attention is given to nutrient digestion, bioavailability, metabolism and excretion with some focus on energy metabolism.

**Objective**
To introduce the students to the both macro- and micronutrients in relation to food and metabolism.

**Content**
The course is devided into two parts. The lectures on micronutrients are given by Prof. Zimmermann and the lectures on macronutrients are given by Prof. Wolfrum. Prof. Zimmermann discusses the micronutrients, including fat-soluble vitamins, water-soluble vitamins, minerals and trace elements. Prof. Wolfrum introduces basic nutritional aspects of proteins, fats, carbohydrates and energy metabolism. The nutrients are described in relation to digestion, absorption and metabolism. Special aspects of homeostasis and homeorhesis are emphasized.

**Lecture notes**
There is no script. Powerpoint presentations will be made available.

**Literature**


### 752-6101-00L Dietary Etiologies of Chronic Disease

**Abstract**
To have the students gain understanding of the links between the diet and the etiology and progression of chronic diseases, including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

**Objective**
To examine and understand the protective effect of foods and food ingredients in the maintenance of health and the prevention of chronic disease, as well as the progression of complications of the chronic diseases.

**Content**
The course evaluates food and food ingredients in relation to primary and secondary prevention of chronic diseases including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

**Lecture notes**
There is no script. Powerpoint presentations will be made available on-line to students.

**Literature**
To be provided by the individual lecturers, at their discretion.

**Prerequisites / notice**
No compulsory prerequisites, but prior completion of Human Nutrition I + II (Humanernährung I+II) is strongly advised.

### 752-6105-00L Epidemiology and Prevention

**Information for UZH students:**
Enrolment to this course unit only possible at ETH. No enrolment to module CS16_101 at UZH.

Please mind the ETH enrolment deadlines for UZH students: https://www.ethz.ch/en/studies/non-degree-courses/special-students-university-of-zurich.html

**Abstract**
The module Epidemiology and prevention describes the process of scientific discovery from the detection of a disease and its causes, to the development and evaluation of preventive and treatment interventions and to improved population health.

**Objective**
The overall goal of the course is to introduce students to epidemiological thinking and methods, which are critical pillars for medical and public health research. Students will also become aware on how epidemiological facts are used in prevention, practice and politics.

**Content**
The module Epidemiology and prevention follows an overall framework that describes the course of scientific discovery from the detection of a disease to the development of prevention and treatment interventions and their evaluation in clinical trials and real world settings. We will discuss study designs in the context of existing knowledge and the type of evidence needed to advance knowledge. Examples from nutrition, chronic and infectious diseases will be used in order to show the underlying concepts and methods.

### 752-6151-00L Public Health Concepts

**Abstract**
The module "public health concepts" offers an introduction to key principles of public health. Students get acquainted with the concepts and methods of epidemiology. Students also learn to use epidemiological data for prevention and health promotion purposes. Public health concepts and intervention strategies are presented, using examples from infectious and chronic diseases.

**Objective**
At the end of this module students are able:
- to interpret the results of epidemiological studies
- to critically assess scientific literature
- to know the definition, dimensions and determinants of health
- to plan public health interventions and health promotion projects

**Content**
Concepts of descriptive and analytical epidemiology, study designs, measures of effect, confounding and bias, screening, surveillance, definition of health and health promotion, health dimensions and health determinants, prevention strategies, public health interventions, public health action cycle, epidemiology and prevention of infectious and chronic diseases (HIV, Tuberculosis, Obesity, Public health nutrition).

**Lecture notes**
Handouts are provided to students in the classroom.

**Prerequisites / notice**
Language of the course is english
To understand the potential effects of nutrition on exercise performance, with a focus on concepts and principles of nutrition before, during and after exercise.

The course will cover elementary aspects of sports nutrition physiology, including carbohydrate, glycogen, fat, protein and energy metabolism. A main focus will be to understand nutritional aspects before exercise to be prepared for intensive exercise bouts, how exercise performance can be supported by nutrition during exercise and how recovery can be assisted by nutrition after exercise. Although this is a scientific course, it is a goal of the course to translate basic sports nutrition science into practical sports nutrition examples.

The course is designed for 3rd year Bachelor students, Master students and postgraduate students (MAS/CAS).

Language: English

It is strongly recommended to attend the lectures. The lecture (including the handouts) is not designed for distance education.

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<thead>
<tr>
<th>Number</th>
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<tbody>
<tr>
<td>557-1012-00L</td>
<td>Leadership I</td>
<td>W</td>
<td>3 credits</td>
<td>2V</td>
<td>F. Kernic</td>
</tr>
<tr>
<td>Abstract</td>
<td>The lectures &quot;Leadership I&quot; (WS) and &quot;Leadership II&quot; (SS) have been designed as a two-semester lecture series, but may also be followed independently of one another or in reverse order. &quot;Leadership I&quot; covers the following fields: leadership basics, leadership theories and leadership styles, the concept of leadership responsibility and the role of communication in practical leadership.</td>
<td></td>
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<td></td>
<td>E. de Bruin</td>
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<tr>
<td>Objective</td>
<td>The aim of this lecture is to give students an introductory overview of relevant topics regarding leadership research and practice, thus enabling them to gain a deeper understanding of the leadership phenomenon. Students should understand different concepts of leadership in the complex interaction between individuals, groups, organisation, context and situation. They should be informed about the evolution of the understanding of mankind in relation to working processes and its impact on organizations and the understanding of leadership theory in the past 100 years. They should grasp the concept of leadership responsibility (leadership ethics) and be able to derive consequences for leadership in practical situations. They should recognize the fundamental importance of communication in leadership situations and receive input which enables them to communicate adequately in specific situations.</td>
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</table>

| Prerequisites / notice | The 1-hour written exam will take place during the last lecture in the semester. |      |       |       |                 |

Practical Training

<table>
<thead>
<tr>
<th>Number</th>
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<th>ECTS</th>
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<tbody>
<tr>
<td>557-1012-00L</td>
<td>Practical Training II</td>
<td>O</td>
<td>15 credits</td>
<td>15P</td>
<td>E. de Bruin</td>
</tr>
<tr>
<td>Abstract</td>
<td>3-months practical work with topics from the major exercise in movement and training doctrines.</td>
<td></td>
<td></td>
<td></td>
<td>E. de Bruin</td>
</tr>
<tr>
<td>Objective</td>
<td>The students should obtain practical experience of 3 month length in possible job environments. The selected places (internal or external) should be as close as possible by the major exercise in movement and training doctrines.</td>
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</thead>
<tbody>
<tr>
<td>557-1011-00L</td>
<td>Practical Training I</td>
<td>O</td>
<td>15 credits</td>
<td>15P</td>
<td>E. de Bruin</td>
</tr>
<tr>
<td>Abstract</td>
<td>3-months practical work with topics from the major exercise in movement and training doctrines.</td>
<td></td>
<td></td>
<td></td>
<td>E. de Bruin</td>
</tr>
<tr>
<td>Objective</td>
<td>The students should obtain practical experience of 3 month length in possible job environments. The selected places (internal or external) should be as close as possible by the major exercise in movement and training doctrines.</td>
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Master's Thesis

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<tr>
<th>Number</th>
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<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>557-1100-00L</td>
<td>Master's Thesis I</td>
<td>O</td>
<td>30 credits</td>
<td>30D</td>
<td>E. de Bruin</td>
</tr>
<tr>
<td>Abstract</td>
<td>Only students who fulfill the following criteria are allowed to begin with their master thesis: a. successful completion of the bachelor programme; b. fulfilling of any additional requirements necessary to gain admission to the master programme.</td>
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<tr>
<td>Objective</td>
<td>6-months research study with topics from the major exercise in movement and training doctrines.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>The student shall apply his basic knowledge in a practical scientific study. He/she will be confronted with the requirements of scientific working. He/she must master these requirements.</td>
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Major in Biomechanics

Compulsory Subjects

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>376-1651-00L</td>
<td>Clinical and Movement Biomechanics</td>
<td>O</td>
<td>4 credits</td>
<td>3G</td>
<td>S. Lorenzetti, R. List, N. Singh</td>
</tr>
<tr>
<td>Abstract</td>
<td>Measurement and modeling of the human movement during daily activities and in a clinical environment;</td>
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<tr>
<td>Objective</td>
<td>The students are able to analyse the human movement from a technical point of view, to process the data and perform modeling with a focus towards clinical application.</td>
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<tr>
<td>Content</td>
<td>This course includes study design, measurement techniques, clinical testing, accessing movement data and anysis as well as modeling with regards to human movement.</td>
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Electives

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>151-0503-00L</td>
<td>Dynamics</td>
<td>W</td>
<td>6 credits</td>
<td>4V+2U</td>
<td>G. Halier, P. Tiso</td>
</tr>
<tr>
<td>Abstract</td>
<td>Kinematics, dynamics and oscillations: Motion of a single particle - Motion of systems of particles - 2D and 3D motion of rigid bodies.</td>
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Autumn Semester 2016

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This course provides Bachelor students of mechanical engineering with fundamental knowledge of kinematics and dynamics of mechanical systems. By studying motion of a single particle, systems of particles and rigid bodies, we introduce essential concepts such as work and energy, equations of motion, and forces and torques. Further topics include stability of equilibria and vibrations. Examples presented in the lectures and weekly exercise lessons help students learn basic techniques that are necessary for advanced courses and work on engineering applications.

Lecture notes
Hand-written slides will be downloadable after each lecture.

Abstract
Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The course provides an overview of the various topics of the different tracks of the biomedical engineering master course and helps orienting the students in selecting their specialized classes and project locations.

Content

Literature
Hand-written slides from the previous year

Prerequisites / notice
Please log in to moodle (https://moodle-app2.let.ethz.ch/auth/shibboleth/login.php), search for "Dynamics", and join the course there. All exercises sheets, lecture materials etc. will be uploaded there.

Objective
To understand the physical and technical principles underlying X-ray imaging, computed tomography, single photon and positron emission tomography, magnetic resonance imaging, ultrasound and Doppler imaging techniques. The mathematical framework is developed to describe image encoding/decoding, point-spread function/modular transfer function, signal-to-noise ratio, contrast behavior for each of the methods. Matlab exercises are used to implement and study basic concepts.

Content
- X-ray imaging - Computed tomography - Single photon emission tomography - Positron emission tomography - Magnetic resonance imaging - Ultrasound/Doppler imaging

Lecture notes
Lecture notes and handouts

Literature
Webb A, Smith N.B. Introduction to Medical Imaging: Physics, Engineering and Clinical Applications; Cambridge University Press 2011

Prerequisites / notice
Analysis, Linear Algebra, Physics, Basics of Signal Theory, Basic skills in Matlab programming
Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

Abstract
This course focuses on basic aspects of central nervous system physiology, including perception, motor control and cognitive functions.

Objective
To understand the basic concepts underlying perceptual, motor and cognitive functions.

Content
Main emphasis sensory systems, with complements on motor and cognitive functions.

Lecture notes
None

Literature
"Principles of Neural Science", Kandel, Schwartz, and Jessel

Prerequisites / notice
none

363-0790-00L Technology Entrepreneurship
Objective
This course provides theory-grounded knowledge and practice-driven skills for founding, financing, and growing new technology ventures. A critical understanding of dos and don'ts is provided through highlighting and discussing real life examples and cases.

Content
See course website: http://www.entrepreneurship.ethz.ch/sresources/courses/tech-entrepreneurship.html

Lecture notes
Lecture slides and case material

376-1219-00L Rehabilitation Engineering II: Rehabilitation of Sensory and Vegetative Functions
Objective
Provide knowledge on the anatomy and physiology of the human sensory system, related dysfunctions and pathologies, and how rehabilitation engineering can provide sensory restoration and substitution.

Content
This lecture is independent from Rehabilitation Engineering I. Thus, both lectures can be visited in arbitrary order.

Rehabilitation Engineering II: Rehabilitation of Sensory and Vegetative Functions

Abstract
Rehabilitation engineering is the application of science and technology to ameliorate the handicaps of individuals with disabilities to reintegrate them into society. The goal is to present classical and new rehabilitation engineering principles applied to compensate or enhance motor, sensory, and cognitive deficits. Focus is on the restoration and treatment of the human sensory and vegetative system.

Introduction, problem definition, overview
Rehabilitation of visual function
- Anatomy and physiology of the visual sense
- Technical aids (glasses, sensor substitution)
- Retina and cortex implants
Rehabilitation of hearing function
- Anatomy and physiology of the auditory sense
- Hearing aids
- Cochlea implants
Rehabilitation and use of kinesthetic and tactile function
- Rehabilitation strategies and devices (e.g. BrainPort)
- Anatomical and physiology of the kinesthetic and tactile sense
- Tactile/haptic displays for motion therapy (incl. electrical stimulation)
- Role of displays in motor learning
Rehabilitation of vestibular function
- Anatomy and physiology of the vestibular sense
- Rehabilitation strategies and devices (e.g. BrainPort)
- Rehabilitation of vegetative Functions
- Cardiac Pacemaker
- Phrenic stimulation, artificial breathing aids
- Bladder stimulation, artificial sphincter
Brain stimulation and recording
- Deep brain stimulation for patients with Parkinson, epilepsy, depression
- Brain-Computer Interfaces
Literature

Introductory Books:


Selected Journal Articles and Web Links:


Prequisites / notice

Target Group:
- Students of higher semesters and PhD students of
- D-MAVT, D-ITET, D-INFK, D-HEST
- Biomedical Engineering, Robotics, Systems and Control
- Medical Faculty, University of Zurich

Students of other departments, faculties, courses are also welcome

This lecture is independent from Rehabilitation Engineering I. Thus, both lectures can be visited in arbitrary order.

376-1714-00L | 3G | K. Maniura, J. Möller, M. Zenobi-Wong | 4 credits | 4 credits

| 376-1714-00L | 3G | K. Maniura, J. Möller, M. Zenobi-Wong | 4 credits | 4 credits

Abstract

Introduction to molecules used for biomaterials, molecular interactions between different materials and biological systems (molecules, cells, tissues). The concept of biocompatibility is discussed and important techniques from biomaterials research and development are introduced.

Objective

The class consists of three parts:
1. Introduction into molecular characteristics of molecules involved in the materials-to-biology interface. Molecular design of biomaterials.
2. The concept of biocompatibility.
3. Introduction into methodology used in biomaterials research and application.

Content

Introduction into native and polymeric biomaterials used for medical applications. The concepts of biocompatibility, biodegradation and the consequences of degradation products are discussed on the molecular level. Different classes of materials with respect to potential applications in tissue engineering and drug delivery are introduced. Strong focus lies on the molecular interactions between materials having very different bulk and/or surface chemistry with living cells, tissues and organs. In particular the interface between the materials surfaces and the eukaryotic cell surface and possible reactions of the cells with an implant material are elucidated. Techniques to design, produce and characterize materials in vitro as well as in vivo analysis of implanted and explanted materials are discussed.

In addition, a link between academic research and industrial entrepreneurship is established by external guest speakers.

Lecture notes

Handouts can be accessed online.
### Bioinformatics I

I will cover the following topics:

- Getting insight into actual areas and problems of biomechanics.
- Principles of experimental design.
  - One-way analysis of variance.
  - Multi-factor experiments and analysis of variance.
  - Block designs.
  - Latin squares.

#### Colloquium in Biomechanics

<table>
<thead>
<tr>
<th>W</th>
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<th>2K</th>
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<tbody>
<tr>
<td>W</td>
<td>2 credits</td>
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</table>

**B. Helgason, S. J. Ferguson, R. Müller, J. G. Snedeker, B. Taylor, K. Würtz-Kozak, M. Zenobi-Wong**

**Studentenverband Schweizerischer Gesellschaft für Biomechanik (SSGB)**

**Handouts provided during the classes and references therein.**

#### Trauma Biomechanics

<table>
<thead>
<tr>
<th>W</th>
<th>Credits</th>
<th>2V+1U</th>
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</thead>
<tbody>
<tr>
<td>W</td>
<td>4 credits</td>
<td>2V+1U</td>
</tr>
</tbody>
</table>

**K.U. Schmitt, M. H. Muser**

**Abstract**

Current topics in biomechanics presented by speakers from academia and industry.

**Objective**

Getting insight into current areas and problems of biomechanics.

---

### Biomechanics of Sports Injuries and Rehabilitation

<table>
<thead>
<tr>
<th>W</th>
<th>Credits</th>
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</tr>
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<tbody>
<tr>
<td>W</td>
<td>3 credits</td>
<td>2V</td>
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</table>

**K.U. Schmitt, J. Goldhahn**

**Abstract**

This lecture introduces the basic principles of injury biomechanics and rehabilitation focussing on sports injuries.

**Objective**

Within the scope of this lecture you will learn the basic principles of trauma biomechanics. Based on examples from sports, you will get to know different mechanisms that can possibly result in injury. Investigating the background and cause of injury should allow you to assess the injury risk for sports activities. Furthermore you should be able to develop measures to prevent such injury.

**Content**

This lecture deals with the basic principles of injury biomechanics and rehabilitation. Mechanisms that can result in injury are presented. Furthermore possibilities to prevent injuries are discussed. Thereby the lecture focuses on sports injuries.

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### Applied Analysis of Variance and Experimental Design

<table>
<thead>
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<tbody>
<tr>
<td>W</td>
<td>5 credits</td>
<td>2V+1U</td>
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</table>

**L. Meier**

**Abstract**


**Objective**

Participants will be able to plan and analyze efficient experiments in the fields of natural sciences. They will gain practical experience by using the software R.

**Content**


**Literature**


**Prerequisites / notice**

The exercises, but also the classes will be based on procedures from the freely available, open-source statistical software R, for which an introduction will be held.

---

### Introduction to Bioinformatics: Concepts and Applications

<table>
<thead>
<tr>
<th>W</th>
<th>Credits</th>
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<tbody>
<tr>
<td>W</td>
<td>6 credits</td>
<td>4G</td>
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</table>

**W. Gruissem, K. Bärenfaller, A. Caflisch, G. Capitani, J. Fütterer, M. Robinson, A. Wagner**

**Abstract**

Storage, handling and analysis of large datasets have become essential in biological research. The course will introduce students to a number of applications of bioinformatics in biology. Freely accessible software tools and databases will be explained and explored in theory and praxis.

**Objective**

Introduction to Bioinformatics I: Concepts and Applications (formerly Bioinformatics I) will provide students with the theoretical background of approaches to store and retrieve information from large databases. Concepts will be developed how DNA sequence information can be used to understand phylogenetic relationships, how RNA sequence relates to structure, and how protein sequence information can be used for genome annotation and to predict protein folding and structure. Students will be introduced to quantitative methods for measuring gene expression and how this information can be used to model gene networks. Methods will be discussed to construct protein interaction maps and how this information can be used to simulate dynamic molecular networks.

In addition to the theoretical background, the students will develop hands-on experiences with the bioinformatics methods through guided exercises. The course provides students from different backgrounds with basic training in bioinformatics approaches that have impact on biological, chemical and physics experimentation. Bioinformatics approaches draw significant expertise from mathematics, statistics and computational science.

Although "Introduction to Bioinformatics I" will focus on theory and praxis of bioinformatics approaches, the course provides an important foundation for the course "Introduction to Bioinformatics II: Fundamentals of computer science, modeling and algorithms" that will be offered in the following semester.

**Content**

Bioinformatics I will cover the following topics:

- From genes to databases and information
- BLAST searches
- Prediction of gene function and regulation
- RNA structure prediction
- Gene expression analysis using microarrays
- Protein sequence and structure databases
- WWW for bioinformatics
- Protein sequence comparisons
- Proteomics and de novo protein sequencing
- Protein structure prediction
- Cellular and protein interaction networks
- Molecular dynamics simulation

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**Autumn Semester 2016**
Practical Training

<table>
<thead>
<tr>
<th>Number</th>
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<tr>
<td>557-2010-00L</td>
<td>Practical Training I</td>
<td>O</td>
<td>15</td>
<td>15P</td>
<td>S. Lorenzetti</td>
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<tr>
<td>Abstract</td>
<td>3-months practical work with topics from the major exercise biomechanics.</td>
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<tr>
<td>Objective</td>
<td>3-months practical work with topics from the major exercise biomechanics.</td>
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<tr>
<td>557-2011-00L</td>
<td>Practical Training II</td>
<td>O</td>
<td>15</td>
<td>15P</td>
<td>S. Lorenzetti</td>
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<tr>
<td>Abstract</td>
<td>3-months practical work with topics from the major exercise biomechanics.</td>
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<tr>
<td>Objective</td>
<td>3-months practical work with topics from the major exercise biomechanics.</td>
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Master's Thesis

<table>
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<tr>
<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>557-2100-00L</td>
<td>Master's Thesis</td>
<td>O</td>
<td>30</td>
<td>30D</td>
<td>B. Taylor</td>
</tr>
</tbody>
</table>
| Abstract     | Only students who fulfill the following criteria are allowed to begin with their master thesis:  
a. successful completion of the bachelor programme;  
b. fulfilling of any additional requirements necessary to gain admission to the master programme.  

Objective | The thesis is the final work of the Master program. It promotes the students abilities to develop and solve a research problem independently, structured under methodological considerations. The thesis is based on the studies of Bachelor program and the lectures of the Master Program. |

Literature | Webb A, Smith N.B. Introduction to Medical Imaging: Physics, Engineering and Clinical Applications; Cambridge University Press 2011 |

Prerequisites / notice | Analysis, Linear Algebra, Physics, Basics of Signal Theory, Basic skills in Matlab programming |

Electives

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>227-0385-10L</td>
<td>Biomedical Imaging</td>
<td>W</td>
<td>6</td>
<td>5G</td>
<td>S. Kozerke, K. Prüssmann, M. Rudin</td>
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<tr>
<td>Abstract</td>
<td>Introduction and analysis of medical imaging technology including X-ray procedures, computed tomography, nuclear imaging techniques using single photon and positron emission tomography, magnetic resonance imaging and ultrasound imaging techniques.</td>
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<tr>
<td>Objective</td>
<td>To understand the physical and technical principles underlying X-ray imaging, computed tomography, single photon and positron emission tomography, magnetic resonance imaging, ultrasound and Doppler imaging techniques. The mathematical framework is developed to describe image encoding/decoding, point-spread function/modular transfer function, signal-to-noise ratio, contrast behavior for each of the methods. Matlab exercises are used to implement and study basic concepts.</td>
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</tbody>
</table>
| Content      | - X-ray imaging  
- Computed tomography  
- Single photon emission tomography  
- Positron emission tomography  
- Magnetic resonance imaging  
- Ultrasound/Doppler imaging |
| Prerequisites / notice | Analysis, Linear Algebra, Physics, Basics of Signal Theory, Basic skills in Matlab programming |

227-0386-00L | Biomedical Engineering                   | W    | 4    | 3G    | J. Váróas, S. J. Ferguson, S. Kozerke, U. Moser, M. Rudin, M. P. Wolf, M. Zenobi-Wong |
| Abstract     | Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The focus is on learning the concepts that govern common medical instruments and the most important organs from an engineering point of view. In addition, the most recent achievements and trends of the field of biomedical engineering are also outlined. |
| Objective    | Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The course provides an overview of the various topics of the different tracks of the biomedical engineering master course and helps orienting the students in selecting their specialized classes and project locations. |
| Lecture notes | Introduction to Biomedical Engineering by Enderle, Banchard, and Bronzino AND https://www1.ethz.ch/tlb/education/BME |

227-1051-00L | Systems Neuroscience (University of Zurich) | W    | 6    | 2V+1U | D. Kiper |
| Notice       | No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: INI415 |
| Abstract     | This course focuses on basic aspects of central nervous system physiology, including perception, motor control and cognitive functions. |
| Objective    | To understand the basic concepts underlying perceptual, motor and cognitive functions. |
| Content      | Main emphasis sensory systems, with complements on motor and cognitive functions. |
| Lecture notes | None |
This course provides theory-grounded knowledge and practice-driven skills for founding, financing, and growing new technology ventures. This course will prepare students for experimental work as it is typically done during the master thesis. The goal is to gain hands-on experience in exercise physiology and consolidate knowledge on physiological adaptations to different types and degrees of physical activity and climatic influences. Conduct physical performance tests and measurements that are typically used to assess performance of athletes and/or patients and that are performed either in small groups or individually. Students will have to solve scientific problems, requiring them to independently study scientific material, apply statistics and report their knowledge will be tested (central element) in the second course week. Passing this test is a requirement for continuing the course. Knowledge of applied statistics will be available at the beginning of the course and statistical success factors in the creation of new firms, including founding, financing and growing a venture. A critical understanding of dos and don'ts is provided through highlighting and discussing real life examples and cases. Technology ventures are significantly changing the global economic picture. Technological skills increasingly need to be complemented by entrepreneurial understanding. The course offers the fundamentals in theory and practice of entrepreneurship in new technology ventures. Main topics covered are success factors in the creation of new firms, including founding, financing and growing a venture. See course website: http://www.entrepreneurship.ethz.ch/sresources/courses/tech-entrepreneurship.html

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Type</th>
<th>Credits</th>
<th>Lecture notes</th>
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</thead>
<tbody>
<tr>
<td>363-0301-00L</td>
<td>Work Design and Organizational Change W 3 credits 2G G. Grote</td>
<td>W</td>
<td>3 credits</td>
<td>Lecture slides and case material</td>
</tr>
</tbody>
</table>

**Abstract**
Good work design is crucial for individual and company effectiveness and a core element to be considered in organizational change. Meaning of work, organization-technology interaction, and uncertainty management are discussed with respect to work design and sustainable organizational change. As course project, students learn and apply a method for analyzing and designing work in business settings.

**Objective**
- Know effects of work design on competence, motivation, and well-being
- Understand links between design of individual jobs and work processes
- Know basic processes involved in systematic organizational change
- Understand the interaction between organization and technology and its impact on organizational change
- Understand relevance of work design for company performance and strategy
- Know and apply methods for analyzing and designing work

**Content**
- Work design: From Adam Smith to job crafting
- Effects of work design on performance and well-being
- Approaches to analyzing and designing work
- Modes of organizational change and change methods
- Balancing stability and flexibility in organizations as design criterium
- The organization-technology interaction and its impact on work design and organizational change
- Example Flexible working arrangements
- Strategic choices for work design

**Literature**
A list of required readings will be provided at the beginning of the course.

**Prerequisites / notice**
The course includes the completion of a course project to be conducted in groups of four students. The project entails applying a particular method for analyzing and designing work processes and is carried out by means of interviews and observations in companies chosen by the students.

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**Course Code** 363-0790-00L

**Course Title** Technology Entrepreneurship

**Abstract**
Technology ventures are significantly changing the global economic picture. Technological skills increasingly need to be complemented by entrepreneurial understanding. This course offers the fundamentals in theory and practice of entrepreneurship in new technology ventures. Main topics covered are success factors in the creation of new firms, including founding, financing and growing a venture.

**Objective**
This course provides theory-grounded knowledge and practice-driven skills for founding, financing, and growing new technology ventures. A critical understanding of dos and don'ts is provided through highlighting and discussing real life examples and cases.

**Content**
See course website: http://www.entrepreneurship.ethz.ch/sresources/courses/tech-entrepreneurship.html

**Lecture notes**
Lecture slides and case material

---

**Course Code** 376-0130-00L

**Course Title** Laboratory Course in Exercise Physiology

**Abstract**
Conduct physical performance tests and measurements that are typically used to assess performance of athletes and/or patients and that deepen the understanding of physiological processes in response to physical exertion.

**Objective**
Gain hands-on experience in exercise physiology and consolidate knowledge on physiological adaptations to different types and degrees of physical activity and climatic influences. Learn fundamental assessment techniques of the muscular system, the cardio-respiratory system and of whole-body performance, learn scientifically correct data analysis and interpretation of results. Insight into today's Sports Medicine.

**Content**
Laboratory course:
Various exercise tests assessing human performance and assessments of physiological responses to activity (examples are VO2max-test, Conconi-Tests, Determination of anaerobic threshold, Cooper-Test, 1-repetition maximum test, lactate minimum test), dynamometry, mechanography, body composition etc.). Insight into measurements in Sports Medicine.

**Lecture notes**
Tutorial on Laboratory Experiments in Exercise Physiology (Editor: Exercise Physiology Lab)

**Literature**
Schmidt/Lang/Heckmann: Physiologie des Menschen, Springer-Verlag, Heidelberg

**Prerequisites / notice**
Prequisite: Anatomy and physiology classes and lab course in physiology successfully completed (BWS students please contact C. M. Spengler)
Desirable: Exercise Physiology Lecture (concomitantly or passed; is selection criterion in case of more applications than lab spaces)

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**Course Code** 376-0221-00L

**Course Title** Methods and Concepts in Human Systems Neuroscience and Motor Control

**Abstract**
This course provides hands-on experience with measurement and analysis methods relevant for Humans Systems Neuroscience and Motor control (nerve/brain stimulation, EMG, EEG, psycho-physical paradigms etc). Students read scientific material, set up experiments, perform measurements in the lab, analyse data, apply statistics and write short reports or essays.

**Objective**
This course will prepare students for experimental work as it is typically done during the master thesis. The goal is to gain hands-on experience with measurement and analysis methods relevant for Humans Systems Neuroscience and Motor control (for example peripheral nerve stimulation, electrical and magnetic brain stimulation, EMG, EEG, psycho-physical paradigms etc). Students will learn how to perform small scientific projects in this area. Students will work individually in small groups and solve scientific problems which require them to perform measurements in human participants, extract relevant readouts from the data, apply appropriate statistics and interpret the results. They will also be required to write small essays and reports and they will get feedback on their writing throughout the course.

**Prerequisites / notice**
Students are required to have successfully completed the course "Neural control of movement and motor learning" and to have basic knowledge of applied statistics. Self-study material about applied statistics will be available at the beginning of the course and statistical knowledge will be tested (central element) in the second course week. Passing this test is a requirement for continuing the course.

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**Course Code** 376-0225-00L

**Course Title** Physical Activities and Health

**Abstract**
This course provides theory-grounded knowledge and practice-driven skills for founding, financing, and growing new technology ventures. This course will prepare students for experimental work as it is typically done during the master thesis. The goal is to gain hands-on experience in exercise physiology and consolidate knowledge on physiological adaptations to different types and degrees of physical activity and climatic influences. Conduct physical performance tests and measurements that are typically used to assess performance of athletes and/or patients and that are performed either in small groups or individually.
This course introduces/explores the complex relationship between physical activity, sedentary behavior and health. It will discuss the evolution of current physical activity recommendations. It will examine the current evidence base that has informed physical activity recommendations and that identified physical activity as a key modifiable lifestyle behavior contributing to disease and mortality.

Objective

On completion of this course students will be able to demonstrate:
1. knowledge of and critical awareness of the role of physical activity and sedentary behavior in the maintenance of health and the etiology, prevention and treatment of disease.
2. thorough knowledge and critical awareness of current recommendations for physical activity, and current prevalence and trends of physical activity and associated diseases.
3. awareness of current national and international physical activity policies and how these impact on global challenges.

Content

Introduction to Physical Activity for Health, including sedentary behavior

- Physical activity epidemiology; concepts principles and approaches
- Physical activity and all cause morbidity and mortality
- Physical activity and chronic disease; Coronary heart disease, diabetes, bone health, cancer and obesity
- Physical activity and brain health
- Physical activity and sedentary behavior recommendations
- Population prevalence of physical activity and sedentary behavior
- Physical activity policies
- Physical activity assessment

Literature

Core texts for this course are:


Selective journal articles from relevant journals such as Journal of Physical Activity and Health and Journal of Aging and Physical Activity

Prerequisites / notice

From the BSc-course the following book is recommended: ‘Essentials of strength training and conditioning’ T. Baechle, R. Earle (3rd Edition)

<table>
<thead>
<tr>
<th>376-1033-00L</th>
<th>History of Sports</th>
<th>W</th>
<th>2 credits</th>
<th>2V</th>
<th>M. Gisler</th>
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</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>Comprehension for development and changes of sports from the ancient world to the presence. Description of sports in services of national idea, from education and health promotion from the middle of the 18th century till this day.</td>
<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>Understanding for the development and adaptation of sports from the ancient world to present times.</td>
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<tr>
<td>Lecture notes</td>
<td>Ein Skript für die aktuelle Veranstaltung wird abgegeben.</td>
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<table>
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<tr>
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<th>2 credits</th>
<th>2V</th>
<th>D. Seiler Hubler</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>Central aspects of Sport related pedagogy will be handled in these lectures. These aspects cover, amongst others, the subject and tasks of Sport related pedagogy. Furthermore, the general and sports relevant foundations of Sport related pedagogy will be covered.</td>
<td></td>
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<tr>
<td>Objective</td>
<td>To gain basic knowledge of sports pedagogy and to recognize starting points for applied sports pedagogical intervention in schools.</td>
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<tr>
<td>Lecture notes</td>
<td>Unterrichtsmaterialien zu den einzelnen Veranstaltungen werden den Studierenden zur Verfügung gestellt.</td>
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<table>
<thead>
<tr>
<th>376-1117-00L</th>
<th>Sport Psychology</th>
<th>W</th>
<th>2 credits</th>
<th>2V</th>
<th>H. Gubelmann</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>This lecture is intended as an introduction to sport psychology and imparts knowledge on selected areas of the subject.</td>
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<tr>
<td>Objective</td>
<td>Students are given insight into different work areas of sport psychology. In order to understand what »sport psychology« is, it is necessary to explain the essence and tasks of sport psychology and what it relates to, and to work out an underlying basis for key topics, such as cognition and emotions. Students' expertise is furthered by presenting and providing more in-depth treatment of additional topics of sport psychology. Selected intervention forms are intended to provide insight into applied sport psychology and ensure that mental processes and their impact in sport can be recognised. Case studies and practical exercises (e.g. objective training) are intended to prompt students to reflect to a greater extent on the forms in which sport psychology can be applied in their practice of sports and to integrate these in their teaching.</td>
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<tr>
<td>Content</td>
<td>Main Topics - Introduction to sport psychology - Cognitions in sports: mental rehearsal and mental training - Emotions and stress - Motivation: goal-setting in sports - Career and career transition in elite sport - Coach-Athlete-Interaction - Psychological aspects of sport-injury rehabilitation - Group dynamics in sport</td>
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<tr>
<td>Lecture notes</td>
<td>Unterrichtsmaterialien zu den einzelnen Veranstaltungen werden den Studierenden zur Verfügung gestellt.</td>
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<table>
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<tr>
<th>376-1127-00L</th>
<th>Sociology of Sport</th>
<th>W</th>
<th>2 credits</th>
<th>2V</th>
<th>M. Lamprecht</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>These lectures deal with the current changes in society and sport and provide an overview of the many different problems and perspectives of sport sociology.</td>
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<tr>
<td>Objective</td>
<td>The lectures set out to: - present the different dimensions, functions and interrelationships of present-day sport - provide an introduction to the central theories and models of (sport) sociology - show how far sport reflects society and how it changes and becomes more differentiated in the process - take current examples from newspapers, magazines and television to highlight the sociological view of sport.</td>
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</table>
The course covers the structure, plasticity and regeneration of the adult nervous system (NS) with focus on:

- sensory systems,
- cognitive functions,
- learning and memory,
- molecular and cellular mechanisms,
- animal models, and
- diseases of the NS.

The main focus is on the development of the NS: Early development of the NS, cellular processes, nerve fiber growth, building of synapses and neuronal networks.

Selected materials for the lecture are available under www.LSSFB.ch --> Lehre, further lecturers.

- Y.Y. Hedinger Huang, R. Huang
- M. Siegrist

Content
- Sport and social change: developments and trends
- The economy and the media: dependencies, consequences, scandals
- Social inequalities and distinctions: gender differences and group behavior
- Conflicts and politics: sports organizations, doping, violence

Lecture notes
- Selected materials for the lecture are available under www.LSSFB.ch --> Lehre

A detailed program with additional references will be delivered at the beginning of the lecture.

376-1155-00L

The Musculoskeletal System and Work

Abstract
- Consolidated findings of movement sciences concerning deterioration, overload and regeneration of the musculoskeletal system are an important basis for an ergonomic working environment. The following topics are covered: Muscle fatigue during the 8-hour day, use of the computer mouse, backaches, Tendinitis, nerve compression, epidemiology, prevention, rehabilitation, laws, measuring procedures.

Objective
- Goal of the course is the activation of physiological and patho-physiological insights for the understanding of loads of the musculoskeletal system and its ability to work. Prevention and revised with the help of a bio-psycho-social model. Furthermore, evidence based methods for a healthy work design will be presented.

Content
- Insights of human movement sciences concerning wear, overstraining and regeneration of the musculoskeletal system form an important base for an ergonomic work design. The following topics will be covered: Muscle fatigue in an 8-hours-day, mouse appliance, back pain, insertion tendinitis, nerve compression, epidemiology, prevention, rehabilitation, laws, and measurement methods.

Lecture notes
- Skript und Folien auf NETZ als PDF-Datei zur Verfügung
- Further textbooks are introduced in the lecture
- Auxiliary tools: None. Bring something to write and your student ID

Literature
- Gavriel Salvendy, Handbook of Human Factors and Ergonomics, 4th edition (2012), is available on NEBIS as electronic version and for free to ETH students
- Further textbooks are introduced in the lecture
- Brouchures, checklists, key articles etc. are uploaded in ILIAS

376-1177-00L

Human Factors I

Abstract
- Every day humans interact with various systems. Strategies of interaction, individual needs, physical & mental abilities, and system properties are important factors in controlling the quality and performance in interaction processes. In the lecture, factors are investigated by basic scientific approaches. Discussed topics are important for optimizing people's satisfaction & overall performance.

Objective
- The goal of the lecture is to empower students in better understanding the applied theories, principles, and methods in various applications. Students are expected to learn how to analyze and optimize the efficiency and acceptance of interfaces between human and the environment, considering costs, benefits, health, and safety as well. Thus, an ergonomic design and evaluation process of products, tasks, and environments may be promoted in different disciplines. The goal is achieved in addressing a broad variety of topics and embedding the discussion in macroscopic factors such as the behavior of consumers and objectives of economy.

Content
- Physiological, physical, and cognitive factors in sensation and perception
- Body spaces and functional anthropometry, Dimensional Human Models
- Experimental techniques in assessing human performance and well-being
- Human factors and ergonomics in systems designs, product development and innovation
- Human information processing and biological cybernetics
- Interaction among consumers, environments, behavior, and tasks

Literature
- Gavriel Salvendy, Handbook of Human Factors and Ergonomics, 4th edition (2012), is available on NEBIS as electronic version and for free to ETH students

376-1179-00L

Applications of Cybernetics in Ergonomics

Abstract
- Cybernetics systems have been studied and applied in various research fields, such as applications in the ergonomics domain. Research interests include the man-machine interaction (MMI) topic which involving the performance in multi-model interactions, quantification in gestalt principles in product development; or the information processing matter.

Objective
- To learn and practice cybernetics principles in interface designs and product development.

Content
- Fitt's law applied in manipulation tasks
- Hick-Hyman law applied in design of the driver assistance systems - Vigilance applied in quality inspection
- Accommodation/vergence crosslink function
- Cross-link models in neurobiology- the ocular motor control system
- Human performance in optimization of production lines

Literature

376-1305-00L

Development of the Nervous System

Abstract
- The course covers the development of the nervous system (NS) with a focus on neurogenesis and migration, axon growth, synapse formation, mol. & cell. mechanisms, and diseases of the developing NS.

Objective
- The aim is to give a deepened insight on the normal development, of the nervous system based on molecular, cellular and biochemical approaches.

Content
- The main focus is on the development of the NS: Early development of the NS, cellular processes, nerve fiber growth, building of synapses and neuronal networks.

Lecture notes
- Must be downloaded from OLAT: https://www.olat.uzh.ch/olat/dmz/ as BIO344

Literature
- The lecture requires reading of book chapters, handouts and original scientific papers. Further information will be given in the individual lectures and are mentioned on OLAT.

Prerequisites / notice
- None. Bring something to write and your student ID

376-1305-01L

Structure, Plasticity and Repair of the Nervous System

Abstract
- The course covers the structure, plasticity and regeneration of the adult nervous system (NS) with focus on: sensory systems, cognitive functions, learning and memory, molecular and cellular mechanisms, animal models, and diseases of the NS.

Objective
- The aim is to give a deepened insight into the structure, plasticity and regeneration of the nervous system based on molecular, cellular and biochemical approaches.

Content
- The main focus is on the structure, plasticity and regeneration of the NS: biology of the adult nervous system; structural plasticity of the adult nervous system, regeneration and repair: networks and nerve fibers, regeneration, pathological loss of cells.
Lecture notes

ETH students: Lecture notes will be provided on Moodle https://moodle-app2.let.ethz.ch/course/view.php?id=694
 Password will be provided at the beginning of the lecture.

UZH students: Lecture notes will be provided on OLAT: https://www.olat.uzh.ch/olat/dmz/
The lecture requires reading of book chapters, handouts and original scientific papers. Further information will be given in the individual lectures and are mentioned on Moodle / OLAT.

376-1665-00L Training and Coaching I W 3 credits 2G O. Buholzer

Abstract
The combining of training and coaching as in the example of sport analysis, which has an effect on youth training and athlete development

Objective
- To develop basics for a differentiate analyses of sports (model)
- To develop a profile of requirements for specific sports
- To develop competencies of training with youth and talents
- To develop the basics of talent training in theory and practice
- To observe athletes in case studies, make judgments and conclusion

Content
Das Modell der Sportartenanalyse
Die Relevanz der einzelnen Leistungsfaktoren
Das Modell der Wettkampfanalyse
Folgerungen für das Training und Coaching in der Sportart
Folgerungen für das Nachwuchstrainings
Folgerungen für die Athletenauswahl, Athletenbeobachtung und -betreuung
Das Nachwuchss- und Talenttraining (Sichtung, Selektion, Förderung)
Projekte aus der Praxis (Talent- und Nachwuchstrainings)
Praxisinput zum Thema Koordination, motorische Grundbedürfnisse, Kraft und Gesundheit
Praxisbeispiele erarbeiten und planen
Konkrete Athletenbeobachtung

Literature
Leistung diagnostische Verfahren, Stiehler(Konzag/Döbler)
Training fundiert erklärt, Handbuch der Trainingslehre, Ingold Verlag 2006
Das sportliche Talent, W. Joch, Meyer&Meyer Verlag, 2002
Das neue Konditionstrainings, Grosser/Starischka/Zimmermann, blv 2002

Prerequisites /

Planung
Die Planungsunterlagen werden zu Semesterbeginn abgegebenen, sind provisorisch und können vom Dozenten geändert werden.
Die Praxislektionen werden jeweils am Mittwoch von 13.00 - 15.00 abgehalten. Die Termine werden in Absprache festgelegt.
Die Semesterarbeit ist 4 Wochen nach Semesterende abzugeben.

376-1710-00L Basics of Exercise Therapy W 2 credits 2V K. Marschall

Abstract
Prerequisite from the 5th semester on.
Requirement: "Introduction of Exercise Therapy" passed.
Basics of Exercise Therapy:
A: diagnostic, anamnese, diagnostic of movement and fonction, assessments in exercise therapy, diagnostic of experience and behavior in relation to movement
B: biological-medical basics, pathophysiological Basics (internal, orthopedic and psychological deseases.
C: didactic knowledge, Reha-didactic

Objective
Students learn the assessments to plan an exercise-therapy-treatment.
They are able to use them. They're able to integrate biological and medical basics.
They are able to preparate a therapy-session

Content
Grundlagen der Diagnostik, Anamnese, Bewegungsdiagnostik, Funktionsdiagnostik
Sport- und Bewegungstherapeutische Testverfahren
Motorische Basisdiagnostik
Diagnostik bewegungsbezogenen Erlebens und Verhaltens
Biologisch-medicinische Grundlagen
Biomechanik (v.a. Gelenke), Pathophysiologische Grundlagen, Modelle der Methodik und Didaktik, Lektionsplanung

Lecture notes

Literature
- Schüle / Huber: Grundlagen der Sporttherapie, Deutscher Ärzteverlag , Köln 2012
- Deimel et al.: Neue aktive Wege in Prävention und Rehabilitation, Deutscher Ärzteverlag, Köln 2007

Prerequisites /

Planung
Die Planungsunterlagen werden zu Semesterbeginn abgegebenen, sind provisorisch und können vom Dozenten geändert werden.
Die Praxislektionen werden jeweils am Mittwoch von 13.00 - 15.00 abgehalten. Die Termine werden in Absprache festgelegt.
Die Semesterarbeit ist 4 Wochen nach Semesterende abzugeben.

376-1717-00L Practical Basics in Sports and Exercise Therapy W 2 credits 2V B. Spörrli Kälin, B. Keller

Abstract
Prerequisite from the 5th semester on.
Requirement: "Introduction of Exercise Therapy" passed.
Impart knowledge of practical basics of Sports and Exersice Therapy

Objective
The members are able to transform the knowledge from the previous courses in practical situations of Sports and Exercise Therapy. They learn basic aspects to design therapy lessons.
### 376-1720-00L Application of MATLAB in the Human Movement Sciences

- **Objective**: Students will acquire the ability to independently load, plot, and process kinematic, kinetic and electromyographical data using the MATLAB computing environment.

- **Content**: Students will learn to import, process and graphically present experimental data using the MATLAB computing environment. Both the data and the methods of analysis will be typical for experiments in Human Movement Science (i.e. kinematics, kinetics and electromyography).

- **Literature**: During the lecture, several electronically available MATLAB introductions are indicated. Course-specific scripts will be provided by the lecturer.

- **Prerequisites / notice**: A Laptop with MATLAB installed (v2009 or higher) and wireless internet access is mandatory. Two students can share a laptop if necessary. A MATLAB student version can be obtained at Stud-IDES for free.

### 376-1722-00L Spinal Cord Injury and Exercise

- **Prerequisite**: Anatomie and Physiology

- **Objective**: Knowledge of the pathophysiology and the concomitant complications of a spinal cord injury and the consequences for physical exercise and trainability during rehabilitation as well as in recreational and elite sport.

- **Content**: The following issues will be discussed: Epidemiology and etiology of spinal cord injury; complications and consequences of spinal cord injury; trainability/exercise physiology and spinal cord injury; history and organisation of wheelchair sports; elite sport and spinal cord injury rehabilitation.

- **Literature**: General literature:
  - ISBN 3-8055-7980-2

- **Prerequisites / notice**: A course work is required. The mark of this course work contributes to the final credits for this lecture. Details will be given during the first lecture.

### 376-2017-00L Biomechanics of Sports Injuries and Rehabilitation

- **Abstract**: This lecture introduces the basic principles of injury mechanics and rehabilitation focussing on sports injuries.

- **Objective**: Within the scope of this lecture you will learn the basic principles of trauma biomechanics. Based on examples from sports, you will get to know different mechanisms that can possibly result in injury. Investigating the background and cause of injury should allow you to assess the injury risk for sports activities. Furthermore you should be able to develop measures to prevent such injury.

- **Content**: This lecture deals with the basic principles of injury mechanics and rehabilitation. Mechanisms that can result in injury are presented. Furthermore possibilities to prevent injuries are discussed. Thereby the lecture focuses on sports injuries.

- **Lecture notes**: Handsouts will be made available.


### 752-6001-00L Introduction to Nutritional Science

- **Abstract**: This course introduces basic concepts of micro- and macronutrient nutrition. Micronutrients studied include fat-soluble and water-soluble vitamins, minerals and trace elements. Macronutrients include proteins, fat and carbohydrates. Special attention is given to nutrient digestion, bioavailability, metabolism and excretion with some focus on energy metabolism.

- **Objective**: To introduce the students to the both macro- and micronutrients in relation to food and metabolism.

- **Content**: The course is divided into two parts. The lectures on micronutrients are given by Prof. Zimmermann and the lectures on macronutrients are given by Prof. Wolfrum. Prof. Zimmermann discusses the micronutrients, including fat-soluble vitamins, water-soluble vitamins, minerals and trace elements. Prof. Wolfrum introduces basic nutritional aspects of proteins, fats, carbohydrates and energy metabolism. The nutrients are described in relation to digestion, absorption and metabolism. Special aspects of homeostasis and homeorhesis are emphasized.

- **Lecture notes**: There is no script. Powerpoint presentations will be made available.

- **Literature**: Elmadfa I & Leitzmann C: Ernährung des Menschen UTB Ulmer, Stuttgart, 4. überarb. Ausgabe 2004

### 752-6101-00L Dietary Etiologies of Chronic Disease

- **Abstract**: This lecture introduces basic concepts of micro- and macronutrient nutrition. Micronutrients studied include fat-soluble and water-soluble vitamins, minerals and trace elements. Macronutrients include proteins, fat and carbohydrates. Special attention is given to nutrient digestion, bioavailability, metabolism and excretion with some focus on energy metabolism.

- **Objective**: To introduce the students to the both macro- and micronutrients in relation to food and metabolism.

- **Content**: The course is divided into two parts. The lectures on micronutrients are given by Prof. Zimmermann and the lectures on macronutrients are given by Prof. Wolfrum. Prof. Zimmermann discusses the micronutrients, including fat-soluble vitamins, water-soluble vitamins, minerals and trace elements. Prof. Wolfrum introduces basic nutritional aspects of proteins, fats, carbohydrates and energy metabolism. The nutrients are described in relation to digestion, absorption and metabolism. Special aspects of homeostasis and homeorhesis are emphasized.

- **Lecture notes**: There is no script. Powerpoint presentations will be made available.

- **Literature**: Elmadfa I & Leitzmann C: Ernährung des Menschen UTB Ulmer, Stuttgart, 4. überarb. Ausgabe 2004
<table>
<thead>
<tr>
<th>Abstract</th>
<th>To have the student gain understanding of the links between the diet and the etiology and progression of chronic diseases, including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective</td>
<td>To examine and understand the protective effect of foods and food ingredients in the maintenance of health and the prevention of chronic disease, as well as the progression of complications of the chronic diseases.</td>
</tr>
<tr>
<td>Content</td>
<td>The course evaluates food and food ingredients in relation to primary and secondary prevention of chronic diseases including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.</td>
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<tr>
<td>Lecture notes</td>
<td>There is no script. Powerpoint presentations will be made available on-line to students.</td>
</tr>
<tr>
<td>Literature</td>
<td>To be provided by the lecturers, at their discretion.</td>
</tr>
<tr>
<td>Prerequisites / notice</td>
<td>No compulsory prerequisites, but prior completion of Human Nutrition I + II (Humanernährung I+II) is strongly advised.</td>
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</table>

**752-6105-00L Epidemiology and Prevention**

Information on further reading will be announced during the lecture. There will be some mandatory as well as voluntary readings. There is no script. Powerpoint presentations will be made available on-line to students.

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<tbody>
<tr>
<td>Abstract</td>
<td>The module Epidemiology and prevention describes the process of scientific discovery from the detection of a disease and its causes, to the development and evaluation of preventive and treatment interventions and to improved population health.</td>
</tr>
<tr>
<td>Objective</td>
<td>The overall goal of the course is to introduce students to epidemiological thinking and methods, which are critical pillars for medical and public health research. Students will also become aware on how epidemiological facts are used in prevention, practice and politics.</td>
</tr>
<tr>
<td>Content</td>
<td>The module Epidemiology and prevention follows an overall framework that describes the course of scientific discovery from the detection of a disease to the development of prevention and treatment interventions and their evaluation in clinical trials and real world settings. We will discuss study designs in the context of existing knowledge and the type of evidence needed to advance knowledge. Examples from nutrition, chronic and infectious diseases will be used in order to show the underlying concepts and methods.</td>
</tr>
<tr>
<td>Lecture notes</td>
<td>Handouts are provided to students in the classroom.</td>
</tr>
<tr>
<td>Prerequisites / notice</td>
<td>Language of the course is English</td>
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</table>

**752-6151-00L Public Health Concepts**

The module "public health concepts" offers an introduction to key principles of public health. Students get acquainted with the concepts and methods of epidemiology. Students also learn to use epidemiological data for prevention and health promotion purposes. Public health concepts and intervention strategies are presented, using examples from infectious and chronic diseases.

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<tbody>
<tr>
<td>Abstract</td>
<td>At the end of this module students are able: - to interpret the results of epidemiological studies - to critically assess scientific literature - to know the definition, dimensions and determinants of health - to plan public health interventions and health promotion projects</td>
</tr>
<tr>
<td>Objective</td>
<td>Concepts of descriptive and analytical epidemiology, study designs, measures of effect, confounding and bias, screening, surveillance, definition of health and health promotion, health dimensions and health determinants, prevention strategies, public health interventions, public health action cycle, epidemiology and prevention of infectious and chronic diseases (HIV, Tuberculosis, Obesity, Public health nutrition).</td>
</tr>
<tr>
<td>Literature</td>
<td>Lecture slides and related handouts will be available on the ETH website.</td>
</tr>
<tr>
<td>Prerequisites / notice</td>
<td>Language of the course is English</td>
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</tbody>
</table>

**853-0033-00L Leadership I**

The lectures "Leadership I" (WS) and "Leadership II" (SS) have been designed as a two-semester lecture series, but may also be followed independently of one another or in reverse order. "Leadership I" covers the following fields: leadership basics, leadership theories and leadership styles, the concept of leadership responsibility and the role of communication in practical leadership.

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<tr>
<td>Abstract</td>
<td>The aim of this lecture is to give students an introductory overview of relevant topics regarding leadership research and practice, thus enabling them to gain a deeper understanding of the leadership phenomenon. Students should understand different concepts of leadership in the complex interaction between individuals, groups, organisation, context and situation. They should be informed about the evolution of the understanding of mankind in relation to working processes and its impact on organizations and the understanding of leadership theory in the past 100 years. They should grasp the concept of leadership responsibility (leadership ethics) and be able to derive consequences for leadership in practical situations. They should recognize the fundamental importance of communication in leadership situations and receive input which enables them to communicate adequately in specific situations.</td>
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<tr>
<td>Objective</td>
<td>The 1-hour written exam will take place during the last lecture in the semester.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Number of participants limited to 60.</td>
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**151-0104-00L Uncertainty Quantification for Engineering & Life Sciences**

Does not take place this semester. Number of participants limited to 60.
Abstract
Quantification of uncertainties in computational models pertaining to applications in engineering and life sciences. Exploitation of massively available data to develop computational models with quantifiable predictive capabilities. Applications of Uncertainty Quantification and Propagation to problems in mechanics, control, systems and cell biology.

Objective
The course will teach fundamental concepts of Uncertainty Quantification and Propagation (UQ+P) for computational models of systems in Engineering and Life Sciences. Emphasis will be placed on practical and computational aspects of UQ+P including the implementation of relevant algorithms in multicore architectures.

Content
Topics that will be covered include: Uncertainty quantification under parametric and non-parametric modelling uncertainty, Bayesian inference with model class assessment, Markov Chain Monte Carlo simulation, prior and posterior reliability analysis.

Lecture notes
The class will be largely based on the book: Data Analysis: A Bayesian Tutorial by Devinderjit Sivia as well as on class notes and related literature that will be distributed in class.

Literature
1. Data Analysis: A Bayesian Tutorial by Devinderjit Sivia
2. Probability Theory: The Logic of Science by E. T. Jaynes
3. Class Notes

Prerequisites / notice
Fundamentals of Probability, Fundamentals of Computational Modeling

Practical Training

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>557-3010-00L</td>
<td>Practical Training I</td>
<td>O</td>
<td>15</td>
<td>15P</td>
<td>C. Spengler</td>
</tr>
<tr>
<td>Abstract</td>
<td>3-months practical experience with topics from the major exercise physiology.</td>
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<tr>
<td>Objective</td>
<td>The students should obtain practical experience of 3 month length in possible job environments. The selected places (internal or external) should be as close as possible by the major exercise physiology.</td>
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<tr>
<td>Content</td>
<td>The content of the practica is determined by the supervisor together with the student.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Practica can be combined with the master thesis. In such a case, it can only be started after the Bachelor Degree was obtained and the Vertiefungsleiter has approved the study.</td>
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<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>557-3011-00L</td>
<td>Practical Training II</td>
<td>O</td>
<td>15</td>
<td>15P</td>
<td>C. Spengler</td>
</tr>
<tr>
<td>Abstract</td>
<td>3-months practical work with topics from the major exercise physiology.</td>
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</tr>
<tr>
<td>Objective</td>
<td>The students should obtain practical experience of 3 month length in possible job environments. The selected places (internal or external) should be as close as possible by the major exercise physiology.</td>
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Master's Thesis

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<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>557-3100-00L</td>
<td>Master's Thesis</td>
<td>O</td>
<td>30</td>
<td>30D</td>
<td>C. Spengler</td>
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<tr>
<td>Abstract</td>
<td>6-months research study with topics from the major exercise physiology.</td>
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</tr>
<tr>
<td>Objective</td>
<td>The student shall apply his basic knowledge in a practical scientific study. He/she will be confronted with the requirements of scientific working. He/she mustmaster these requirements.</td>
<td></td>
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<tr>
<td>Content</td>
<td>The content of the master thesis is determined by the supervisor together with the student. The thesis can begin only after the approval Vertiefungsleiter.</td>
<td></td>
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<tr>
<td>Prerequisites / notice</td>
<td>The master thesis can only be started after the Bachelor Degree was obtained and the Vertiefungsleiter has approved the study.</td>
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</tbody>
</table>

Sport Practical

For the entire offering see Sport Teaching Diploma.

see Sport Teaching Diploma, Sport Practical: Basic Education

see Sport Teaching Diploma, Sport Practical: Major Education

see Sport Teaching Diploma, Sport Practical: Education acquired outside ETH

GESS Science in Perspective

Recommended GESS Science in Perspective (Type B) for D-HEST.

see GESS Science in Perspective: Type A: Enhancement of Reflection Capability

see GESS Science in Perspective: Language Courses ETH/UZH

Human Movement Sciences Master - Key for Type

<table>
<thead>
<tr>
<th>Type</th>
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<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
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<tr>
<td>Dr</td>
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<tr>
<td>O</td>
<td>Compulsory</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
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<td>Key for Hours</td>
<td>Description</td>
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<tr>
<td>V</td>
<td>lecture</td>
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<tr>
<td>G</td>
<td>lecture with exercise</td>
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<td>U</td>
<td>exercise</td>
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<td>S</td>
<td>seminar</td>
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<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
## Biology (General Courses)

### Complementary Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>151-0255-00L</td>
<td>Energy Conversion and Transport in Biosystems</td>
<td>Z Dr</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>D. Poulikakos, A. Ferrari</td>
</tr>
</tbody>
</table>

**Abstract**
Theory and application of thermodynamics and energy conversion in biological systems with focus on the cellular level.

**Objective**
Theory and application of energy conversion at the cellular level. Understanding of the basic features governing solutes transport in the principal systems of the human cell. Connection of characteristics and patterns from other fields of engineering to biofluidics. Heat and mass transport processes in the cell, generation of forces, work and relation to biomedical technologies.

**Content**
Mass transfer models for the transport of chemical species in the human cell. Organization and function of the cell membrane and of the cell cytoskeleton. The role of molecular motors in cellular force generation and their function in cell migration. Description of the functionality of these systems and of analytical experimental and computational techniques for understanding of their operation. Introduction to cell metabolism, cellular energy transport and cellular thermodynamics.

**Lecture notes**
Material in the form of hand-outs will be distributed.

**Literature**
Lecture notes and references therein.

| 376-1791-00L | Introductory Course in Neuroscience I (University of Zurich)          | Z Dr | 2 credits | 2V   | J.M. Fritschy, W. Knecht          |

**Abstract**

Mind the enrolment deadlines at UZH: http://www.uzh.ch/studies/application/mobilitaet_en.html

**Objective**
The course gives an introduction to human and comparative neuroanatomy, molecular, cellular and systems neuroscience.

**Content**
1) Human Neuroanatomy I&II
2) Comparative Neuroanatomy
3) Development I&II
4) Membran and Action Potential
5) Synaptic Transmission & Plasticity I&II
6) Glia and Blood-Brain-Barrier
7) Somatosensory and Motor System
8) Visual System
9) Auditory System
10) Circuits underlying Emotion
11) Modeling of Neural Circuits

**Prerequisites / notice**
For doctoral students of the Neuroscience Center Zurich (ZNZ).

| 376-1795-00L | Advanced Course in Neurobiology I (Functional Anatomy of the Rodent Brain) (University of Zurich) | Z Dr | 2 credits | 2V   | J.M. Fritschy, H. U. Zeilhofer |

**Abstract**

Mind the enrolment deadlines at UZH: http://www.uzh.ch/studies/application/mobilitaet_en.html

**Objective**
The goal of this Advanced Course in Neurobiology is to provide students with a broader knowledge in several important areas of neurobiology. The course consists of four parts: Part I deals with various topics in developmental neurobiology. Part II is devoted to aspects of signal transduction. Part III focuses on synaptic transmission. Part IV gives deeper insights into systems neuroscience.

**Prerequisites / notice**

| 551-1159-00L | Molecular Systems Biology                                             | Z Dr | 0 credits | 1K   | U. Sauer, R. Aebersold            |

**Abstract**

An overview of systems biology research

**Objective**

Seminar series on current research topics in systems biology

**Lecture notes**
none

| 701-0265-00L | Ecology and Evolution                                               | Z Dr | 1 credit  | 2S   | E. Postma, J. Jokela             |

**Abstract**

Information for UZH students:
Enrolment to this course unit only possible at ETH. No enrolment to module BIO608 at UZH.

Please mind the ETH enrolment deadlines for UZH students: https://www.ethz.ch/en/studies/non-degree-courses/special-students/special-students-university-of-uzh.html

**Objective**
To become proficient in reading scientific literature, to understand how to look at publications, to understand them and to be able to put them in context. The course also trains the skills needed for the preparation of scientific contributions and the ability to put things into a broader context. Training in how to participate in a scientific discussion, how to make an argument and how to listen to arguments of others.

**Content**
All topics focus on themes from ecology and evolution, notably so on studies on adaptation of organisms, their evolutionary history, or on questions of current methodology.

**Lecture notes**
none
The main goal of this course is to enhance the student's ability to:

The students acquire advanced practical skills in linear regression analysis and are also familiar with its extensions to generalized linear models. The students are supposed to obtain detailed insight into the fundamentals of separation processes that are frequently applied in modern life science processes in particular, fine chemistry and biotechnology.

The class covers separation techniques that are central in the purification and downstream processing of chemicals and bio-pharmaceuticals. Examples from both areas illustrate the utility of the methods: 1) Liquid-liquid extraction; 2) Adsorption and chromatography; 3) Membrane processes; 4) Crystalization and precipitation.

The students are supposed to obtain detailed insight into the fundamentals of separation processes that are frequently applied in modern life science processes in particular, fine chemistry and biotechnology.

The course offers a practically oriented introduction into regression modeling methods. The basic concepts and some mathematical background are included, with the emphasis lying in learning "good practice" that can be applied in every student's own projects and daily work life. A special focus will be laid in the use of the statistical software package R for regression analysis.

The students acquire advanced practical skills in linear regression analysis and are also familiar with its extensions to generalized linear modeling.

The course starts with the basics of linear modeling, and then proceeds to parameter estimation, tests, confidence intervals, residual analysis, model choice, and prediction. More rarely touched but practically relevant topics that will be covered include variable transformations, multicollinearity problems and model interpretation, as well as general modeling strategies.

The last third of the course is dedicated to an introduction to generalized linear models: this includes the generalized additive model, logistic regression for binary response variables, binomial regression for grouped data and poisson regression for count data.

The exercises, but also the classes will be based on procedures from the freely available, open-source statistical software package R, for which an introduction will be held.

In the Mathematics Bachelor and Master programmes, the two course units 401-0649-00L "Applied Statistical Regression" and 401-3622-00L "Regression" are mutually exclusive. Registration for the examination of one of these two course units is only allowed if you have not registered for the examination of the other course unit.

The course consists of a series of research seminars on Structural Biology, Biochemistry and Biophysics, given by both scientists of the National Center of Competence in Research (NCCR) in Structural Biology and external speakers. Information on the individual seminars is provided on the following websites:

http://www.structuralbiology.uzh.ch/educ002.asp
http://www.biol.ethz.ch/dbiol-cal/index

The goal of this course is to provide doctoral and postdoctoral students with a broad overview on the most recent developments in biochemistry, structural biology and biophysics.

This course has its focus on the responsible conduct of research (RCR) and the ethical dimensions of the biological and biomedical sciences.

The main goal of this course is to enhance the student's ability to:
- recognize and identify ethical issues and conflicts,
- analyze and develop well-reasoned responses to the kinds of ethical problems a scientist is likely to encounter.

Additionally, students will become familiar with regulations and ethical guidelines relevant for their research field on the international, governmental, institutional and professional level.

To achieve these objectives, teaching methods will include lectures, discussions, case study work (alone and in groups), moral games, paper work and exercises.
Introduction in Ethics and Research Ethics
- What is ethics? What ethics is not...;
- Awareness: what constitutes an ethical question? Distinguishing ethical questions from other kinds of questions; Science & ethics: a comparison;
- The ethics movement in the biological and health sciences;
- What is research ethics and why is it important?
- Values (personal, cultural & ethical) in science & principles for ethical conduct in research;
- Professional codes of conduct: functions and limitations

Ethical approaches in the conduct of research (Normative Ethics)
- Overview over important theories for research ethics: virtue theories, duty-based theories (rights theory, categorical imperative, prima facie duties), consequentialist theories, other theories);
- The plurality of ethical theories and its consequences;
- The concept of dignity

Moral reasoning I: Arguments
- Why arguments? What is a good argument? The structure of (moral) arguments;
- Deductive and inductive arguments; Validity and soundness;
- Assessing moral arguments

Moral reasoning II: Decision-making
- How (not) to approach ethical issues...; Is there a correct method for answering moral questions?
- Models of method in Applied Ethics: a) Top-down approaches; b) the reflective equilibrium; c) a bottom-up approach: casuistry (or reasoning-by-analogy);
- Is there a right answer?

II. Research Ethics / Responsible Conduct of Research (RCR)

Integrity in Research & Research Misconduct
- What is "integrity" in scientific research? What is research misconduct (falsification, fabrication, plagiarism - FFP) and questionable research practices (QRP)?
- Factors leading to misconduct; Procedure for responding to allegations of research misconduct;
- The confidant of ETH Zurich

Data Management
- Data collection and recordkeeping; Analysis and selection of data;
- Ownership of data; retention and sharing of data;
- Falsification and fabrication of data

Research involving animals
- The moral status of animals; Ethical approaches to animal experimentation: Animal welfare (Peter Singer) and Animal rights (Tom Regan);
- The 3 R's (replacement, reduction, refinement);
- Ethical assessment of conflicting issues in animal experimentation;
- The dignity of animals in the Swiss constitution;

Research involving human subjects
- History & guidelines (Nuremberg Code; Declaration of Helsinki; Belmont Report; International Ethical Guidelines for Biomedical Research Involving Human Subjects (CIOMS Guidelines); Convention on Human Rights and Biomedicine (Oviedo Convention);
- Informed consent; confidentiality and anonymity; research risks and benefits; vulnerable subjects;
- Clinical trials;
- Biobanks;
- Ethics Committees / Institutional Review Boards (IRB)

Authorship & Peer review
- Criteria for authorship;
- Plagiarism;
- Challenges to openness and freedom in scientific publication;
- Open access
- Peer review

Social responsibility
- What is social responsibility? Social responsibility: whose obligation?
- Public advocacy by researchers

Lecture notes
Course material (handouts, case studies, exercises, surveys and papers) will be available during the lectures and on the course homepage.

Literature
Recommended literature:
- "Introduction to the Responsible Conduct of Research" (http://ori.dhhs.gov/education/products/RCRintro/)

Detailed literature lists for the different topics of the course will be provided in the script/handout or on the course work space.

376-1581-00L Cancer: Fundamentals, Origin and Therapy Z 2 credits 2G H. Nägeli

Abstract
### Objective
Students are able to describe selected chemicals, biological and molecular processes that occur in cells spontaneously or after physical or chemical exposure and resulting in a tumor. They are able to list important cancer-inducing agents and explain the respective mechanism of action. They have knowledge of significant risk factors for cancer diseases. They are confronted with the basics of toxicology and they can explain the principle of the most common therapeutic strategies.

### Content
The lecture deals with problems of tumor epidemiology (causes, mortality, incidence). Cancer is delineated as a multi-step process. Classes of chemical compounds that induce cancer are discussed as well as the reactive metabolites that may be built from. Covalent binding to DNA is discussed and different types of mutations resulting thereof. A selection of proto-oncogenes and tumor suppressor genes is presented. Their function will be discussed as well as the changes which are found in these genes in tumor cells, starting from single nucleotide exchanges up to large deletions.

The reason for genetic predisposition to cancer will be discussed as well as cancer relevant aspects of cell cycle regulation. Phenomenons like angiogenesis and metastasis are presented as well as the mechanisms that protect the genome from mutagenic damage. Further subjects address old and new strategies of cancer treatment. Personalised cancer treatment.

### Lecture notes
Handouts with reproductions of all presented transparencies will be distributed.

### Literature

### Prerequisites / notice
The lecture requires an active participation of the students. All students will participate in individual or group work focussing on specific subject of the lecture. Students will have ample time for preparation during lecture time.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Semester</th>
<th>Credits</th>
<th>ECTS</th>
<th>Language</th>
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<tbody>
<tr>
<td>551-0530-00L</td>
<td>Repair, Recombination, Replication</td>
<td>Z</td>
<td>0</td>
<td>1K</td>
<td>J. Matos</td>
</tr>
<tr>
<td>551-1109-00L</td>
<td>Seminars in Microbiology</td>
<td>Z Dr</td>
<td>0</td>
<td>2K</td>
<td>M. Aebi, H.M. Fischer, W.D. Hardt, J. Piel, J. Vorholt-Zambelli</td>
</tr>
<tr>
<td>401-0620-00L</td>
<td>Statistical Consulting</td>
<td>Z Dr</td>
<td>0</td>
<td>0.1K</td>
<td>M. Kalisch, L. Meier</td>
</tr>
<tr>
<td>551-0512-00L</td>
<td>Current Topics in Molecular and Cellular Neurobiology</td>
<td>Z Dr</td>
<td>2</td>
<td>1S</td>
<td>U. Suter</td>
</tr>
<tr>
<td>551-0737-00L</td>
<td>Experimental Ecology: Evolution and Ecology</td>
<td>Z</td>
<td>2</td>
<td>2S</td>
<td>S. Bonhoeffer</td>
</tr>
<tr>
<td>551-0509-00L</td>
<td>Current Immunological Research in Zürich</td>
<td>Z Dr</td>
<td>0</td>
<td>1K</td>
<td>R. Spörrl, M. Detmar,</td>
</tr>
</tbody>
</table>
Abstract
This monthly meeting is a platform for Zurich-based immunology research groups to present and discuss their ongoing research projects. At each meeting three PhD students or Postdocs from the participating research groups present an ongoing research project in a 30 min seminar followed by a plenary discussion.

Objective
The aim of this monthly meeting is to provide further education for master and doctoral students as well as Postdocs in diverse topics of immunology and to give an insight in the related research. Furthermore, this platform fosters the establishment of science- and technology-based interactions between the participating research groups.

Content
Presentation and discussion of current research projects carried out by various immunology-oriented research groups in Zurich.

Lecture notes
none

551-1405-00L  Electron Cryomicroscopy Seminar  Z Dr  0 credits  0.5S  M. Pilhofer, further lecturers
Abstract
Intergroup seminar for scientists and students interested in electron cryomicroscopy
Objective
The goal of the seminar is to provide an exchange forum for anyone interested in electron cryomicroscopy (tomography and single particle).
The first ~10 minutes are used for exchange on instrument status and technical issues, followed by a ~30 min presentation and discussion of a specific project.
The seminar can also be used to discuss current literature and report from conferences.
Prerequisites / notice
Presented project data are confidential. Sign-up for seminar announcements by emailing pilhofer@biol.ethz.ch.

551-1106-00L  Progress Reports in Microbiology and Immunology  Dr  0 credits  5S  J. Piel, M. Aebi, H.M. Fischer, W.D. Hardt, A. Oxenius, J. Vorholt-Zambelli
Abstract
Presentation and discussion of current research results in the field of Microbiology and Infection Immunology
Objective
Precise and transparent presentation of research findings in relation to the current literature, critical discussion of experimental data and their interpretation, development and presentation of future research aims

551-0209-00L  Sustainable Plant Systems (Seminar)  Z Dr  2 credits  2S  M. Paschke, further lecturers
Abstract
Participants will be able to discuss and understand sustainability in the context of plant science research
Objective
Key objectives for the seminar are that (1) participants will be able to discuss issues of sustainability in the context of plant science research topics, e.g. how a specific research topic is important for understanding and advancing sustainability of plant systems and that (2) participants will be able to phrase their own visions for sustainability in plant sciences, their group work topic and their own MSc or PhD project. Plant science research topics will be on conservation agriculture, agro-ecology, plant breeding for orphan crops and methane emissions from wetland ecosystems.

551-1121-00L  Progress Reports in Microbial Glycobiology and Fungal Defense Mechanisms  Dr  0 credits  3S  M. Aebi
Abstract
Does not take place this semester.
Students must sign up via secr.micro.biol.ethz.ch
Objective
Presentation and discussion of current research results in the field of Microbial Glycobiology and Fungal Defense Mechanisms
Precise and transparent presentation of research findings in relation to the current literature, critical discussion of experimental data and their interpretation, development and presentation of future research aims

Biology (General Courses) - Key for Type

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

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<tr>
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<td>exercise</td>
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<td>practical/laboratory course</td>
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<td>A</td>
<td>independent project</td>
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<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
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</tbody>
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ECTS European Credit Transfer and Accumulation System
Special students and auditors need special permission from the lecturers.
**Biology Bachelor**

► First Year, 1. Semester

★★ Compulsory Subjects First Year Examinations

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>401-0291-00L</td>
<td>Mathematics I</td>
<td>O</td>
<td>6 credits</td>
<td>4V+2U</td>
<td>E. W. Farkas</td>
</tr>
</tbody>
</table>

**Abstract**

Mathematics I/II is an introduction to one- and multidimensional calculus and linear algebra emphasizing on applications.

**Objective**

Students understand mathematics as a language for modeling and as a tool for solving practical problems in natural sciences. Students can analyze models, describe solutions qualitatively or calculate them explicitly if need be. They can solve examples as well as their practical applications manually and using computer algebra systems.

**Content**

Einführung in die Differential- und Integralerechnung von Funktionen einer Variablen und Anwendungen:

Funktionen, Stetigkeit, Differentialrechnung, Anwendungen der Differentialrechnung, Integralerechnung, Potenzreihen, Komplexe Zahlen, Matrizen.

**Literature**

Siehe Lernmaterialien > Literatur

L. Papula, Mathematik für Ingenieure und Naturwissenschaftler, 11. Auflage, Vieweg und Teubner

Th. Wihler, Mathematik für Naturwissenschaften, 2 Bände: Einführung in die Analysis, Einführung in die Lineare Algebra; Haupt-Verlag Bern, UTB

Ch. Blatter, Lineare Algebra; VDF

H. H. Storrer: Einführung in die mathematische Behandlung der Naturwissenschaften I; Birkhäuser.

**Prerequisites / notice**


Der Zugang zu den Übungsserien erfolgt online. Vorlesungsverzeichnis > Lernmaterialien > Material zur Vorlesung

<table>
<thead>
<tr>
<th>252-0852-00L</th>
<th>Foundations of Computer Science</th>
<th>O</th>
<th>4 credits</th>
<th>2V+2U</th>
<th>L. E. Fässler, H. J. Böckenhauer, M. Dahinden, D. Komm, H. Lehner</th>
</tr>
</thead>
</table>

**Abstract**

Students learn to apply selected concepts and tools from computer science for working on interdisciplinary projects.

The following topics are covered: modeling and simulations, introduction to programming, visualizing multi-dimensional data, introduction matrices, managing data with lists and tables and with relational databases, universal methods for algorithm design.

**Objective**

The students learn to

- understand the role of computer science in science,
- to control computer and automate processes of problem solving by programming,
- choose and apply appropriate tools from computer science,
- process and analyze real-world data from their subject of study,
- handle the complexity of real-world data,
- know universal methods for algorithm design.

**Content**

1. The role of computer science in science
2. Introduction to Programming with Python
3. Modeling and simulations
4. Introduction to Matrices with Matlab
5. Visualizing multidimensional data
6. Data management with lists and tables
7. Data management with a relational database
8. Universal methods for algorithm design

**Lecture notes**

All materials for the lecture are available at www.gdi.ethz.ch

**Prerequisites / notice**

This course is based on application-oriented learning. The students spend most of their time working through projects with data from natural science and discussing their results with teaching assistants. To learn the computer science basics there are electronic tutorials available.

<table>
<thead>
<tr>
<th>551-0105-00L</th>
<th>Fundamentals of Biology IA</th>
<th>O</th>
<th>5 credits</th>
<th>5G</th>
<th>M. Aebi, E. Hafen</th>
</tr>
</thead>
</table>

**Abstract**

The course provides an introduction to the basics of molecular- and cell biology and genetics.

**Objective**

Introduction to modern biology and to principal biological concepts.

**Content**

The course is divided into several chapters:

1. Basic principles of Evolution.
2. Chemistry of Life: Water; Carbon and molecular diversity; biomolecules
3. The cell: structure; membrane structure and function, cell cycle
4. Metabolism: Respiration; Photosynthesis; Fermentation
5. Inheritance: meiosis and sexual reproduction; Mendelian genetics, chromosomal basis of inheritance, molecular basis of inheritance, from gene to protein, regulation of gene expression; genomes and their evolution

**Lecture notes**

None.

**Literature**

The text-book "Biology" (Campbell, Reece) (10th edition) is the basis of the course. The structure of the course is largely identical with that of the text-book.

**Prerequisites / notice**

Certain sections of the text-book must be studied by self-instruction.

<table>
<thead>
<tr>
<th>529-1001-01L</th>
<th>General Chemistry (for Biology/Pharmacy/HST)</th>
<th>O</th>
<th>4 credits</th>
<th>4V</th>
<th>W. Uhlig</th>
</tr>
</thead>
</table>

**Abstract**

The lecture deals with a number of basic chemistry concepts. These include (amongst others) chemical reactions, energy transfer during chemical reactions, properties of ionic and covalent bonds, Lewis structures, properties of solutions, kinetics, thermodynamics, acid-base equilibrium, electrochemistry and properties of metal complexes.

**Objective**

The course is designed to provide an understanding of the basic principles and concepts of general and inorganic chemistry.
The lecture deals with a number of basic chemistry concepts. These include (amongst others) chemical reactions, energy transfer during chemical reactions, properties of ionic and covalent bonds, Lewis structures, properties of solutions, kinetics, thermodynamics, acid-base equilibria, electrochemistry and properties of metal complexes.


Weiterführende Literatur:
Brown, LeMay, Bursten CHEMIE (deutsch)
Houscroft and Constable, CHEMISTRY (englisch)
Oxtoby, Gillis, Nachtrieb, MODERN CHEMISTRY (englisch)

529-1011-00L Organic Chemistry I (for students of Biology, Pharmaceutical Sci., and Health Sci. & Tech.)

| Objective | Understanding the basic concepts and definitions of organic chemistry. Knowledge of the functional groups and classes of compounds that are important in biological systems. Foundations for the understanding of the relationship between structure and reactivity. |
| Lecture notes | Printed lecture notes are available. Exercises, answer keys and other handouts can be downloaded from the Moodle course “Organic Chemistry I” of the current semester (https://moodle-app2.let.ethz.ch). |
| Literature | Lecture notes are available. |

Prerequisites / notice
The course consists of plenary lectures (2 h per week) and problem-solving lessons (2 h per week, groups of ca. 25 people). In addition, online exercises are available in the e-learning environment Moodle (Course OC I).

First Year Laboratory Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>535-1001-00L Laboratory Course General Chemistry (for Biology and Pharmacy)</td>
<td>O</td>
<td>6 credits</td>
<td>8P</td>
<td></td>
</tr>
</tbody>
</table>

Objective
Introduction to the practical work in a chemistry laboratory. The most important manipulations and techniques are treated, as well as the most fundamental chemical reaction types.

Content
- Knowledge of the basic chemical laboratory methods.
- Basic knowledge of the scientific approach in experimenting.
- Observation and interpretation of real-world chemical processes.
- Keeping of a reliable laboratory journal.

Lecture notes
Course manual in German (is handed out to the students at the beginning of the lessons). Language: German, English upon request.

Literature
Introduction to qualitative analysis.

Prerequisites / notice
This practical course causes costs for materials and chemicals. The costs are charged to the students at the end of semester.

2. Year, 3. Semester

Core Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-1023-00L Physical Chemistry I (for Biology and Pharmacy)</td>
<td>O</td>
<td>3 credits</td>
<td>2V+1U</td>
<td></td>
</tr>
</tbody>
</table>

Abstract

Objective
Understanding the fundamental thermodynamical properties of chemical and biological systems.

Content

Lecture notes
in process, will be distributed at the beginning of the first lecture

Literature

Prerequisites / notice
Prerequisite: mathematics I-II, functions of multiple variables, partial derivatives.

551-0103-00L Fundamentals of Biology II: Cell Biology

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
</tr>
</thead>
</table>

5 credits | 5V |

E. Hafen, U. Kutay, J. Matos, G. Schertler, U. Suter, S. Werner
The goal of this course is to provide students with a wide general understanding of cell biology. With this material as a foundation, students will have enough of a cell biological basis to begin their specialization not only in cell biology but also in related fields such as biochemistry, microbiology, pharmacological sciences, molecular biology, and others.

The focus is animal cells and the development of multicellular organisms with a clear emphasis on the molecular basis of cellular structures and phenomena. The topics include biological membranes, the cytoskeleton, protein sorting, energy metabolism, cell cycle and division, viruses, extracellular matrix, cell signaling, embryonic development and cancer research.

Some of the lectures are given in the English language. Certain sections of the text-book must be studied by self-instruction.

**Objective**

The course provides an introduction to Biochemistry / Molecular Biology with some emphasis on chemical and biophysical aspects.

**Content**

The course teaches the basis and typical applications of methods for the analysis of nucleic acid sequences, mass spectrometric analysis of proteins and proteomes and advanced light and fluorescent imaging methods.

**Lecture notes**

Materials supporting the lectures and exercises will be made available via Moodle.

**Literature**

The course will consist of lectures covering the theoretical and technical base of the respective analytical methods and of exercises where typical applications of the methods in modern experimental biology are discussed.

**Prerequisites / notice**

Some of the lectures are given in the English language.

---

**551-1003-00L Methods of Biological Analysis**

**Abstract**

Principles of the most important separation techniques and the interpretation of molecular spectra.

**Objective**

The course will teach the basis and typical applications of methods for the analysis of nucleic acid sequences, mass spectrometric analysis of proteins and proteomes and advanced light and fluorescent imaging methods.

**Content**

Knowledge of the necessary basics and the possibilities of application of the relevant spectroscopical and separation methods in analytical chemistry.

**Lecture notes**

A comprehensive script is available in the HCI-Shop. A summary of the part "Spektroskopie" defines the relevant material for the exam.

**Prerequisites / notice**

Materials supporting the lectures and exercises will be made available via Moodle.

---

**401-0643-13L Statistics II**

**Abstract**

Vertiefung von Statistikmethoden. Nach dem detaillierten Fundament aus Statistik I liegt nun der Fokus auf konzeptueller Breite und konkreter Problemlösungsfähigkeit mit der Statistiksoftware R.

**Objective**


---

**401-0643-13L Statistics II**

**Abstract**

Vertiefung von Statistikmethoden. Nach dem detaillierten Fundament aus Statistik I liegt nun der Fokus auf konzeptueller Breite und konkreter Problemlösungsfähigkeit mit der Statistiksoftware R.

**Objective**


---

**401-0643-13L Statistics II**

**Abstract**

Vertiefung von Statistikmethoden. Nach dem detaillierten Fundament aus Statistik I liegt nun der Fokus auf konzeptueller Breite und konkreter Problemlösungsfähigkeit mit der Statistiksoftware R.

**Objective**


---

**401-0643-13L Statistics II**

**Abstract**

Vertiefung von Statistikmethoden. Nach dem detaillierten Fundament aus Statistik I liegt nun der Fokus auf konzeptueller Breite und konkreter Problemlösungsfähigkeit mit der Statistiksoftware R.

**Objective**

### Biodiversity

<table>
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<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-0245-00L</td>
<td>Introduction to Evolutionary Biology</td>
<td>O</td>
<td>2</td>
<td>2V</td>
<td>G. Velicer, S. Wielgoss</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course introduces important questions about the evolutionary processes involved in the generation and maintenance of biological diversity across all domains of life and how evolutionary science investigates these questions.</td>
<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>This course introduces important questions about the evolutionary processes involved in the generation and maintenance of biological diversity across all domains of life and how evolutionary science investigates these questions. The topics covered range from different forms of selection, phylogenetic analysis, population genetics, life history theory, the evolution of sex, social evolution to human evolution. These topics are important for the understanding of a number of evolutionary problems in the basic and applied sciences.</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Content</td>
<td>Topics likely to be covered in this course include research methods in evolutionary biology, adaptation, evolution of sex, evolutionary transitions, human evolution, infectious disease evolution, life history evolution, macroevolution, mechanisms of evolution, phylogenetic analysis, population dynamics, population genetics, social evolution, speciation and types of selection.</td>
<td></td>
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</tbody>
</table>
| Literature   | Textbook: Evolutionary Analysis
Scott Freeman and Jon Herron
| Prerequisites / notice | The exam is based on lecture and textbook. |

<table>
<thead>
<tr>
<th>Number</th>
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</tr>
</thead>
<tbody>
<tr>
<td>551-0435-00L</td>
<td>Systematic Biology: Zoology</td>
<td>O</td>
<td>3</td>
<td>2V+2P</td>
<td>O. Y. Martin, M. Greeff</td>
</tr>
<tr>
<td>Abstract</td>
<td>Lecture: The lecture provides an overview of animal diversity. Using key selected groups, phylogenetic, morphological and ecological aspects are addressed. Two priority topics are the arthropods and the vertebrates (including vertebrate fauna of Switzerland). Practical: Knowledge of selected animal groups and their characteristics (supplementing the lecture) of the basic methods.</td>
<td></td>
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<tr>
<td>Objective</td>
<td>Lecture: The systematic classification of animals and the characteristics of the most important animal groups, basic animal body plans. Practical: Examples of selected animal groups and their characteristics; acquire the relevant skills: simple preparations, dissection, microscopy, drawing, protocols.</td>
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<tr>
<td>Content</td>
<td>Lecture: Body plans, characteristics, diversity and phylogenetic position of the main groups of Protozoa, Invertebrates, and Vertebrates, with a special focus on Arthropods and Vertebrates (including vertebrate fauna of Switzerland). Practical: Macroscopic and microscopic study of selected Protozoa, Invertebrates (especially insects) and Vertebrates: morphology and anatomy; behaviour, mainly locomotion, feeding, and reproduction.</td>
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<tr>
<td>Lecture notes</td>
<td>A script for the course will be sold in the lecture, and additional material will be handed out (particularly in the practical).</td>
<td></td>
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</tr>
<tr>
<td>Literature</td>
<td>No further literature required, the script contains suggestions for further reading.</td>
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<tbody>
<tr>
<td>551-0227-00L</td>
<td>Mycology</td>
<td>O</td>
<td>2</td>
<td>2V</td>
<td>M. Aebi</td>
</tr>
<tr>
<td>Abstract</td>
<td>The lecture gives an introduction into the field of Mycology. It provides an overview of the fungal lifestyle (hyphal growth/mycelium; reproductive cycles; ecology of the fungi; use of fungi)</td>
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<tr>
<td>Objective</td>
<td>Understanding the fungal life form. Knowledge of the specific properties of the fungal cell Knowledge of the different reproductive cycles in all fungal phyla Knowledge of the different nutritional modes of the fungi; correlation with habitat and ecology Knowledge of the application of fungi in food production and biotechnology</td>
<td></td>
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</tr>
<tr>
<td>Content</td>
<td>The lecture focuses on the following topics within Mycology: 1. The fungal lifestyle 2. Differentiation processes of the Mycelium 3. Reproductive cycles and systematic grouping of fungi 4. Ecology of the fungi 5. Use of fungi</td>
<td></td>
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<tr>
<td>Lecture notes</td>
<td>none; hand-outs will be prepared before the lectures</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Literature</td>
<td>none</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prerequisites / notice</td>
<td>none</td>
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</tbody>
</table>

### Cellular and Molecular Biology

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<td>Introduction to Evolutionary Biology</td>
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<td>2V</td>
<td>G. Velicer, S. Wielgoss</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course introduces important questions about the evolutionary processes involved in the generation and maintenance of biological diversity across all domains of life and how evolutionary science investigates these questions.</td>
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<td>Objective</td>
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<td>Topics likely to be covered in this course include research methods in evolutionary biology, adaptation, evolution of sex, evolutionary transitions, human evolution, infectious disease evolution, life history evolution, macroevolution, mechanisms of evolution, phylogenetic analysis, population dynamics, population genetics, social evolution, speciation and types of selection.</td>
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| Literature   | Textbook: Evolutionary Analysis
Scott Freeman and Jon Herron
| Prerequisites / notice | The exam is based on lecture and textbook. |

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<tbody>
<tr>
<td>529-0229-00L</td>
<td>Practical Course Organic Chemistry (for Students of Biology and Pharmaceutical Sciences)</td>
<td>O</td>
<td>8</td>
<td>12P</td>
<td>C. Thilgen, F. Diederich, Y. Yamakoshi</td>
</tr>
<tr>
<td>Abstract</td>
<td>Analytical part: basic operations for the separation of mixtures of organic compounds (recrystallization, distillation, extraction, chromatography) Synthetic part (main part): at least 8 synthetic steps (one- or two-step syntheses).</td>
<td></td>
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</tbody>
</table>

Latest online enrolment is 10 days before the beginning of the semester.
Learn the basic techniques for the preparation and purification of organic compounds.

Deepen the understanding of reaction mechanisms.

**Content**
Analytical part: basic operations for the separation of mixtures of organic compounds (recrystallization, distillation, extraction, chromatography).

Synthetic part (main part): at least 8 synthetic steps (one- or two-step syntheses).

Introduction to database searches (Reaxys, SciFinder).

**Lecture notes**
Documentation will be handed out at the beginning of the course.

**Literature**
1) P. Wörfel, M. Bitzer, U. Claus, H. Felber, M. Hübel, B. Vollenweider, Laborpraxis (Bd. 1: Einführung, allgemeine Methoden; Bd. 2: Messmethoden; Bd. 3: Trennungsmethoden; Bd. 4: Analytische Methoden), Birkhäuser Verlag.

**Prerequisites / notice**
The basic reactions of Organic Chemistry and their mechanisms should be known (cf. course 529-1012-00L Organic Chemistry II for Students of Biology, Pharmaceutical Sciences, and Health Sci. and Tech.).

As a prerequisite, all participants need to pass the "Safety Test HCI Chemie V2 English" (see https://moodle-app2.let.ethz.ch). A printout of the certificate generated by the system needs to be presented to the teaching assistants prior to starting lab work.

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## Biological Chemistry

<table>
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<td>529-0229-00L</td>
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<td>O</td>
<td>8</td>
<td>12P</td>
<td>C. Thilgen, F. Diederich, Y. Yamakoshi</td>
</tr>
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</table>

**Abstract**
Analytical part: basic operations for the separation of mixtures of organic compounds (recrystallization, distillation, extraction, chromatography).

Synthetic part (main part): at least 8 synthetic steps (one- or two-step syntheses).

Introduction to database searches (Reaxys, SciFinder).

**Objective**
Learn the basic techniques for the preparation and purification of organic compounds.

Deepen the understanding of reaction mechanisms.

**Lecture notes**
Documentation will be handed out at the beginning of the course.

**Literature**
1) P. Wörfel, M. Bitzer, U. Claus, H. Felber, M. Hübel, B. Vollenweider, Laborpraxis (Bd. 1: Einführung, allgemeine Methoden; Bd. 2: Messmethoden; Bd. 3: Trennungsmethoden; Bd. 4: Analytische Methoden), Birkhäuser Verlag.

**Prerequisites / notice**
The basic reactions of Organic Chemistry and their mechanisms should be known (cf. course 529-1012-00L Organic Chemistry II for Students of Biology, Pharmaceutical Sciences, and Health Sci. and Tech.).

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## Concept Courses

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<tr>
<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-2413-00L</td>
<td>Evolutionary Genetics</td>
<td>W</td>
<td>6</td>
<td>4V</td>
<td>T. Städler, A. Widmer, P. C. Brunner, M. C. Fischer</td>
</tr>
</tbody>
</table>

**Abstract**
The concept course 'Evolutionary Genetics' consists of two lectures that jointly provide an introduction to the fields of population and quantitative genetics (emphasis on basic concepts) and ecological genetics (more emphasis on evolutionary and ecological processes of adaptation and speciation).

**Objective**
The aim of the course is to provide students with a solid introduction to the fields of population genetics, quantitative genetics, and ecological genetics. The concepts and research methods developed in these fields have undergone profound transformations; they are of fundamental importance in our understanding of evolutionary processes, both past and present. Students should gain an appreciation for the concepts, methods, and explanatory power of evolutionary genetics.

**Content**
Population genetics - Types and sources of genetic variation; randomly mating populations and the Hardy-Weinberg equilibrium; effects of inbreeding, natural selection; random genetic drift and effective population size; gene flow and hierarchical population structure; molecular population genetics: neutral theory of molecular evolution and basics of coalescent theory.

Quantitative genetics - Continuous variation; measurement of quant. characters; genes, environments and their interactions; measuring their influence; response to selection; inbreeding and crossbreeding, effects on fitness; Fisher’s fundamental theorem.

Ecological Genetics - Concepts and methods for the study of genetic variation and its role in adaptation, reproductive isolation, hybridization and speciation.

**Lecture notes**
Handouts

**Literature**

**Prerequisites / notice**
There will be 5 optional extra sessions for the population genetics part (following lectures 2-6) for computer simulations, designed to help understand the course material.

<table>
<thead>
<tr>
<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-0307-00L</td>
<td>Molecular and Structural Biology I: Protein Structure and Function</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>R. Glockshuber, K. Locher, E. Weber-Barr</td>
</tr>
</tbody>
</table>

D-BIOL BSc students are obliged to take part I and part II (next semester) as a two-semester course.

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Data: 06.03.2019 12:57  Autumn Semester 2016  Page 218 of 1571
Concepts and molecular mechanisms underlying the biochemistry of the cell, providing advanced insights into structure, function and regulation of individual cell components. Particular emphasis will be put on the spatial and temporal integration of different molecules and signaling pathways into global cellular processes such as intracellular transport, cell division & growth, and cell migration.  

The full-year course (551-0319-00 & 551-0320-00) focuses on the molecular mechanisms and concepts underlying the biochemistry of cellular physiology, investigating how these processes are integrated to carry out highly coordinated cellular functions. The molecular characterization of complex cellular functions requires a combination of approaches such as biochemistry, but also cell biology and genetics. This course is therefore the occasion to discuss these techniques and their integration in modern cellular biochemistry. The students will be able to describe the structural and functional details of individual cell components, and the spatial and temporal regulation of their interactions. In particular, they will learn to explain the integration of different molecules and signaling pathways into complex and highly dynamic cellular processes such as intracellular transport, cytoskeletal rearrangements, cell motility, cell division and cell growth. In addition, they will be able to illustrate the relevance of particular signaling pathways for cellular pathologies such as cancer.

Abstract

Basics:

- Creighton, T.E., Proteins, Freeman, (1993)
- Fersht, A., Enzyme, Structure and Mechanism in Protein Science (1999), Freeman.

Current topics: References will be given during the lectures.
Introduction to Bioinformatics: Concepts and Applications (formerly Bioinformatics I) will provide students with the theoretical background of approaches to store and retrieve information from large databases. Concepts will be developed how DNA sequence information can be used to understand phylogenetic relationships, how RNA sequence relates to structure, and how protein sequence information can be used for genome annotation and to predict protein folding and structure. Students will be introduced to quantitative methods for measuring gene expression and how this information can be used to model gene networks. Methods will be discussed to construct protein interaction maps and how this information can be used to simulate dynamic molecular networks.

In addition to the theoretical background, the students will develop hands-on experiences with the bioinformatics methods through guided exercises. The course provides students from different backgrounds with basic training in bioinformatics approaches that have impact on biological, chemical and physics experimentation. Bioinformatics approaches draw significant expertise from mathematics, statistics and computational science.

Although "Introduction to Bioinformatics I" will focus on theory and praxis of bioinformatics approaches, the course provides an important foundation for the course "Introduction to Bioinformatics II: Fundamentals of computer science, modeling and algorithms" that will be offered in the following semester.

Content

Bioinformatics I will cover the following topics:

- From genes to databases and information
- BLAST searches
- Prediction of gene function and regulation
- RNA structure prediction
- Gene expression analysis using microarrays
- Protein sequence and structure databases
- WWW for bioinformatics
- Protein sequence comparisons
- Proteomics and de novo protein sequencing
- Protein structure prediction
- Cellular and protein interaction networks
- Molecular dynamics simulation

Literature

Mainly based on recent original literature, a detailed list will be distributed during the first lecture.
Objective
Overview of normal development, plasticity and regeneration of the nervous system based on molecular, cellular and biochemical approaches.

Content
Development: Early development of the nervous system, cellular level, nerve fiber growth, building of neuronal networks; biology of the adult nervous system; structural plasticity of the adult nervous system, regeneration and repair: networks and nerve fibers, regeneration, pathological loss of cells.

Lecture notes
Structure, Plasticity and Repair of the Nervous System (376-1305-01L): Lecture notes will be provided on Moodle https://moodle-app2.let.ethz.ch/course/view.php?id=694
Password will be provided at the beginning of the lecture.

Literature
The lecture requires reading of book chapters, handouts and original scientific papers. Further information will be given in the individual lectures.

Block Courses

Block Courses in 1st Quarter of the Semester
From 20.09.2016 13:00 hr to 12.10.2016 17:00 hr

<table>
<thead>
<tr>
<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-0333-00L</td>
<td>Biodiversity and Ecological Significance of Fungi</td>
<td>W</td>
<td>6</td>
<td>7P</td>
<td>Leuchtmann, R. Berndt, Senn-Irlet</td>
</tr>
<tr>
<td>551-0191-00L</td>
<td>Practical Aspects of Plant Biotechnology</td>
<td>W</td>
<td>6</td>
<td>7G</td>
<td>Dix, N. J., Webster, J. W.</td>
</tr>
<tr>
<td>551-0193-00L</td>
<td>Biological Information Mining</td>
<td>W</td>
<td>6</td>
<td>7G</td>
<td>Bärenfaller, J. Fütterer</td>
</tr>
</tbody>
</table>

Objective

Abstract

Content

Lecture notes

Literature

Number of participants limited to 8.

Number of participants limited to 6.

Does not take place this semester.

Password will be provided at the beginning of the lecture.

Pathological loss of cells.

Students will use lists of genes obtained in real experiments and learn how to obtain gene-centered information from literature and databases. They will use tools for gene function prediction and visualization of protein-protein interaction networks. The work will lead to a more meaningful annotation of co-detected genes and generate a hypothesis about their functional relationship.

Lectures will particularly focus on the contribution of biotechnology towards crop improvement, with examples from our own work on crops including rice and wheat.

Following topics will be covered:

-Genetic biotechnology: status and prospects
-Plant genetic transformation (methods)
-Molecular characterization of transformed plants
-Introduction to selection marker systems (examples, antibiotic and herbicide resistance, phosphomannose-isomerase, marker-free systems, visible markers)
-Introduction to promoter types (example tissue specific promoters)
-Plant tissue culture techniques
-Crop improvement through biotechnology (examples from our work on rice, wheat and cassava)
-Geno/allelic mining from plant genetic resource collections

A visit to the ETH greenhouse facilities at Eschikon will provide an opportunity to visualize and discuss different rice, wheat and cassava projects performed at the ETH Plant Biotechnology Lab.

For the practical part, protocols will be distributed within the course and Lecture material will be made available.

Relevant literature information will be provided within the course.

Data: 06.03.2019 12:57  Autumn Semester 2016  Page 221 of 1571
Many new biological analysis methods result in lists of genes or proteins related to biological structures, functions, or processes. The information available about the genes or proteins is often scattered in multiple databases and publications, making it difficult to extract and uncover common features or relationships among the biological molecules.

In the course students will use lists of genes or proteins from ongoing experiments in the laboratory and learn how to find and assemble gene-centered information in the literature, different databases and with analysis tools. The training and research will lead to a better and more meaningful annotation of co-detected genes members and generate a hypothesis about their functional relationship.

The work will be done exclusively using a computer. Students will work independently but with close supervision by experienced scientists. Daily discussions of the work will ensure progress. The computer work will be accompanied by lectures on theoretical and practical aspects of databases, gene networks and the project context of the gene lists that will be analyzed. Students will present their results and hypotheses at the end of the block course.

### 551-0347-00L

**Molecular Mechanisms of Cell Growth and Polarity**

- **Number of participants allowed to:** 12.
- **Literature**
  - will be selected with reference to the assigned research project.
- **Content**
  - During this Block-Course, the students will learn to
    1. describe and compare the principles and molecular mechanisms of cell polarity in fungi and animal cells,
    2. apply, evaluate and compare experimental strategies in the different model systems, and
    3. select the best model system to answer a particular question.
- **Objective**
  - The students learn to describe the principles and molecular mechanisms of cell polarity, using different model systems as examples:
    - Animal cells during epithelial and neuronal differentiation
    - Fungi during morphogenesis and aging.
  - Based on lectures, literature reading, presentations and practical lab work the students will be able to compare experimental strategies in different model systems, and to develop open questions in the field of cell polarity. Students will also know about the mechanisms and consequences of asymmetric cell division such as those performed by stem cells and asymmetric protein functions during morphogenesis and aging.
- **Objective**
  - Students - in groups of 2 or max 3 - will be integrated into a research project connected to the subject of the course, within one of the participating research groups.
- **Lecture notes**
  - There will be optional papers to be read before the course start. They serve as framework orientation for the practical parts of this block course and will be made accessible to you shortly before the course starts on the relevant Moodle site.
- **Literature**
  - Documentation and recommended literature (review articles) will be provided during the course.

### 551-1129-00L

**Understanding and Engineering Microbial Metabolism**

- **Number of participants allowed to:** 6.
- **Abstract**
  - This laboratory course has a focus on current research topics in our laboratory related to metabolic engineering, the general understanding of metabolism, and is focused particularly on C1-metabolism. Projects will be conducted in small groups.
- **Objective**
  - The course aims at introducing key principles of metabolic engineering and techniques applied in metabolism related research. The main focus of this block course is on practical work and will familiarize participants with complementary approaches, in particular genetic, biochemical and analytical techniques. Results will be presented by students in scientific presentations.
- **Content**
  - The course and will include topics such as pathway elucidation & engineering and related ongoing research projects in the lab.
  - Experimental work applied during the course will comprise methods such as cloning work & transformation, growth determination, enzyme activity assays, liquid-chromatography mass-spectrometry and dynamic labeling experiments.
- **Objective**
  - Provides an overview on student’s learning and shows ways to make the classroom experience more engaging and effective for students.
  - Students will learn to produce a research-based paper on a project they work on during the course.
- **Lecture notes**
  - None
- **Literature**
  - Will be provided at the beginning of the course.

### 551-0916-00L

**Learning and Teaching Biology**

- **Number of participants allowed to:** 20.
- **Abstract**
  - This course represents an introduction to recent research into student learning on the conceptual foundations of modern biology, together with pedagogical methods associated with effective instruction and its valuation. Students will be involved in active research into conceptual and practical issues involved in biology education and methods to discover student preconceptions.
- **Objective**
  - The course is not taught by a particular book, but recommended literature (review articles and selected primary literature) will be provided during the course.
- **Literature**
  - Literature will be selected with reference to the assigned research project.

#### Block Courses in 2nd Quarter of the Semester

*From 13.10.2016 08:00 hr to 4.11.2016 17:00 hr*

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-0345-00L</td>
<td>Mechanisms of Bacterial Pathogenesis</td>
<td>W</td>
<td>6</td>
<td>7P</td>
<td>W.D. Hardt</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>Research laboratory class in small groups. Research projects on current topics in cellular microbiology and bacterial pathogenesis are assigned to each student.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>Introduction to a current topic in cellular microbiology and/or molecular genetics of a bacterial pathogen. Experimental work in the research lab and introduction to the current lab techniques. Work with the current research literature in bacterial pathogenesis. Writing of a research protocol. Requirement for obtaining the credit points: oral presentation of the research project and evaluation of the research protocol.</td>
<td></td>
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</tr>
<tr>
<td><strong>Content</strong></td>
<td>Research projects on the model pathogen Salmonella.</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>Lecture notes</strong></td>
<td>none.</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td><strong>Literature</strong></td>
<td>Literature will be selected with reference to the assigned research project.</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>551-0421-00L</td>
<td>Biology and Ecology of Fungi in Forests</td>
<td>W</td>
<td>6</td>
<td>7G</td>
<td>I. L. Brunner, S. H. Egli, D. H. Rigling</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>Introduction of the biological and ecological basics of fungi in forests. Focusing on mycorrhizal, saprobic, and pathogenic fungi and their functional relevance in the forest ecosystems. To get to know current methodological research approaches on the basis of selected examples with practical works in forest and lab as well as excursions and lectures.</td>
<td></td>
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<tr>
<td><strong>Objective</strong></td>
<td>Knowledge of the fungi of forest and its ecological significance. Knowing of current methodological research approaches. Self-reliant and deepened activities of selected topics of fungi from forests.</td>
<td></td>
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</tr>
</tbody>
</table>
Content
Introduction of the biological and ecological basics of fungi in forests. Focusing on mycorrhizal, saprobic, and pathogenic fungi and their functional relevance in the forest ecosystems. To get to know current methodological research approaches on the basis of selected examples with practical works in forest and lab as well as excursions and lectures.

Lecture notes
Unterlagen zum Kurs werden abgegeben.

Literature

Prerequisites / notice
Der Blockkurs findet an der Eidg. Forschungsanstalt WSL in Birmensdorf statt. Der Wald vor der Haustüre des Institutes macht diesen Kurs besonders praxisnah.

Erreichbarkeit mit Tram 14 bis Triemli, danach PTT-Bus 220 oder 350 bis Birmensdorf Sternen/WSL, oder mit S9 bis Birmensdorf SBB und mit PTT-Bus eine Station in Richtung Zürich bis Birmensdorf Sternen/WSL.

551-0359-00L Plant Biochemistry
6 credits

Abstract
In this block course, students actively participate in ongoing research projects on plant metabolism and are tutored individually by doctoral students and postdocs. In a lecture series, the theoretical background for the projects and their interrelationship is provided, and in a seminar series, students will present their projects as well as discuss topical recent publications.

Objective
In this block course, students actively participate in ongoing research projects on plant metabolism and are tutored individually by doctoral students and postdocs.

Content
Participation in the following research projects will be possible: Photosynthetic metabolism: how is photo-assimilated carbon allocated to sustain plant growth? Chloroplast biology: how is chloroplast function integrated with that to the whole cell? Starch biosynthesis and degradation: how are complex, semi-crystalline starch granules made from simple sugars, and once made, how are they degraded again to release the stored carbohydrate? Regulation of metabolism through protein-protein interaction; how and why do proteins involved in starch metabolism interact with each other to form multi-subunit enzymes and multi-enzyme complexes? Sugar sensing; How does a plant know how much sugar it has, and how does this influence development.

Lecture notes
No script

Literature
No script.

551-1513-00L Cancer Cell Signaling: Mechanisms, Targets and Therapeutic Approaches
6 credits

Abstract
This course will consider the pathogenetic landscape of cancer, explore how abnormalities of cellular information management cause cancer and demonstrate how the integrated application of modern omics technologies, mouse cancer models and human pathology provides a foundation for developing individualized cancer therapeutics. The course combines practical work with discussions and presentations.

Objective
Insights into and overview about the genetic alterations that underlie different cancer types, the complex cancer cell circuitries governing tumor development, modern approaches used in contemporary basic and translational cancer research and sophisticated strategies to control individual cancers and combat drug resistance.

Lecture notes
No script

Literature
No script.

551-1147-00L Bioactive Natural Products from Bacteria
6 credits

Abstract
Lab course. In small groups projects of relevance to current research questions in the field of bacterial natural product biosynthesis are addressed.

Objective
Introduction to relevant subjects of the secondary metabolism of bacteria. Training in practical work in a research laboratory. Scientific writing in form of a research report.

Content
Research project on bacteria that produce bioactive natural products (e.g., Streptomycetes, Cyanobacteria, uncultivated bacteria). The techniques used will depend on the project, e.g. PCR, cloning, natural product analysis, precursor feeding studies, enzyme expression and analysis.

Lecture notes
none.

Literature
Will be provided for each of the projects at the beginning of the course.

551-0351-00L Membrane Biology
6 credits

Abstract
The course will introduce the students to the key concepts in membrane biology and will allow them to be involved in laboratory projects related to that broad field. The course will consist of lectures, literature discussions, and practical laboratory work in small groups. Results of the practical projects will be presented during the poster session at the end of the course.

Objective
The aim of the course is to expose the students to a wide range of modern research areas encompassed by the field of membrane biology.

Content
Students will be engaged in research projects aimed at understanding the biological membranes at the molecular, organellar and cellular levels. Students will design and perform experiments, evaluate experimental results, analyze the current scientific literature and understand the relevance of their work in the context of the current state of the membrane biology field.

Lecture notes
No script

Literature
The recommended literature, including reviews and primary research articles, will be provided during the course.

Prerequisites / notice
The course will be taught in English. All general lectures will be held at ETH Hönggerberg; special lectures will be organized by individual participating groups. Students will be divided into small groups to carry out experiments at ETH or at the Paul Scherrer Institute. Travel to the Paul Scherrer Institute will be organized by car rental or public transportation.

Block Courses in 3rd Quarter of the Semester
From 8.11.2016 13:00 hr to 30.11.2016 17:00 hr

Number Title Type ECTS Hours Lecturers
551-0355-00L Phytopathology
6 credits

Abstract
Fundamentals (theoretical and practical) in phytopathology, eg. interaction between plants and plant-pathogenic microorganisms, morphology and lifecycles of plant-pathogenic fungi, evolution of plant-pathogenic fungi, biological control of plant diseases

Objective
Insight into ongoing research projects
Experiments within ongoing phytopathological research projects
Macro- and microscopic diagnostic of plant diseases

Lecture notes

Biological Chemistry B: New Enzymes from Directed Evolution Experiments

Abstract

During the block course in the fall semester, we will carry out biological-chemical enzyme evolution experiments using molecular genetic mutation technologies and in vivo selection in recombinant bacterial strains. By working in parallel, teams of 2 participants each will generate a variety of different variants of a chorismate mutase. Individual enzyme catalysts will be purified and subsequently characterized using several different spectroscopic methods. The detailed chemical-physical analyses include determination of the enzymes' kinetic parameters, their molecular mass, and the integrity of the protein structure. The results obtained from the individual evolution experiments will be compared and discussed at the end of the class in a final seminar. We expect that during this lab course we will not only generate novel enzymes, but also gain new mechanistic insights into the investigated catalyst.

Objective

All technologies used for the experiments will be explained to the students in theory and in practice with the goal that they will be able to independently apply them for the course project and in future research endeavors. After the course, an individual report about the results obtained has to be prepared.

Content

The class deals with a specifically designed and genuine research project. We intend to carry out biological-chemical enzyme evolution experiments using molecular genetic mutation technologies and in vivo selection in recombinant bacterial strains. By working in parallel, teams of 2 participants each will generate a variety of different variants of a chorismate mutase. Individual enzyme catalysts will be purified and subsequently characterized using several different spectroscopic methods. The detailed chemical-physical analyses include determination of the enzymes' kinetic parameters, their molecular mass, and the integrity of the protein structure. The results obtained from the individual evolution experiments will be compared and discussed at the end of the class in a final seminar. We expect that during this lab course we will not only generate novel enzymes, but also gain new mechanistic insights into the investigated catalyst.

Lecture notes

General literature to "Directed Evolution" and chorismate mutases, e.g.:


Prerequisites / notice

Further literature will be indicated in the distributed script.

This laboratory course will involve experiments that require a tight schedule and (sometimes) long (!) working days. The maximum number of participants for the laboratory class is limited, but surplus applicants may contact P. Kast directly to have their names added to a waiting list. A valid registration is considered a commitment for attendance of the entire course, as involved material orders and experimental preparations are necessary and, once the class has started, the flow of the experiments must not be interrupted by individual absences. In case of an emergency, please immediately notify P. Kast. For more information, see also http://www.protein.ethz.ch/kast/praktikum.html

Methods in Cellular Biochemistry

Abstract

Students will learn about biochemical approaches to analyze cellular functions. The course consists of practical projects in small groups, lectures and literature discussions. The course concludes with the presentation of results at a poster session.

Objective

Students will learn to design, carry out and assess experiments using current biochemical and cell biological strategies to analyze cellular functions in a wide range of model systems. In particular they will learn novel imaging techniques along with biochemical approaches to understand fundamental cellular pathways. Furthermore, they will learn to assess strengths and limitations of the different approaches and be able to discuss their validity for the analysis of cellular functions.

Literature

Documentation and recommended literature (review articles and selected primary literature) will be provided during the course.

Prerequisites / notice

This course will be taught in English.

Insulin Signaling

Abstract

The students will obtain an overview about the current topics of research in insulin signaling and how it impacts on growth, metabolism and cell differentiation. They will learn to design experiments and use techniques necessary to analyze different aspects of insulin signaling, including physiological actions in whole animals as well as in tissue culture. Through lectures and literature seminars, they will learn about the open questions of insulin signaling research and discuss approaches to address these questions experimentally.

In practical lab projects the students will perform physiological in vivo studies as well as biochemical experiments. Finally, they will learn how to present and discuss their data. Student assessment is a graded semester performance based on individual performance in the laboratory, a written exam and the lab data presentation.

Experimental Food Microbiology for Biologists

Prerequisites: It is recommended to attend the course Lebensmittel-Mikrobiologie (752-4005-00L) as a preparation.

Abstract

Teaching of basic experimental knowledge for detection and identification of microorganisms in food. Practical experiments were accompanied by theoretical introductions. Students become acquainted with classical and state-of-the-art molecular techniques for the rapid detection of food borne pathogens and experiments in dependence on current research topics of the Laboratory of Food Microbiology.

Objective

Introduction of methods and techniques of food microbiology

Content

Teaching of basic experimental knowledge for detection and identification of foodborne pathogens by applying state-of-the-art techniques as well as modern molecular techniques for the rapid identification of relevant foodborne pathogens.

Lecture notes

Handouts were provided at the start of the course

- Krämer: "Lebensmittel-Mikrobiologie" (Ulmer; UTB)
- Süßmuth et al.: "Mikrobiologisch-Biochemisches Praktikum" (Thieme)
Prerequisites / notice

During the course we will work with the food-borne pathogen Listeria monocytogenes. Listeria monocytogenes represents a particular threat to pregnant women. Due to biosafety reasons participation is not allowed in case of pregnancy.

551-0363-00L Complex Carbohydrates - Biosynthesis, Structure & Function

<table>
<thead>
<tr>
<th>Number of participants limited to minimum 2 and maximum 8.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract: In vitro &amp; in vivo experiments will introduce current research on the biosynthesis, structure &amp; function of protein-bound glycans in different pro- and eukaryotic microorganisms.</td>
</tr>
<tr>
<td>Objective: Participants are familiar with the biosynthesis, structure and function of N-glycans in microorganisms and with the methods for their analysis.</td>
</tr>
<tr>
<td>Content: * Topics: biosynthesis of asparagine-linked glycans in pro- and eukaryotes; structure of glycans in different organisms; methods to analyse the structure of glycans; function of glycans in protein quality control * Introductory lectures * Seminar with presentation and discussion of recent publications * Experiments that exemplify the current research done in the group</td>
</tr>
</tbody>
</table>

551-0117-00L Plant Volatiles in Plant Insect Interactions

<table>
<thead>
<tr>
<th>Does not take place this semester.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract: During the course students will become familiar with methods for the collection and analysis of plant-derived volatile organic compounds and explore the role of these compounds in mediating plant-insect interactions.</td>
</tr>
<tr>
<td>Objective: The course will cover six main topics that will be connected throughout the experimental phase: 1) Plant volatile biosynthesis and classification 2) Insect olfactory physiology 3) Volatile-mediated plant-herbivore interactions 4) Volatile-mediated multitrrophic interactions 5) Manipulation of plant volatile emission by vector- borne disease agents 6) Methods for volatile collection and analysis. The lab practical will be performed in a system consisting of the cabbage butterfly Pieris brassicae, its host plant Brassica oleracea (Brussels sprouts), and the parasitoid wasp Cotesia glomerata (natural enemy of P. brassicae). Students will collect volatiles from herbivore-damaged and undamaged plants and learn how to identify and quantize these compounds through gas chromatography coupled with mass spectrometry and flame ionization detection (GG-MS-FID). Afterwards, they will be able to compare volatile emissions from herbivore-damaged and undamaged plants and identify important volatile compounds associated with herbivory. Finally, students will evaluate the effect of herbivore-induced volatile compounds on the behavior of the herbivore (P. brassicae) and its natural enemy (C. glomerata), using different behavioral assays, including Y-tube olfactometers and wind tunnels.</td>
</tr>
<tr>
<td>Lecture notes: No script</td>
</tr>
<tr>
<td>Literature: The recommended literature, including reviews and primary research articles, will be provided during the course.</td>
</tr>
</tbody>
</table>

Block Courses in 4th Quarter of the Semester

From 1.12.2016 08:00 hr to 23.12.2016 17:00 hr

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-0361-00L</td>
<td>Biology of Bryophytes and Ferns</td>
<td>W</td>
<td>6 credits</td>
<td>7G</td>
<td>R. Holderegger, A. L. Bergamini</td>
</tr>
<tr>
<td>551-1309-00L</td>
<td>RNA-Biology</td>
<td>W</td>
<td>6 credits</td>
<td>7G</td>
<td>C. Claudio, F. Allain, J. Hall, H. L. Lightfoot, B. Mateescu, O. Voinnet, K. Weis, A. Wutz</td>
</tr>
<tr>
<td>551-1511-00L</td>
<td>Parallels Between Tissue Repair and Cancer</td>
<td>W</td>
<td>6 credits</td>
<td>7G</td>
<td>S. Werner, U. Auf dem Keller, M. Bordoli, M. Schäfer</td>
</tr>
</tbody>
</table>

| Grade according to poster presentation and contributions during the course. |
| Requirements: First and second year courses in Botany and Evolution. |

IMPORTANT NOTICE:

Autumn Semester 2016

Page 225 of 1571
To learn the cellular and molecular principles underlying tissue repair processes, in particular in the skin and in the liver, and the parallels and differences to cancer. To learn modern technologies in Molecular and Cellular Biology as well as Histology and to use these technologies to study questions related to mechanisms underlying tissue repair and cancer.

This course aims at the understanding of the cellular and molecular mechanisms underlying tissue repair processes in response to different insults. The focus will be on repair of the skin and the liver. In addition, we will highlight the parallels and differences between tissue repair and cancer. Experimental approaches include biochemical studies, molecular and cellular studies using cultured cell lines and primary cells, as well as analysis of murine and human tissues. The course combines practical work with lectures, discussions, project preparations and presentations.

The aims of the block course are that participants

(I) understand the function and evolution of insulin/TOR signaling

(II) learn how genetic approaches in different organisms contribute to the understanding of human diseases such as cancer

(III) will get familiarized with reading and discussing research articles

(IV) get a first exposure to current research.

The block course consists of

(I) experiments:
Teams of two students each will join research labs to work on current projects focusing on growth regulation in both single-cell eukaryotes (yeast) and multicellular animals (Drosophila). The students will present their projects and results to their colleagues.

(II) lectures on growth regulation in yeast and Drosophila.

(III) journal clubs to discuss recent literature.

Students will acquire the skills to cultivate bacteria, plunge-freeze samples for cryotomography, collect data using an electron cryomicroscope, process raw data, analyze tomograms, perform subtomogram averaging, model structures of interest, and generate movies for visualization.

The course combines practical work with lectures, discussions, project preparations and presentations.

The taxonomic part will cover macroinvertebrates (e.g. Crustacean, aquatic insects), microinvertebrates and algae. The goal is to get to know the most important identification traits.

The practical part includes excursions to Greifensee, to the river Sense (natural river system) and to the river Töss (groundwater).

Practical part:
The habitat properties of freshwaters. Applied case studies and experiments testing ecological and evolutionary processes in freshwaters. Important aspects regarding ecosystem metabolism and patterns, biotic interactions, and conceptual paradigms in freshwater ecosystems. Important aspects regarding ecosystem metabolism and habitat properties of freshwaters. Applied case studies and experiments testing ecological and evolutionary processes in freshwaters.

The course combines Limnology (the study of inland waters in its broad sense) with ecological and evolutionary concepts. It deals with applied case studies and experiments testing ecological and evolutionary processes in freshwaters.

The lecture part covers ecology and evolution of aquatic organisms in lentic and lotic waters. Topics include: Adaptations, distribution patterns, biotic interactions, and conceptual paradigms in freshwater ecosystems. Important aspects regarding ecosystem metabolism and habitat properties of freshwaters. Applied case studies and experiments testing ecological and evolutionary processes in freshwaters.

During the experimental part of this course you will learn the principles of doing research to observe interrelations in aquatic ecosystems. You will measure and interpret biological and physical data (e.g. during experiments, field work) and present the collected knowledge. After this course you will know the most important aquatic species groups (macroinvertebrates, microinvertebrates and cryptogames) in Switzerland and the most important identification traits.

The course contains a lecture part, an experimental part, two determination courses (aquatic invertebrates and algae) and field excursions.

Lecturers

J. Jokela, P. Spaak, F. Altermatt, T. Gonser, K. J. Räsänen, C. T. Robinson

This course is designed to provide an overview of the world's typical continental aquatic ecosystems. After this course you will be able to understand how aquatic organisms have adapted to their habitat, and how the interactions (e.g. food web) between organisms work.

During the experimental part of this course you will learn the principles of doing research to observe interrelations in aquatic ecosystems. You will measure and interpret biological and physical data (e.g. during experiments, field work) and present the collected knowledge. After this course you will know the most important aquatic species groups (macroinvertebrates, microinvertebrates and cryptogames) in Switzerland and the most important identification traits.

The course contains a lecture part, an experimental part, two determination courses (aquatic invertebrates and algae) and field excursions.

Lecturer:
The lecture part covers ecology and evolution of aquatic organisms in lentic and lotic waters. Topics include: Adaptations, distribution patterns, biotic interactions, and conceptual paradigms in freshwater ecosystems. Important aspects regarding ecosystem metabolism and habitat properties of freshwaters. Applied case studies and experiments testing ecological and evolutionary processes in freshwaters.

Practical part:
The practical part includes excursions to Greifensee, to the river Sense (natural river system) and to the river Töss (groundwater).

Additionally, you will perform in small groups an independent experiment in a research group at Eawag.

The taxonomic part will cover macroinvertebrates (e.g. Crustacean, aquatic insects), microinvertebrates and algae. The goal is to get to know the most common aquatic taxa in Switzerland, to identify them with commonly used identification literature, and to get an idea how these organisms are used in research and practice. (language: German, translation of the most important things during the course possible)

Course notes and power point presentations provided during the course.

The maximal participating number of biology students is 14.
Analysis of Human T and B Cell Responses to Infectious Agents

Number of participants limited to 8.

Objective
Students actively participate in ongoing research projects on the analysis of human T and B cell response to pathogens and vaccines. They will be tutored in small groups by doctoral students and postdocs. In a lecture series, the theoretical background for the projects will be provided and the students will have the opportunity to present their projects and discuss recent publications.

Abstract
To learn current methodologies in human immunology through experimental work in the lab. To learn current concepts through lectures and discussion of original papers. Requirement for obtaining the credit points: oral presentation of the research project in a ppt format.

Protein Folding, Assembly and Degradation

Number of participants limited to 6.

Objective
The course should enable the students to understand and apply biophysical methods, in particular kinetic and spectroscopic methods, to unravel the mechanism of complex reactions of biological macromolecules and assemblies in a quantitative manner.

Abstract
Students will carry out defined research projects related to the current research topics of the groups of Prof. Glockshuber and Prof. Weber-Ban. The topics include mechanistic studies on the assembly of adhesive pili from pathogenic bacteria, disulfide bond formation in the bacterial periplasm, ATP-dependent chaperone-protease complexes and formation of amyloid deposits in Alzheimer's disease.

Content
The students will be tutored in their experimental work by doctoral or postdoctoral students from the Glockshuber or Weber-Ban group. In addition, the course includes specific lectures that provide the theoretical background for the experimental work, as well as exercises on the numeric evaluation of biophysical data, and literature work.

Participation in one of the following projects will be possible:

Projects of the Glockshuber group:
- Purification, biophysical characterization and structure determination of enzymes required for disulfide bond formation in the periplasm of Gram-negative bacteria.
- Identification of intermediates in the aggregation of the human Abeta peptide

Experimental work on these projects involves:
- Molecular cloning, recombinant protein production in E. coli and protein purification
- Protein crystallization
- Thermodynamic and kinetic characterization of conformational changes in proteins and protein-ligand interactions by fluorescence and circular dichroism spectroscopy
- Analysis of rapid reactions by stopped-flow fluorescence
- Negative-stain electron microscopy
- Light scattering

Projects of the Weber-Ban group:
- Generation and purification of site-directed variants of the E. coli ClpA/P protease and chaperone-proteasome complexes from other organisms, their biophysical characterization, including rapid kinetics by stopped-flow methods, ATPase activity measurements, negative-stain electron microscopy and light scattering

Number of participants limited to 11.

Genomic and Genetic Methods in Cell and Developmental Biology

Number of participants limited to 11.

Objective
The course aims to provide students with a comprehensive overview of mammalian developmental biology and stem cell systems both on the theoretical as well as the experimental level. Centering the course on genetic and genomic methods engages the students in unravelling the mechanism of complex reactions of biological macromolecules and assemblies in a quantitative manner.

Abstract
This course aims to provide students with a comprehensive overview of mammalian developmental biology and stem cell systems both on the theoretical as well as the experimental level. Centering the course on genetic and genomic methods engages the students in contemporary research and prepares for future studies in the course of semester and master projects.

Content
The course will consist of a series of lectures, essay assignments, project development and discussion workshops, and 2 and a half week of lab work with different mammalian cell systems embedded in real life research projects. At the end of the course students will take an exam consisting of questions on the topic of the lectures and workshops. It is expected that students will be able to apply the knowledge to concrete problems.

GESS Science in Perspective

see GESS Science in Perspective: Type A: Enhancement of Reflection Capability

see GESS Science in Perspective: Language Courses ETH/ÜZH

Recommended GESS Science in Perspective (Type B) for D-BIOL.

Biology Bachelor - Key for Type

<p>| Dr | Suitable for doctorate | W | Eligible for credits |
| O | Compulsory | E- | Recommended, not eligible for credits |
| W+ | Eligible for credits and recommended | Z | Courses outside the curriculum |</p>
<table>
<thead>
<tr>
<th>Key for Hours</th>
<th>Example</th>
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<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

ECTS European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
Biology Teaching Diploma

The programme “Teaching Diploma, Two Subjects in One-Step Procedure” will not be offered anymore since Autumn Semester 2010. Therefore new matriculations are no longer possible. The courses offered below are valid only for students who have registered before.

Detailed information on the programme at: www.didaktischeausbildung.ethz.ch

▶ Biology as First Subject

▶ Educational Science

Course offerings in the category Educational Science are listed under “Programme: Educational Science for Teaching Diploma and TC”.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0242-06L</td>
<td>Cognitively Activating Instructions in MINT Subjects</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>R. Schumacher</td>
</tr>
<tr>
<td></td>
<td>Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).</td>
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<tr>
<td></td>
<td>This course unit can only be enrolled after successful participation in, or during enrollment in the course “Human Learning (EW 1)”.</td>
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<tr>
<td></td>
<td>This seminar focuses on teaching units in chemistry, physics and mathematics that have been developed at the MINT Learning Center of the ETH Zurich. In the first meeting, the mission of the MINT Learning Center will be communicated. Furthermore, in groups of two, the students will intensively work on, refine and optimize a teaching unit following a goal set in advance.</td>
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<tr>
<td></td>
<td>Objectives: - Get to know cognitively activating instructions in MINT subjects - Get information about recent literature on learning and instruction</td>
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<td></td>
<td>Prerequisites / notice: Für eine reibungslose Semesterplanung wird uns frühe Anmeldung und persönliches Erscheinen zum ersten Lehrveranstaltungstermin ersucht.</td>
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<tr>
<td>851-0242-07L</td>
<td>Human Intelligence</td>
<td>W</td>
<td>1</td>
<td>1S</td>
<td>E. Stern, P. Edelsbrunner, B. Rütsche</td>
</tr>
<tr>
<td></td>
<td>Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).</td>
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<td></td>
<td>Number of participants limited to 30.</td>
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<tr>
<td></td>
<td>This course unit can only be enrolled after successful participation in, or during enrollment in the course “Human Learning (EW 1)”.</td>
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<tr>
<td></td>
<td>Abstract: The focus will be on the book “Intelligenz: Grosse Unterschiede und ihre Folgen” by Stern and Neubauer. Participation at the first meeting is obligatory. It is required that all participants read the complete book. Furthermore, in two meetings of 90 minutes, concept papers developed in small groups (5 to 10 students) will be discussed.</td>
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<tr>
<td></td>
<td>Objective: - Understanding of research methods used in the empirical human sciences - Getting to know intelligence tests - Understanding findings relevant for education</td>
<td></td>
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<tr>
<td>851-0242-08L</td>
<td>Research Methods in Educational Science</td>
<td>W</td>
<td>1</td>
<td>1S</td>
<td>P. Edelsbrunner, B. Rütsche, E. Stern, E. Ziegler</td>
</tr>
<tr>
<td></td>
<td>Number of participants limited to 30.</td>
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<tr>
<td></td>
<td>This course unit can only be enrolled after successful participation in, or during enrollment in the course “Human Learning (EW 1)”.</td>
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<tr>
<td></td>
<td>Abstract: Literature from the learning sciences is critically discussed with a focus on research methods. At the first meeting, working groups will be assembled and meetings with those will be set up. In the small groups students will write critical essays about the read literature. At the third meeting, we will discuss the essays and develop research questions in group work.</td>
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<tr>
<td></td>
<td>Objective: - Understand research methods used in the empirical educational sciences - Understand and critically examine information from scientific journals and media - Understand pedagogically relevant findings from the empirical educational sciences</td>
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<td></td>
<td>Number of participants limited to 20.</td>
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<td></td>
<td>The successful completion of both course no. 851-0240-00L “Menschliches Lernen (EW 1)” and course no. 851-0238-01L “Unterstützung und Diagnose von Wissenserwerbsprozessen (EW 3)” is a necessary prerequisite for this course.</td>
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<td></td>
<td>Abstract: In teams of two, participants in this seminar conduct their own research project. Each team is advised by one of the researchers serving as lecturers in this course. Basic conceptual and methodological issues are the topic of a series of plenary meetings; however, the major part of the work is done in small-group meetings with the advising researcher, and in self-directed research projects.</td>
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<td></td>
<td>Objective: The course is targeted at advanced students who have taken an interest in gathering practical research experience in the field of Learning &amp; Instruction. In teams of two, students conduct their own research projects (planning, conducting, analyzing, interpreting, and presenting research); thus, the course requires a high amount of self-directed working. Students are personally advised, and supported in their research project, by one of the researchers serving as lecturers in this course. During the first half the semester, relevant methodological knowledge and skills are practiced during plenary meetings and in students’ independent reading (e.g. generating and testing research questions, designing experiments, and analyzing data in the field of Learning and Instruction) Learning goals include: - Participants can illustrate and explain basic methods and concepts for research in the fields of Learning and Instruction, e.g. with the help of practical examples. - Participants can generate testable research questions for a topic relevant in the fields of Learning and Instruction. - Participants can design and conduct a study that is relevant for answering their research question. - Participants can summarize and evaluate the main results from a study in the field of learning and instruction, with regard to the research question being asked.</td>
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see Educational Science Teaching Diploma

▶ Subject Didactics in Biology

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
</table>

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Thematische Schwerpunkte

P. Faller

Eine kurze Anleitung zur mentorierten Arbeit in Fachdidaktik wird zur Verfügung gestellt.

J. Egli

Mentored Work Subject Didactics Biology B - Basic conditions for tuition (MAR - recognition of Matura certificates - curricula, standards), selection of topics and reduction of the complexity of topics.

In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.

The objective is for the students:

- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.

- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

Content

Die Literatur ist themenspezifisch. Die Studierenden beschaffen sie sich in der Regel selber (siehe Lernziele). In besonderen Fällen wird sie vom Betreuer zur Verfügung gestellt.

The Subject Didactics as well as possible branch-specific requirements must be fulfilled prior to commencing the mentored paper.

Abstract

In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.

Objective

The objective is for the students:

- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.

- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

Content

Themenwahl nach Vereinbarung.

Die Literatur ist themenspezifisch. Die Studierenden beschaffen sie sich in der Regel selber (siehe Lernziele). In besonderen Fällen wird sie vom Betreuer zur Verfügung gestellt.

Prerequisites / notice

Beginn nach Absprache jederzeit möglich, jedoch erst nach Abschluss der Fachdidaktik I und II und nach der Absolvierung allfälliger fachwissenschaftlicher Voraussetzungen.

Die Arbeit sollte vor Beginn des Unterrichtspraktikums abgeschlossen werden.

Allfällige fachwissenschaftliche Auflagen müssen alle erfüllt sein, bevor mit der Mentorierten Arbeit begonnen werden kann.

Subject Didactics Biology A

Simultaneous enrolment in Introductory Internship Biology

- course 551-0968-00L - is compulsory.

Abstract

- Basic conditions for tuition (MAR - recognition of Matura certificates - curricula, standards), selection of topics and reduction of the complexity of topics.

- Application of teaching methods and techniques from educational science in biology classes.

- Planning and preparation of lessons.


Objective

- Students can discuss and put into practice in their teaching work the conditions and objectives set out in the regulations governing the school-leaving examination (Matura), the framework curriculum and the condition and objectives specified by their school.

- They are in a position to select learning objectives and formulate these on the basis of the target level model. They can plan and prepare lessons and can also develop appropriate learning assignments.

- Students can reconstruct specialist contents in didactic terms and develop teaching modules suitable for the different levels from these on the basis of the subject structure and learner requirements.

- They can reduce the complexity of subject-based specialist contents and present them in such a way that they are comprehensible and meaningful for learners.

- They can select appropriate media for their work (e.g. school books) and use these. They can employ appropriate experiments.

- They can use different forms of examination for monitoring performance.

- Students are in a position to implement and discuss the concepts of biology teaching and learning on the basis of specific topics covered in school biology.

Content


Lecture notes

Wird laufend in der Vorlesung abgegeben.
**Professional Training (First Subject)**

**Important:** You can only enrol in the courses of this category if you have not more than 12 CP left for possible additional requirements.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>551-0968-00L</td>
<td>Introductory Internship Biology ■</td>
<td>O</td>
<td>3</td>
<td>6P</td>
<td>P. Faller</td>
</tr>
<tr>
<td>Abstract</td>
<td>During the introductory teaching practice, the students sit in on five lessons given by the teacher responsible for their teaching practice, and teach five lessons themselves. The students are given observation and reflection assignments by the teacher responsible for their teaching practice.</td>
<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>Right at the start of their training, students acquire initial experience with the observation of teaching, the establishment of concepts for teaching and the implementation of teaching. This early confrontation with the complexity of everything that teaching involves helps students decide whether they wish to and, indeed, ought to, continue with the training. It forms a basis for the subsequent pedagogical and subject-didactics training.</td>
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<tr>
<td>Literature</td>
<td>Wird von der Praktikumslehrperson bestimmt.</td>
<td></td>
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<tr>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>551-0966-00L</td>
<td>Teaching Internship Biology ■</td>
<td>O</td>
<td>8</td>
<td>17P</td>
<td>P. Faller</td>
</tr>
<tr>
<td>Abstract</td>
<td>The teaching practice takes in 50 lessons: 30 are taught by the students, and the students sit in on 20 lessons. The teaching practice lasts 4-6 weeks. It gives students the opportunity to implement the contents of their specialist-subject, educational science and subject-didactics training in the classroom. Students also conduct work assignments in parallel to their teaching practice.</td>
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<tr>
<td>Objective</td>
<td>- Students use their specialist-subject, educational-science and subject-didactics training to draw up concepts for teaching. - They are able to assess the significance of tuition topics in their subject from different angles (including interdisciplinary angles) and impart these to their pupils. - They acquire the skills of the teaching trade. - They practise finding the balance between instruction and openness so that pupils can and, indeed, must make their own cognitive contribution. - They learn to assess pupils’ work. - Together with the teacher in charge of their teacher training, the students constantly evaluate their own performance.</td>
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</tr>
<tr>
<td>Literature</td>
<td>Wird von der Praktikumslehrperson bestimmt.</td>
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<tr>
<td>551-0967-00L</td>
<td>Teaching Internship Biology II ■</td>
<td>W</td>
<td>4</td>
<td>9P</td>
<td>P. Faller</td>
</tr>
<tr>
<td>Abstract</td>
<td>This is a supplement to the Teaching Internship required to obtain in the corresponding subject. It is aimed at enlarging the already acquired teaching experience. Students observe 10 lessons and teach 15 lessons independently.</td>
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<tr>
<td>Objective</td>
<td>Students are able to assess in their subject the importance of teaching topics from different angles. They learn and master the teaching trade. They can structure a given lesson topic for a group of learners technically and didactically correctly and they can transfer it into an appropriate learning environment. They manage to find the balance between instruction and openness, so that the learners have both, the necessary freedom and sufficient orientation to acquire actively and a effectively adaptive (expert) knowledge.</td>
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<th>Number</th>
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<tbody>
<tr>
<td>551-0969-01L</td>
<td>Examination Lesson I Biology ■</td>
<td>O</td>
<td>1</td>
<td>2P</td>
<td>P. Faller</td>
</tr>
<tr>
<td>Abstract</td>
<td>In the context of an examination lesson conducted and graded at a high school, the candidates provide evidence of the subject-matter-based and didactic skills they have acquired in the course of their training.</td>
<td></td>
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<tr>
<td>Objective</td>
<td>- To develop and conduct teaching that is conducive to learning at high school level, substantiating it in terms of the subject-matter and from the didactic angle - To analyze the tuition they have given with regard to its strengths and weaknesses, and outline improvements.</td>
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<tr>
<td>Lecture notes</td>
<td>Dokument: Schriftliche Vorbereitung für Prüfungslektionen.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Nach Abschluss der übrigen Ausbildung.</td>
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<th>Lecturers</th>
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<tr>
<td>551-0969-02L</td>
<td>Examination Lesson II Biology ■</td>
<td>O</td>
<td>1</td>
<td></td>
<td>P. Faller</td>
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</tbody>
</table>

Data: 06.03.2019 12:57  Autumn Semester 2016  Page 231 of 1571
Simultaneous enrolment in “Examination Lesson I: Biology” (551-0969-01L) is compulsory.

Abstract
In the context of an examination lesson conducted and graded at a high school, the candidates provide evidence of the subject-matter-based and didactic skills they have acquired in the course of their training.

Objective
On the basis of a specified topic, the candidate shows that they are in a position:
- to develop and conduct teaching that is conducive to learning at high school level, substantiating it in terms of the subject-matter and from the didactic angle
- to analyze the tuition they have given with regard to its strengths and weaknesses, and outline improvements.

Content
The Studierenden erfahren das Lektionsthema in der Regel 10 Tage vor dem Prüfungstermin. Von der zuständigen Lehrperson erhalten sie Informationen über den Wissensstand der zu unterrichtenden Klasse und können sie vor dem Prüfungstermin besuchen.
Sie erstellen eine Vorbereitung gemäss Anleitung und reichen diese 48 Stunden vor dem Prüfungstermin den beiden Prüfungsexperten ein.
Die gehaltene Lektion wird kriteriernbasiert beurteilt. Die Beurteilung umfasst auch die schriftliche Vorbereitung und eine mündliche Reflexion des Kandidats/ der Kandidatin über die gehaltene Lektion im Rahmen eines kurzen Kolloquiums.

Lecture notes
Dokument: Schriftliche Vorbereitung für Prüfungslektionen.

Prerequisites
Nach Abschluss der übrigen Ausbildung.

551-0913-00L Professional Exercises in Biology
Primarily target exercises in biology in schools. This includes finding, testing and further developing suitable protocols for different subject areas of school biology. Working out how to didactically embed the experiments in lessons.

Abstract
Implementation of Subject Didactics I and II with the focus on conducting biological experiments in schools. This includes finding, testing and further developing suitable protocols for different subject areas of school biology. Working out how to didactically embed the experiments in lessons.

Objective
After successfully completing the module, students should be in a position:
- to call up more in-depth specialist knowledge of biology, covering a wide range of topics, and to impart this to others.
- to analyse controversial topics and to give factual explanations for these.
- to conduct more in-depth work on a research topic and to compile a tuition unit based on this topic.
- to prepare tuition units involving complex learning matter at a high specialist level which are suitably tailored to the recipients, and to teach these in a manner conducive to learning.

Lecture notes
Hand out of course material.

Prerequisites
Der Teil biologische Experimente findet im Rahmen von 7 Halbtagen statt.


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<tr>
<th>Number</th>
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<tr>
<td>551-0963-00L</td>
<td>Specialized Biology Course with an Educational Focus: Teaching Diploma</td>
<td>O</td>
<td>12</td>
<td>26A</td>
<td>E. Hafen, J. Egli, W.D. Hardt, M. Zwicky</td>
</tr>
</tbody>
</table>

Abstract
Specialist aspects of biology are covered from the angle of imparting these to pupils, their historical development, and their significance for the subject, the individual and society.

Objective
After successfully completing the module, students should be in a position:
- to call up more in-depth specialist knowledge of biology, covering a wide range of topics, and to impart this to others.
- to analyse controversial topics and to give factual explanations for these.
- to conduct more in-depth work on a research topic and to compile a tuition unit based on this topic.
- to prepare tuition units involving complex learning matter at a high specialist level which are suitably tailored to the recipients, and to teach these in a manner conducive to learning.

Content
Demanding biological topics are dealt with under consideration of the special needs of persons involved in teaching. The module comprises the parts:

1) Lecture (Tues. 08.00-09.45 hrs)
2) Colloquium (every second Tues. 10.15-12.00 hrs., begins on first lecture day)
3) Seminar with presentation (every second Tues. 10.15-12.00 hrs., begins in second lecture week)
4) Seminar thesis in a research group (7 weeks)

Lecture notes
Unterlagen für den Unterricht werden online mit Hilfe der e-learning Platform OLAT abgegeben.

Prerequisites
This Course lasts for two semesters. It can be started in autumn or in spring. Booking is only required once.

Performance Assessment:
Performance is assessed during the course of the entire modul, with a final test. Active participation in the colloquia and group seminars is required. The thesis report and an oral presentation have to be completed.

The Specialized Biology Course with an Educational Focus (12 CP) can be acknowledged, in agreement with the advisor of the respective elective major, as one of the two obligatory research projects (each 15 CP). In such a case, additional 3 CP must be obtained in another course.

In case of overbooking of the course, students enrolled in the Teaching Diploma in Biology will have priority for registration.

The course is organized jointly with the University of Zurich (Fachbereich Biologie) and is held at the Life Science Zurich Learning Center of the ETH Zurich and the University of Zurich.
Demanding biological topics are dealt with under consideration of the special needs of persons involved in teaching. The module:

1) Lecture (Tues. 08.00-09.45 hrs)
2) Colloquium (every second Tues. 10.15-12.00 hrs., begins on first lecture day)
3) Seminar with presentation (every second Tues. 10.15-12.00 hrs., begins in second lecture week)
4) Semester thesis in a research group (3.5 weeks)

Lecture notes
None.

Literature
Specific references will be made available for the individual projects.

Prerequisites / notice
The program of this course represents one half (6 CP) of that of the Specialized Biology Course with an Educational Focus (551-0963-00, 12 CP).

Compulsory Elective Courses

Further course offerings from the category Educational Science are listed under "Programme: Educational Science for Teaching Diploma and TC".

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<thead>
<tr>
<th>Number</th>
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<tbody>
<tr>
<td>851-0180-00L</td>
<td>Research Ethics ▼</td>
<td>W</td>
<td>2 credits</td>
<td>2G</td>
<td>G. Achermann</td>
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</tbody>
</table>

*Particularly suitable for students of D-BIOL, D-CHAB, D-HEST*

Abstract
This course has its focus on the responsible conduct of research (RCR) and the ethical dimensions of the biological and biomedical sciences.

Objective
The main goal of this course is to enhance the student’s ability to:
- recognize and identify ethical issues and conflicts,
- analyze and develop well-reasoned responses to the kinds of ethical problems a scientist is likely to encounter.

Additionally, students will become familiar with regulations and ethical guidelines relevant for their research field on the international, governmental, institutional and professional level.

To achieve these objectives, teaching methods will include lectures, discussions, case study work (alone and in groups), moral games, paper work and exercises.
I. Ethics & the Process of Ethical Inquiry

Introduction in Ethics and Research Ethics
- What is ethics? What ethics is not...;
- Awareness: what constitutes an ethical question? Distinguishing ethical questions from other kinds of questions; Science & ethics: a comparison;
- The ethics movement in the biological and health sciences;
- What is research ethics and why is it important?
- Values (personal, cultural & ethical) in science & principles for ethical conduct in research;
- Professional codes of conduct: functions and limitations

Ethical approaches in the conduct of research (Normative Ethics)
- Overview over important theories for research ethics: virtue theories, duty-based theories (rights theory, categorical imperative, prima facie duties), consequentialist theories, other theories);
- The plurality of ethical theories and its consequences;
- The concept of dignity

Moral reasoning I: Arguments
- Why arguments? What is a good argument? The structure of (moral) arguments;
- Deductive and inductive arguments; Validity and soundness;
- Assessing moral arguments

Moral reasoning II: Decision-making
- How (not) to approach ethical issues...; Is there a correct method for answering moral questions?
- Models of method in Applied Ethics: a) Top-down approaches; b) the reflective equilibrium; c) a bottom-up approach: casuistry (or reasoning-by-analogy);
- Is there a right answer?

II. Research Ethics / Responsible Conduct of Research (RCR)

Integrity in Research & Research Misconduct
- What is "integrity" in scientific research? What is research misconduct (falsification, fabrication, plagiarism - FFP) and questionable research practices (QRP)?
- Factors leading to misconduct; Procedure for responding to allegations of research misconduct;
- The confidant of ETH Zurich

Data Management
- Data collection and recordkeeping; Analysis and selection of data;
- Ownership of data; retention and sharing of data;
- Falsification and fabrication of data

Research involving animals
- The moral status of animals; Ethical approaches to animal experimentation: Animal welfare (Peter Singer) and Animal rights (Tom Regan);
- The 3 Rs (replacement, reduction, refinement);
- Ethical assessment of conflicting issues in animal experimentation;
- The dignity of animals in the Swiss constitution;

Research involving human subjects
- History & guidelines (Nuremberg Code; Declaration of Helsinki; Belmont Report; International Ethical Guidelines for Biomedical Research Involving Human Subjects (CIOMS Guidelines); Convention on Human Rights and Biomedicine (Oviedo Convention);
- Informed consent; confidentiality and anonymity; research risks and benefits; vulnerable subjects;
- Clinical trials;
- Biobanks
- Ethics Committees / Institutional Review Boards (IRB)

Authorship & Peer review
- Criteria for authorship;
- Plagiarism;
- Challenges to openness and freedom in scientific publication;
- Open access
- Peer review

Social responsibility
- What is social responsibility? Social responsibility: whose obligation?
- Public advocacy by researchers

Lecture notes
Course material (handouts, case studies, exercises, surveys and papers) will be available during the lectures and on the course homepage.

Literature
Recommended literature:
- "Introduction to the Responsible Conduct of Research" (http://or.odhs.gov/education/products/RCRintro/)

Detailed literature lists for the different topics of the course will be provided in the script/handout or on the course work space.
The seminar covers the following topics:

1. Theories and concepts of inter- and transdisciplinary research
2. The specific challenges of inter- and transdisciplinary research
3. Involving stakeholders
4. Collaborating disciplines
5. Exploration of tools and methods
6. Analysing participants' projects to improve inter- and transdisciplinary elements

Literature will be made available to the participants

The seminar is specifically suitable for PhD or PostDoc researchers. It is open to master students (minor "global change and sustainability") and further interested people, who preferably are preparing, or working on, a project/thesis.

701-1551-00L Environmental Governance W 3 credits 2G E. Lieberherr

Abstract

The course addresses environmental policies, focusing on new steering approaches, which are generally summarized as environmental governance. The course also provides students with tools to analyze environmental policy processes and assesses the key features of environmental governance by examining various practical environmental policy examples.

Objective

To understand how an environmental problem may (not) become a policy and explain political processes, using basic concepts and techniques from political science.

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

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

Content

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

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

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

Lecture notes

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

Literature

We will mostly work with readings from the following books:

Prerequisites / notice

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

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

701-1551-00L Sustainability Assessment W 3 credits 2G P. Krüttli, C. E. Pohl

Abstract

The course deals with the concepts and methodologies for the analysis and assessment of sustainable development. A special focus is given to the social dimension and to social justice as a guiding principle of sustainability as well as to trade-offs between the three dimensions of sustainability.

The course is seminar-like, interactive.

Objective

At the end of the course students should

Know:
- core concepts of sustainable development, and;
- the concept of social justice - normatively and empirically - as a core element of social sustainability;
- important empirical methods for the analysis and assessment of local / regional sustainability issues.

Understand and reflect on:
- the challenges of trade-offs between the different goals of sustainable development;
- and the respective impacts on individual and societal decision-making.

Content

The course is structured as follows:
- Overview of rationale, objectives, concepts and origins of sustainable development;
- Importance and application of sustainability in science, politics, society, and economy;
- Sustainable (local / regional) development in different national / international contexts;
- Analysis and evaluation methods of sustainable development with a focus on social justice;
- Trade-offs in selected examples.

Lecture notes

Handouts.

Literature

Selected scientific articles & book chapters

551-0916-00L Learning and Teaching Biology W 6 credits 7G E. Hafen

Does not take place this semester.

The block course will only take place with a minimum of 10 participants.

Abstract

This course represents an introduction to recent research into student learning on the conceptual foundations of modern biology, together with methodological approaches associated with effective instruction and its valuation. Students will be involved in active research into conceptual and practical issues involved in biology education and methods to discover student preconceptions.

Objective

Provides an overview on student's learning and shows ways to make the classroom experience more engaging and effective for students. Students will learn to produce a research-based paper on a project they work on during the course.
Biology as Second Subject

Subject Didactics in Biology

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-0971-00L</td>
<td>Subject Didactics Biology I - Simultaneous enrolment in Introductory Internship Biology</td>
<td>O</td>
<td>4 credits</td>
<td>3G</td>
<td>P. Faller</td>
</tr>
</tbody>
</table>

Abstract

- Basic conditions for tuition (MAR - recognition of Matura certificates - curricula, standards), selection of topics and reduction of the complexity of topics.
- Application of teaching methods and techniques from educational science in biology classes.
- Planning and preparation of lessons.

Objective

- Students can discuss and put into practice in their teaching work the conditions and objectives set out in the regulations governing the school-leaving examination (Matura), the framework curriculum and the conditions and objectives specified by their school.
- They are in a position to select learning objectives and formulate these on the basis of the target level model. They can plan and prepare lessons and can also develop appropriate learning assignments.
- Students can reconstruct specialist contents in didactic terms and develop teaching modules suitable for the different levels from these on the basis of the subject structure and learner requirements.
- They can reduce the complexity of subject-based specialist contents and present them in such a way that they are comprehensible and meaningful for learners.
- They can select appropriate media for their work (e.g. school books) and use these. They can employ appropriate experiments.
- The students can use different forms of examination for monitoring performance.
- Students are in a position to implement and discuss the concepts of biology teaching and learning on the basis of specific topics covered in school biology.

Content


Lecture notes

Wird laufend in der Vorlesung abgegeben.

Prerequisites / notice

Studierende müssen LE zusammen mit dem Einführungspraktikum - LE 551-0968-00L - belegen.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-0961-00L</td>
<td>Mentored Work Subject Didactics Biology A - Mentored Work Subject Didactics in Biology for Teaching Diploma, Teaching Diploma Biology as Minor Subject. The Subject Didactics as well as possible branch-specific requirements must be fulfilled prior to commencing the mentored paper.</td>
<td>O</td>
<td>2 credits</td>
<td>4A</td>
<td>J. Egli</td>
</tr>
</tbody>
</table>

Abstract

In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.

Objective

The objective is for the students:
- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.
- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

Content

Themenwahl nach Vereinbarung.

Lecture notes

Eine kurze Anleitung zur mentorierten Arbeit in Fachdidaktik wird zur Verfügung gestellt.

Prerequisites / notice

Beginn nach Absprache jederzeit möglich, jedoch erst nach Abschluss der Fachdidaktik I und II und nach der Absolvierung allfälliger fachwissenschaftlicher Voraussetzungen.

Die Arbeit sollte vor Beginn des Unterrichtspraktikums abgeschlossen werden.

Allfällige fachwissenschaftliche Auflagen müssen alle erfüllt sein, bevor mit der Mentorierten Arbeit begonnen werden kann.

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-0962-00L</td>
<td>Mentored Work Subject Didactics Biology B - Mentored Work Subject Didactics in Biology for Teaching Diploma, Teaching Diploma Biology as Minor Subject and for students upgrading TC to Teaching Diploma. The Subject Didactics as well as possible branch-specific requirements must be fulfilled prior to commencing the mentored paper.</td>
<td>O</td>
<td>2 credits</td>
<td>4A</td>
<td>J. Egli</td>
</tr>
</tbody>
</table>

Abstract

In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.

Objective

The objective is for the students:
- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.
- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.
Content

Thematic Schwerpunkte
Die Gegenstände der mentorierten Arbeit in Fachdidaktik stammen in der Regel aus dem gymnasialen Unterricht.

Lernformen


Lecture notes

Eine kurze Anleitung zur mentorierten Arbeit in Fachdidaktik wird zur Verfügung gestellt.

Literature

Die Literatur ist themenspezifisch. Die Studierenden beschaffen sie sich in der Regel selber (siehe Lernziele). In besonderen Fällen wird sie vom Betreuer zur Verfügung gestellt.

Prerequisites / notice

Beginn nach Absprache jederzeit möglich, jedoch erst nach Abschluss der Fachdidaktik und der Absolvierung allfälliger fachwissenschaftlicher Voraussetzungen.

Die Arbeit sollte vor Beginn des Unterrichtspraktikums abgeschlossen werden.

Allfällige fachwissenschaftliche Auflagen müssen alle erfüllt sein, bevor mit der Mentorierten Arbeit begonnen werden kann.

Professional Training in Biology

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-0965-00L</td>
<td>Teaching Internship Including Examination Lessons Biology as Minor Subject. Repetition of the Teaching Internship is excluded even if Examination Lessons are to be repeated.</td>
<td>O</td>
<td>4</td>
<td>9P</td>
<td>P. Faller</td>
</tr>
</tbody>
</table>

Abstract

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

Objective

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

Course Units for Additional Admission Requirements

The courses below are only available for students with additional admission requirements.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-0980-00L</td>
<td>Anthropology (University of Zurich) No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: BIO133 Mind the enrolment deadlines at UZH: <a href="http://www.uzh.ch/studies/application/mobilitaet_en.html">http://www.uzh.ch/studies/application/mobilitaet_en.html</a></td>
<td>E-</td>
<td>3</td>
<td>6G</td>
<td>University lecturers</td>
</tr>
</tbody>
</table>

Abstract

Genetics, fossil remains, comparative anatomy and behavioral research prove the affiliation of humans to primates. This mammalian order represents variations of a single theme. The main adaptations and the critical steps of phylogeny are presented.

Objective

Upon successfully completing of the module the students can:
- interpret the main features of primates and especially of fossil hominids in the evolutionary and functional context;
- explain the genetic, phenetic and cultural diversity of modern human populations as the result of evolutionary processes;
- recognize similarities and differences in the behavior and the cognitive lines from humans and animals, in particular monkeys;
- explain why cultural evolution occurs only in humans;
- discuss the question "What are human beings?" from an evolutionary biological perspective.

376-0151-00L

Anatomy and Physiology I

5 credits

L. Slomianka, C. Spengler,
M. Ristow, K. De Bock,
L. Slomianka, C. Spengler,
N. Wenderoth, D. P. Wolfer

Abstract

Basic knowledge of the anatomy and physiology of tissues, of the embryonal and postnatal development, of the basic terminology of pathology, the neuro-muscular system, the cardiovascular system and the respiratory system.

Objective

Basic knowledge of human anatomy and physiology and basics of clinical pathophysiology.
Content

Short overview of human anatomy, physiology and general pathology.

Anatomy and Physiology I (fall term):
Basics of cytology, histology, embryology, general pathology; nervous system, muscles, cardiovascular system, respiratory system

Anatomy and Physiology II (spring term):
digestive system, kidney and urinary tract, endocrine system, skin, thermoregulation, sensory organs, male and female reproductive system, pregnancy and child birth.

Lecture notes

Literature
Anatomie:

Schiebler TH, Korf H-W: Anatomie (10. vollständig überarbeitete Auflage)
Steinkopf / Springer, Heidelberg 2007

Martini FH, Timmons MJ, Tallitsch RB. Human Anatomy

Physiologie:

Prerequisites / notice
Voraussetzungen: 1. Jahr, naturwissenschaftlicher Teil

Biology Teaching Diploma - Key for Type

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

Key for Hours

<table>
<thead>
<tr>
<th>Key</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

ECTS

European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
### Compulsory Concept Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-2413-00L</td>
<td>Evolutionary Genetics</td>
<td>O</td>
<td>6 credits</td>
<td>4V</td>
<td>T. Städler, A. Widmer, P. C. Brunner, M. C. Fischer</td>
</tr>
</tbody>
</table>

**Abstract**
The concept course ‘Evolutionary Genetics’ consists of two lectures that jointly provide an introduction to the fields of population and quantitative genetics (emphasis on basic concepts) and ecological genetics (more emphasis on evolutionary and ecological processes of adaptation and speciation).

**Objective**
The aim of the course is to provide students with a solid introduction to the fields of population genetics, quantitative genetics, and ecological genetics. The concepts and research methods developed in these fields have undergone profound transformations; they are of fundamental importance in our understanding of evolutionary processes, both past and present. Students should gain an appreciation for the concepts, methods and explanatory power of evolutionary genetics.

**Content**
Population genetics - Types and sources of genetic variation; randomly mating populations and the Hardy-Weinberg equilibrium; effects of inbreeding; natural selection; random genetic drift and effective population size; gene flow and hierarchical population structure; molecular population genetics; neutral theory of molecular evolution and basics of coalescent theory.

Quantitative genetics - Continuous variation; measurement of quant. characters; genes, environments and their interactions; measuring their influence; response to selection; inbreeding and crossbreeding, effects on fitness; Fisher’s fundamental theorem.

Ecological Genetics - Concepts and methods for the study of genetic variation and its role in adaptation, reproductive isolation, hybridization and speciation.

**Lecture notes**
Handouts

**Literature**

**Prerequisites / notice**
There will be 5 optional extra sessions for the population genetics part (following lectures 2-6) for computer simulations, designed to help understand the course material.

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<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-0323-00L</td>
<td>Plant Ecology</td>
<td>O</td>
<td>3 credits</td>
<td>2V</td>
<td>S. Gusewll, J. Levine</td>
</tr>
</tbody>
</table>

**Abstract**
This class focuses on ecological processes involved with plant life, mechanisms of plant adaptation, plant-animal and plant-soil interactions, plant strategies and implications for the structure and function of plant communities. The discussion of original research examples familiarises students with research questions and methods; they learn to evaluate results and interpretations.

**Objective**
Students will be able to:
- propose methods to study ecological processes involved with plant life, and how these processes depend on internal and external factors;
- analyse benefits and costs of plant adaptations;
- explain plant strategies with relevant traits and trade-offs;
- explain and predict the assembly of plant communities;
- explain implications of plant strategies for animals, microbes and ecosystem functions;
- evaluate studies in plant ecology regarding research questions, assumptions, methods, as well as the reliability and relevance of results.

**Content**
Plants represent the matrix of natural communities. The structure and dynamics of plant populations drives the function of ecosystems. This course presents essential processes and plant traits involved with plant life. We focus on research questions that have been of special interest to plant ecologists as well as current topical questions. We use original research examples to discuss how ecological questions are studied and how results are interpreted.

- Growth: what determines the production of a plant?
- Nutrients: consumption or recycling; opposite strategies and feedbacks on soils;
- Clonality: collaboration and division of labour in plants;
- Plasticity: benefits and costs of plant intelligence;
- Flowering and pollination: how expensive is sex?
- Seed types, dispersal, seed banks and germination: strategies and trade-offs in the persistence of plant populations;
- Development and structure of plant populations;
- Stress, disturbance and competition as drivers of different plant strategies;
- Herbivory: plant-animal feedbacks and functioning of grazing ecosystems
- Fire: impacts on plants, vegetation and ecosystems.
- Plant functional types and rules in the assembly of plant communities.

**Lecture notes**
Handouts and further reading will be available electronically at the beginning of the semester.

**Prerequisites / notice**
Prerequisites
- General knowledge of plant biology
- Basic knowledge of plant systematics
- General ecological concepts

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### Elective Compulsory Master Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>751-4801-00L</td>
<td>System-Oriented Management of Herbivore Insects I</td>
<td>W</td>
<td>2 credits</td>
<td>2G</td>
<td>D. Mazi</td>
</tr>
</tbody>
</table>

**Abstract**
The focus is on the potential to assess strategies and tactics of pest management, taking into account the demands from the economy, the environment and the society. Significant agricultural approaches will be explained using practical examples, including prevention using natural resources, surveillance and forecasting, resistance management, as well as product registration, incl. ecotoxicology.

**Objective**
The students gain a good understanding of fundamental aspects of pest management in agroecosystems. They will have the ability to assess options for action in view of requirements from the economy, the ecology and the society. Further, they will learn to perform searches on relevant issues in pest management, and to critically evaluate case studies.

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-1409-00L</td>
<td>Research Seminar: Ecological Genetics</td>
<td>W</td>
<td>2 credits</td>
<td>1S</td>
<td>A. Widmer, S. Fior</td>
</tr>
</tbody>
</table>

**Abstract**
In this research seminar we will critically discuss current topics in Ecological Genetics using publications from the leading scientific journals in this field.

**Objective**
It is our aim that participants gain insight into the current research topics and knowledge available in Ecological Genetics and learn to critically assess and appreciate scientific publications in this field.

**Lecture notes**
None

**Literature**
None

**Prerequisites / notice**
Active participation in the discussions is a prerequisite for this course.

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<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-1703-00L</td>
<td>Ecology of Anthropogenic Habitats</td>
<td>W</td>
<td>2 credits</td>
<td>1V</td>
<td>D. Ramseier</td>
</tr>
</tbody>
</table>

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Data: 06.03.2019 12:57  Autumn Semester 2016  Page 239 of 1571
The focus will be on agro-ecology and ecology of urban habitats. Both experience frequent disturbances, specific chemical influences, and extreme climatic conditions. Additionally, in urban habitats edaphic conditions are difficult as well. Turnover of species diversity and composition are higher, both locally and temporary, compared to natural conditions at comparable sites.

**Objective**

Knowledge of agro-ecosystems and urban ecosystems; their origin, ecosystem services, mechanisms and importance for the maintenance of biodiversity.

**701-1441-00L**

**Alpine Ecology and Environments**  
*W 2 credits 2G  S. Dietz, D. Ramseier*

**Abstract**

The online course ALPECOLe provides a global overview of the complex ecosystems of mountain regions, and of their great diversity of habitats and organisms. The course is interdisciplinary and the various approaches are designed to help understand the past, present and future of mountain ecosystems.

**Objective**

Knowledge of alpine environments worldwide and their ecology

**Content**

The online course is subdivided into
- 5 lessons on abiotic factors: geology, soils and their forming processes, climate, and disturbance factors
- 12 lessons on plants: diversity, patterns and processes, treeslines, water & nutrients, carbon cycle, atmospheric influences, sexual and clonal reproduction, and one specific lesson on aquatic environments
- 5 lessons on animals: habitats and adaptations, origin of species, food ecology and impact of domestic livestock
- 3 lessons on landscape evolution: quarryernary paleoenvironments, methods like radiocarbon dating, pollen records, dendrochronology, stable isopes, and historical data
- 1 lesson on global change

Students can also follow a virtual walk through alpine areas where context-based information on alpine environments can be accessed. Moreover, all mayor alpine areas of the world can be selected on a map and then informative pictures of those landscapes and faunistic and floristic inhabitants will be shown.

**Prerequisites / notice**

Online exercises and tests allow to test the learned matter.

**Literature**

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

**751-5121-00L**

**Insect Ecology**  
*W 2 credits 2V  R. R. Kariyat Ramachandran, C. De Moraes, M. Mescher*

**Abstract**

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

**Objective**

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

**Prerequisites / notice**

Students prepare for the seminar by working through particular lessons. Each student has to present some special aspect of one lesson. The seminar contribution is part of the performance assessment.

**Lecture notes**

Provided to students through ILIAS

**Literature**

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

**401-0625-01L**

**Applied Analysis of Variance and Experimental Design**  
*W 5 credits 2V+1U  L. Meier*

**Abstract**


**Objective**

Participants will be able to plan and analyze efficient experiments in the fields of natural sciences. They will gain practical experience by using the software R.

**Content**


**Prerequisites / notice**

The exercises, but also the classes will be based on procedures from the freely available, open-source statistical software R, for which an introduction will be held.

**401-0649-00L**

**Applied Statistical Regression**  
*W 5 credits 2V+1U  M. Dettling*

**Abstract**

This course offers a practically oriented introduction into regression modeling methods. The basic concepts and some mathematical background are included, with the emphasis lying in learning "good practice" that can be applied in every student's own projects and daily work life. A special focus will be laid in the use of the statistical software package R for regression analysis.

**Objective**

The students acquire advanced practical skills in linear regression analysis and are also familiar with its extensions to generalized linear modeling.

**Content**

The course starts with the basics of linear modeling, and then proceeds to parameter estimation, tests, confidence intervals, residual analysis, model choice, and prediction. More rarely touched but practically relevant topics that will be covered include variable transformations, multicollinearity problems and model interpretation, as well as general modeling strategies.

The last third of the course is dedicated to an introduction to generalized linear models: this includes the generalized additive model, logit regression for binary response variables, binomial regression for grouped data and poisson regression for count data.

**Lecture notes**

A script will be available.

**Literature**

Faraway (2005): Linear Models with R  
Faraway (2006): Extending the Linear Model with R  
Draper & Smith (1998): Applied Regression Analysis  
Fox (2008): Applied Regression Analysis and GLMs  
Montgomery et al. (2006): Introduction to Linear Regression Analysis

**Prerequisites / notice**

The exercises, but also the classes will be based on procedures from the freely available, open-source statistical software package R, for which an introduction will be held.

In the Mathematics Bachelor and Master programmes, the two course units 401-0649-00L "Applied Statistical Regression" and 401-3622-00L "Regression" are mutually exclusive. Registration for the examination of one of these two course units is only allowed if you have not registered for the examination of the other course unit.

**701-0301-00L**

**Applied Systems Ecology**  
*W 3 credits 2V  D. Schröter, A. Gessler*

This course provides the ecological systems' knowledge needed to question applied solutions to current environmental issues. Our central aim is to balance participants' respect for complexity with a sense of possibility by providing examples from the vast solution space offered by ecological systems, such as e.g. green infrastructure to manage water.
At the end of the course...

...you know how to structure your inquiry and how to proceed the analysis when faced with a complex environmental issue. You can formulate the relevant questions, find answers (supported by discussions, input from the lecturers and the literature), and you are able to present your conclusions clearly and cautiously.

...you understand the complexity of interactions and structures in ecosystems. You know how ecosystem processes, functions and services interact and feed back across multiple spatio-temporal scales (in general, plus in depth case examples).

...you understand that biodiversity and the interaction between organisms are an integral part of ecosystems. You are aware that the link between biodiversity and process/function/service is rarely fully understood. You know how to honestly deal with this lack of understanding and can nevertheless find, critically analyse and communicate solutions.

...you understand the importance of ecosystem services for society. ...

...you have an overview of the methods of ecosystem research and have a deeper insight into some of them, e.g. ecosystem observation, manipulation and modelling.

...you have reflected on ecology as a young discipline at the heart of significant applied questions.

This course provides the ecological systems' knowledge needed to question applied sustainability solutions. We will critically assess the complexity of current environmental issues, illustrating basic ecological concepts and principles. Our central aim is to balance participants' respect for complexity with a sense of possibility by providing examples from the vast solution space offered by ecological systems, such as e.g. green infrastructure to manage water.

The course is structured around four larger topical areas: (1) Integrated Water Management -- Green infrastructure (land management options) as an alternative to engineered solutions (e.g. large reservoirs) in flood and drought management; (2) Fire dynamics, the water cycle and biodiversity -- The surprising dynamics of species life cycles and populations in arid landscapes; (3) Rewilding, e.g. re-introducing apex predators (e.g. wolves), or large ungulates (e.g. bison) in protected areas -- A Nature conservation trend with counterintuitive effects; (4) Coupling of aquatic and terrestrial systems: carbon, nitrogen and phosphorus transfers of global importance on landscape scale.

The course focuses on practical work at the computer. We will make use of the graphical user interface RStudio: www.rstudio.org

Part I of the course covers the following topics:
- What is R?
- R Basics: reading and writing data from/to files, creating vectors & matrices, selecting elements of dataframes, vectors and matrices, arithmetics;
- Types of data: numeric, character, logical and categorical data, missing values;
- Simple (statistical) functions: summary, mean, var, etc., simple statistical tests;
- Writing simple functions;
- Introduction to graphics: scatter-, boxplots and other high-level plotting functions, embellishing plots by title, axis labels, etc., adding elements (lines, points) to existing plots.

The course focuses on practical work at the computer. We will make use of the graphical user interface RStudio: www.rstudio.org
The course consists of four parts. We first introduce modern genetic sequencing technology, and algorithms to obtain sequence alignments.

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

Objective

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

Lecture Topics and Tentative Schedule

Week 1  No Lecture: First day of autumn semester

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


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

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

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

Week 8  Pathogen effects on food quality and safety.

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

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

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

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

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

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

Lecture notes

Detailed lecture notes (~160 pages) will be available for purchase at the cost of reproduction at the start of the semester.
The course is not based on any of the textbooks below, but they are excellent choices as accompanying material:
- Drummond, A. & Bouckaert, R. 2015. Bayesian evolutionary analysis with BEAST

Basic knowledge in linear algebra, analysis, and statistics will be helpful. Some programming experience will be useful for the exercises, but is not required. Programming skills will not be tested in the examination.

**Literature**


**Prerequisites / notice**

- Basic statistical training (e.g. Mathematik IV in D-USYS): Data distributions, descriptive statistics, hypothesis testing, linear regression, analysis of variance
- Basic experience in data handling and data analysis in R

**Lecture notes**

Lecture notes and additional reading will be available electronically a few days before the course.

**Literature**

Suggested books for additional reading (available electronically):


**Prerequisites / notice**

- Basic statistical training (e.g. Mathematik IV in D-USYS): Data distributions, descriptive statistics, hypothesis testing, linear regression, analysis of variance
- Basic experience in data handling and data analysis in R

**Enrollment**

Enrollment is limited to Master students of the study programme Environmental Sciences majoring Ecology and Evolution and to Master students of the study programme Biology majoring Ecology and Evolution (Elective Compulsory Master Courses), time of enrolment is decisive.

It is possible to enrol until September 12. The registration will only be effective once confirmed.

**Abstract**

Course focuses on the ecology and evolution of macroparasites and their hosts. Through lectures and practical work, students learn about diversity and natural history of parasites, adaptations of parasites, ecology of host-parasite interactions, applied parasitology, and human macroparasites in the modern world.

**Objective**

1. Identify common macroparasites in aquatic organisms.
2. Understand ecological and evolutionary processes in host-parasite interactions.
3. Conduct parasitological research.

**Content**

Lectures:
1. Diversity and natural history of parasites (i.e. systematic groups and life-cycles).
2. Adaptations of parasites (e.g. evolution of life-cycles, host manipulation).
3. Ecology of host-parasite interactions (e.g. parasite communities, effects of environmental changes).
4. Applied parasitology (e.g. aquaculture and fisheries).
5. Human macroparasites (schistosomiasis, malaria).

Practical exercises:
1. Examination of parasites in fish (identification of species and description of parasite communities).
2. Examination of parasites in molluscs (identification and examination of host exploitation strategies).
3. Examination of parasites in amphipods (identification and examination of effects on hosts).

**Objective**

Course objectives:
1. i) gain understanding of the strengths and limitations of experimental evolution for addressing evolutionary questions relative to other forms of evolutionary analysis, and
2. ii) gain the ability to effectively design and analyze evolution experiments that address fundamental or applied questions in evolutionary biology.
Experimental evolution is a powerful and increasingly prominent approach to investigating evolutionary processes. Students will analyze experimental evolution literature covering a diverse range of topics, species and types of analysis and will lead discussions of this literature. Students will develop a written project proposal for a novel evolution experiment (or a novel analysis of a published experiment) to address an unanswered question and will also deliver an oral presentation of the project proposal. Evaluation will be based on a combination of participation in and leadership of literature discussions, in-class exams, and oral and written presentations of the project proposal.

**Literature**
Primary research papers and review articles.

**Prerequisites / notice**
701-0245-00 Introduction to Evolutionary Biology (or equivalent).

### Elective Concept Courses

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<th>Number</th>
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<th>Lecturers</th>
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**Abstract**
Storage, handling and analysis of large datasets have become essential in biological research. The course will introduce students to a number of applications of bioinformatics in biology. Freely accessible software tools and databases will be explained and explored in theory and praxis.

**Objective**
Introduction to Bioinformatics I: Concepts and Applications (formerly Bioinformatics I) will provide students with the theoretical background of approaches to store and retrieve information from large databases. Concepts will be developed how DNA sequence information can be used to understand phylogenetic relationships, how RNA sequence relates to structure, and how protein sequence information can be used for genome annotation and to predict protein folding and structure. Students will be introduced to quantitative methods for measuring gene expression and how this information can be used to model gene networks. Methods will be discussed to construct protein interaction maps and how this information can be used to simulate dynamic molecular networks.

In addition to the theoretical background, the students will develop hands-on experiences with the bioinformatics methods through guided exercises. The course provides students from different backgrounds with basic training in bioinformatics approaches that have impact on biological, chemical and physics experimentation. Bioinformatics approaches draw significant expertise from mathematics, statistics and computational science.

Although "Introduction to Bioinformatics I" will focus on theory and praxis of bioinformatics approaches, the course provides an important foundation for the course "Introduction to Bioinformatics II: Fundamentals of computer science, modeling and algorithms" that will be offered in the following semester.

**Content**
Bioinformatics I will cover the following topics:
- From genes to databases and information
- BLAST searches
- Prediction of gene function and regulation
- RNA structure prediction
- Gene expression analysis using microarrays
- Protein sequence and structure databases
- WWW for bioinformatics
- Protein sequence comparisons
- Proteomics and de novo protein sequencing
- Protein structure prediction
- Cellular and protein interaction networks
- Molecular dynamics simulation

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<tr>
<th>Number</th>
<th>Title</th>
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<tbody>
<tr>
<td>551-0313-00L</td>
<td>Microbiology (Part I)</td>
<td>W</td>
<td>3 credits</td>
<td>2V</td>
<td>W.D. Hardt, L. Eberl, H.M. Fischer, J. Piel, M. Pilhofer</td>
</tr>
</tbody>
</table>

**Abstract**
Advanced lecture class providing a broad overview on bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

**Objective**
This concept class will be based on common concepts and introduce to the enormous diversity among bacteria and archaea. It will cover the current research on bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

**Content**
Advanced class covering the state of the research in bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

**Lecture notes**
Updated handouts will be provided during the class.

**Literature**
Current literature references will be provided during the lectures.

**Prerequisites / notice**
English
The lecture "Grundlagen der Biologie II: Mikrobiologie" is the basis for this advanced lecture.

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<th>Number</th>
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<tr>
<td>551-0309-00L</td>
<td>Concepts in Modern Genetics</td>
<td>W</td>
<td>6 credits</td>
<td>4V</td>
<td>Y. Barral, D. Bopp, A. Hajnal, M. Stoffel, O. Voinnet</td>
</tr>
</tbody>
</table>

**Abstract**
Concepts of modern genetics and genomics, including principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

**Objective**
This course focuses on the concepts of classical and modern genetics and genomics.

**Content**
The topics include principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

**Lecture notes**
Scripts and additional material will be provided during the semester.

**Prerequisites / notice**
This course is a co-production of the University of Zurich and ETH Zurich, and will be taught in English. The course takes place on Monday afternoon at ETH Hoenggerberg, and on Tuesday morning at UZH Irchel.
Content
Development: Early development of the nervous system, cellular level, nerve fiber growth, building of neuronal networks; biology of the adult nervous system; structural plasticity of the adult nervous system, regeneration and repair: networks and nerve fibers, regeneration, pathological loss of cells.

Lecture notes
Structure, Plasticity and Repair of the Nervous System (376-1305-01L): Lecture notes will be provided on Moodle https://moodle-app2.let.ethz.ch/course/view.php?id=694
Password will be provided at the beginning of the lecture.

Literature
The lecture requires reading of book chapters, handouts and original scientific papers. Further information will be given in the individual lectures.

ECTS
The lecture requires reading of book chapters, handouts and original scientific papers. Further information will be given in the individual lectures.

The full-year course (551-0319-00 & 551-0320-00) focuses on the molecular mechanisms and concepts underlying the biochemistry of the cell, providing advanced insights into structure, function and regulation of individual cell components. Particular emphasis will be put on the spatial and temporal integration of different molecules and signaling pathways into global cellular processes such as intracellular transport, cell division & growth, and cell migration.

The students will be able to describe the structural and functional details of individual cell components, and the spatial and temporal regulation of their interactions. In particular, they will learn to explain the integration of different molecules and signaling pathways into complex and highly dynamic cellular processes such as intracellular transport, cytoskeletal rearrangements, cell motility, cell division and cell growth. In addition, they will be able to illustrate the relevance of particular signaling pathways for cellular pathologies such as cancer.

The topics include: biophysical and electrical properties of membranes; viral membranes; structural and functional insights into intracellular transport and targeting; vesicular trafficking and phagocytosis; post-transcriptional regulation of gene expression.

Introduction to Neuroinformatics

The course provides an introduction to the functional properties of neurons. Particularly the description of membrane electrical properties (action potentials, channels), neuronal anatomy, synaptic structures, and neuronal networks. Simple models of computation, learning, and behavior will be explained. Some artificial systems (robot, chip) are presented.

ECTS
The course requires reading of book chapters, handouts and original scientific papers. Further information will be given in the individual lectures.

The full-year course (551-0319-00 & 551-0320-00) focuses on the molecular mechanisms and concepts underlying the biochemistry of the cell, providing advanced insights into structure, function and regulation of individual cell components. Particular emphasis will be put on the spatial and temporal integration of different molecules and signaling pathways into global cellular processes such as intracellular transport, cell division & growth, and cell migration.

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Introduction to Neuroinformatics

The course provides an introduction to the functional properties of neurons. Particularly the description of membrane electrical properties (action potentials, channels), neuronal anatomy, synaptic structures, and neuronal networks. Simple models of computation, learning, and behavior will be explained. Some artificial systems (robot, chip) are presented.
Different scientific guests working in the field of molecular cognition, neurochemistry, neuromorphology and neurophysiology present their latest scientific results. To exchange scientific knowledge and data and to promote communication and collaborations among researchers. Moreover, students aiming at getting a credit point for this colloquium choose one topic and write a comprehensive critical essay on the presented research topic.

**Content**

The course focuses on basic aspects of central nervous system physiology, including perception, motor control and cognitive functions. Main emphasis sensory systems, with complements on motor and cognitive functions.

**Objective**

To understand the basic concepts underlying perceptual, motor and cognitive functions.

None

We display articles pertaining to the issues we cover in the class on the course's webpage.

Since we are all experts on consciousness, we expect active participation and discussions!

Mind the enrolment deadlines at UZH:

http://www.uzh.ch/studies/application/mobilitaet_en.html

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.

Since we are all experts on consciousness, we expect active participation and discussions!

Mind the enrolment deadlines at UZH:

http://www.uzh.ch/studies/application/mobilitaet_en.html

None

The topics depend heavily on the invited speakers, and thus change from week to week. All topics concern neural computation and their implementation in biological or artificial systems.
Viral and non-Viral Vectors for Human Gene-Therapy - W 2 credits 3V

UZH Module Code: BIO708

Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

Abstract
Basic aspects of virology, the viral mechanisms for transfer of genetic material into cells, different vector-systems and target cells, animal models, specific applications for inborn diseases of the immune system and of metabolism, adverse effects, and new developments of vector systems will be taught.

Objective
Knowledge of important viral and non-viral vector systems.
Knowledge of application in human diseases.
Knowledge of limiting factors.

Computational Biology W 4 credits 3G T. Stadler, C. Magnus

Abstract
The aim of the course is to provide up-to-date knowledge on how we can study biological processes using genetic sequencing data. Computational algorithms extracting biological information from genetic sequence data are discussed, and statistical tools to understand this information in detail are introduced.

Objective
Attendees will learn which information is contained in genetic sequencing data and how to extract information from them using computational tools. The main concepts introduced are:
* stochastic models in molecular evolution
* phylogenetic & phylodynamic inference
* maximum likelihood and Bayesian statistics

Attendees will apply these concepts to a number of applications yielding biological insight into:
* epidemiology
* pathogen evolution
* macroevolution of species

Content
The course consists of four parts. We first introduce modern genetic sequencing technology, and algorithms to obtain sequence alignments from the output of the sequencers. We then present methods to directly analyze this alignment (such as BLAST algorithm, GWAS approaches). Second, we introduce mechanisms and concepts of molecular evolution, i.e. we discuss how genetic sequences change over time. Third, we employ evolutionary concepts to infer ancestral relationships between organisms based on their genetic sequences, i.e. we discuss methods to infer genealogies and phylogenies. We finally introduce the field of phylodynamics. The aim of that field is to understand and quantify the population dynamic processes (such as transmission in epidemiology or speciation & extinction in macroevolution) based on a phylogeny. Throughout the class, the models and methods are illustrated on different datasets giving insight into the epidemiology and evolution of a range of infectious diseases (e.g. HIV, H1N1 influenza, Ebola). Applications of the methods to the field of macroevolution provide insight into the evolution and ecology of different species clades. Students will be trained in the algorithms and their application both on paper and in silico as part of the exercises.

Lecture notes
Slides of the lecture will be available online.
https://www.bsse.ethz.ch/cevo/education/cb-materials.html
The course is not based on any of the textbooks below, but they are excellent choices as accompanying material:

- Drummond, A. & Bouckaert, R. 2015. Bayesian evolutionary analysis with BEAST

Basic knowledge in linear algebra, analysis, and statistics will be helpful. Some programming experience will be useful for the exercises, but is not required. Programming skills will not be tested in the examination.

### 551-1407-00L

**RNA Biology Lecture Series I: Transcription & Processing & Translation**

<table>
<thead>
<tr>
<th>Number</th>
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<th>ECTS</th>
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<tr>
<td>551-0317-00L</td>
<td>Immunology I</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>A. Oxenius, M. Kopf</td>
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<td>Introduction into structural and functional aspects of the immune system.</td>
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<td>Basic knowledge of the mechanisms and the regulation of an immune response.</td>
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<td>Introduction into structural and functional aspects of the immune system.</td>
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<td>Basic knowledge of the mechanisms and the regulation of an immune response.</td>
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<td>- Introduction and historical background</td>
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<td>- Innate and adaptive immunity. Cells and organs of the immune system</td>
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<td>- T cells and antibodies</td>
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<td>- Generation of diversity</td>
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<td>- Antigen presentation and Major Histocompatibility (MHC) antigens</td>
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<td>- Thymus and T cell selection</td>
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<td>- Autoimmunity</td>
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<td>- Cytotoxic T cells and NK cells</td>
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<td>- Th1 and Th2 cells, regulatory T cells</td>
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<td>- Allergies</td>
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<td>- Hypersensitivities</td>
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<td>- Vaccines, immune-therapeutic interventions</td>
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</table>

**Literature**


**Prerequisites / notice**

Immunology I (WS) and Immunology II (SS) will be examined as one learning entity in a "Sessionsprüfung".

### 551-0309-00L

**Concepts in Modern Genetics**

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<tr>
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<tbody>
<tr>
<td>551-0319-00L</td>
<td>Cellular Biochemistry (Part I)</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>U. Kutay, R. I. Enchev, B. Kornmann, M. Peter, I. Zemp, further lecturers</td>
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<td></td>
<td>Concepts and molecular mechanisms underlying the biochemistry of the cell, providing advanced insights into structure, function and regulation of individual cell components. Particular emphasis will be put on the spatial and temporal integration of different molecules and signaling pathways into global cellular processes such as intracellular transport, cell division &amp; growth, and cell migration.</td>
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<td></td>
<td>The full-year course (551-0319-00 &amp; 551-0320-00) focuses on the molecular mechanisms and concepts underlying the biochemistry of cellular physiology, investigating how these processes are integrated to carry out highly coordinated cellular functions. The molecular characterization of complex cellular functions requires a combination of approaches such as biochemistry, but also cell biology and genetics. This course is therefore the occasion to discuss these topics and their integration in modern cellular biochemistry.</td>
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<td></td>
<td>The students will be able to describe the structural and functional details of individual cell components, and the spatial and temporal regulation of their interactions. In particular, they will learn to explain the integration of different molecules and signaling pathways into complex and highly dynamic cellular processes such as intracellular transport, cytoskeletal rearrangements, cell motility, cell division and cell growth. In addition, they will be able to illustrate the relevance of particular signaling pathways for cellular pathologies such as cancer.</td>
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<td></td>
<td>Structural and functional details of individual cell components, regulation of their interactions, and various aspects of the regulation and compartmentalisation of biochemical processes. Topics include: biophysical and electrical properties of membranes; viral membranes; structural and functional insights into intracellular transport and targeting; vesicular trafficking and phagocytosis; post-transcriptional regulation of gene expression.</td>
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<td></td>
<td>Scripts and additional material will be provided during the semester. Please contact Dr. Alicia Smith for assistance with the learning materials. (<a href="mailto:alicia.smith@bc.biol.ethz.ch">alicia.smith@bc.biol.ethz.ch</a>)</td>
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<tr>
<td></td>
<td>Recommended supplementary literature (review articles and selected primary literature) will be provided during the course.</td>
<td></td>
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</tbody>
</table>

**Literature**

- *Drummond, A. & Bouckaert, R. 2015. Bayesian evolutionary analysis with BEAST*
- *Yang, Z. 2006. Computational Molecular Evolution.*

**Prerequisites / notice**

To attend this course the students must have a solid basic knowledge in chemistry, biochemistry and general biology. The course will be taught in English.
<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-0313-00L</td>
<td>Microbiology (Part I)</td>
<td>O</td>
<td>3</td>
<td>2V</td>
<td>W.D. Hardt, L. Ebert, H.M. Fischer, J. Piel, M. Pilhofer</td>
</tr>
<tr>
<td>Abstract</td>
<td>Advanced lecture class providing a broad overview on bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.</td>
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<tr>
<td>Objective</td>
<td>This concept class will be based on common concepts and introduce to the enormous diversity among bacteria and archaea. It will cover the current research on bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.</td>
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<tr>
<td>Content</td>
<td>Advanced class covering the state of the research in bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.</td>
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<tr>
<td>Lecture notes</td>
<td>Updated handouts will be provided during the class.</td>
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</tr>
<tr>
<td>Literature</td>
<td>Current literature references will be provided during the lectures.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Prerequisites / notice</td>
<td>The lecture &quot;Grundlagen der Biologie II: Mikrobiologie&quot; is the basis for this advanced lecture.</td>
<td></td>
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<tr>
<td>Literature</td>
<td>Immunology I</td>
<td>O</td>
<td>3</td>
<td>2V</td>
<td>A. Oxenius, M. Kopf</td>
</tr>
<tr>
<td>Content</td>
<td>Introduction into structural and functional aspects of the immune system. Basic knowledge of the mechanisms and the regulation of an immune response.</td>
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</tr>
<tr>
<td>Objective</td>
<td>Introduction into structural and functional aspects of the immune system. Basic knowledge of the mechanisms and the regulation of an immune response.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prerequisites / notice</td>
<td>Immunology I (WS) and Immunology II (SS) will be examined as one learning entity in a &quot;Sessionsprüfung&quot;.</td>
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<tr>
<td>Number</td>
<td>Title</td>
<td>Type</td>
<td>ECTS</td>
<td>Hours</td>
<td>Lecturers</td>
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</tr>
<tr>
<td>551-0512-00L</td>
<td>Current Topics in Molecular and Cellular Neurobiology</td>
<td>W</td>
<td>2</td>
<td>1S</td>
<td>U. Suter</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course is a literature seminar or &quot;journal club&quot;. Each Friday a student, or a member of the Suter Lab in the Institute of Molecular Health Sciences, will present a paper from the recent literature.</td>
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<tr>
<td>Objective</td>
<td>The course introduces you to recent developments in the fields of cellular and molecular neurobiology. It also supports you to develop your skills in critically reading the scientific literature. You should be able to grasp what the authors wanted to learn i.e. their goals, why the authors chose the experimental approach they used, the strengths and weaknesses of the experiments and the data presented, and how the work fits into the wider literature in the field. You will present one paper yourself, which provides you with practice in public speaking.</td>
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<tr>
<td>Lecture notes</td>
<td>Presentations will be made available after the seminars.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>You must attend at least 80% of the journal clubs, and give a presentation of your own. At the end of the semester there will be a 30 minute oral exam on the material presented during the semester. The grade will be based on the exam (45%), your presentation (45%), and a contribution based on your active participation in discussion of other presentation (10%).</td>
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<tr>
<td>Literature</td>
<td>Number of participants limited to 8.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Number of participants limited to 8.</td>
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<tr>
<td>Number</td>
<td>Title</td>
<td>Type</td>
<td>ECTS</td>
<td>Hours</td>
<td>Lecturers</td>
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<tr>
<td>551-1103-00L</td>
<td>Microbial Biochemistry</td>
<td>W</td>
<td>4</td>
<td>2V</td>
<td>J. Vorholt-Zambelli, J. Piel</td>
</tr>
<tr>
<td>Abstract</td>
<td>Advanced class covering the state of the research in bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.</td>
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<tr>
<td>Objective</td>
<td>Current literature references will be provided during the lectures.</td>
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</tr>
<tr>
<td>Literature</td>
<td>English</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prerequisites / notice</td>
<td>The lecture &quot;Grundlagen der Biologie II: Mikrobiologie&quot; is the basis for this advanced lecture.</td>
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</tbody>
</table>
The course will cover six grand topics in immunology (B cells, innate immunity, antigen presentation, tumor immunity, thymus and T cells, and tumor immunology). Important biochemical processes specific to bacteria and archaea will be presented that contribute to the widespread occurrence of prokaryotes. Applied aspects of microbial biochemistry will be pointed out as well as research fields of current scientific interest. Emphasis is on concepts of energy generation and assimilation.

**List of topics:**
- Eating sugars and letting them in
- Complex: (Ligno-)Cellulose and in demand for bioenergy
- Of climate relevance: The microbial C1 cycle
- What are AMO and Anammox?
- 20 amino acids: the making of
- Extending the genetic code
- The 21st and 22nd amino acid
- Some exotic biochemistry: nucleotides, cofactors
- Ancient biochemistry? Iron-sulfur clusters, polymers
- Secondary metabolites: playground of evolution

**Lecture notes**
A script will be provided during the course.

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551-1105-00L  **Glycobiology**  W  4 credits  2V  **M. Aebi, T. Hennet**

**Abstract**
Structural principles, nomenclature and different classes of glycosylation. The different pathways of N- and O-linked protein glycosylation and glycolipid biosynthesis in prokaryotes and eukaryotes are discussed. Specific glycan binding proteins and their role in deciphering the glycan code are presented. The role of glycans in infectious diseases, antigen mimicry and autoimmunity are discussed.

**Objective**
Detailed knowledge in 1) the different areas of prokaryotic and eukaryotic glycobiology, in particular in the biosynthesis of glycoproteins and glycolipids, 2) the cellular machinery required for these pathways, 3) the principles of carbohydrate/protein interaction, 4) the function of lectins, 5) the role of glycans in infectious disease.

**Content**
- Structure and linkages; analytical approaches; N-linked protein glycosylation (ER, Golgi); glycans assisting protein folding and quality control; O-linked protein glycosylation; glucosaminoglycans; glycolipids; prokaryotic glycosylation pathways; lectins; glycans and infectious disease

**Literature**
Introduction to Glycobiology; M.E.Taylor, K.Drickamer, Oxford University Press, 2003

**Prerequisites / notice**
The course will be in English. It will include the preparation of short essays (marked) about defined topics in Glycobiology.

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551-1117-00L  **Cutting Edge Topics: Immunology and Infection Biology**  W  2 credits  1S  **A. Oxenius, B. Becher, C. Halin Winter, M. Kopf, S. R. Leibundgut, C. Münz, A. Trkola, M. van den Broek**

**Abstract**
Weekly seminar about cutting edge topics in immunology and infection biology. Internationally renowned experts present their current research followed by an open discussion.

**Objective**
Weekly seminar about cutting edge topics in immunology and infection biology. Internationally renowned experts present their current research followed by an open discussion.

**Content**
- Immunology and infection biology.
- The specific topics are variable and depend each semester on the list of invited experts.

---

551-1153-00L  **Systems Biology of Metabolism**  W  4 credits  2V  **U. Sauer, N. Zamboni, M. Zampieri**

**Abstract**
Starting from contemporary biological problems related to metabolism, the course focuses on systems biological approaches to address them. In a problem-oriented, this-is-how-it-is-done manner, we thereby teach modern methods and concepts.

**Objective**
Develop a deeper understanding of how relevant biological problems can be solved, thereby providing advanced insights to key experimental and computational methods in systems biology.

**Content**
The aim of this course is to confront students with current research topics and with scientific presentation. The course offers the opportunity to gain in-depth knowledge about diverse topics which are often only briefly touched in the concept courses and to engage in discussion with experts in the field.

**Lecture notes**
Script and original publications will be supplied during the course.

**Prerequisites / notice**
The course extends many of the generally introduced concepts and methods of the Concept Course in Systems Biology. It requires a good knowledge of biochemistry and basics of mathematics and chemistry.

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551-1171-00L  **Immunology: from Milestones to Current Topics**  W  4 credits  2S  **B. Ludewig, J. Kisielow, M. Kopf, A. Oxenius, University lecturers**

**Abstract**
Milestones in Immunology: on old concepts and modern experiments

**Objective**
The course will cover six grand topics in immunology (B cells, innate immunity, antigen presentation, tumor immunity, thymus and T cells, and tumor immunology). The specific topics are variable and depend each semester on the list of invited experts.

**Content**
- Milestones and current topics of innate immunity, antigen presentation, B cells, thymus and T cells, cytotoxic T cells and NK cells, and tumor immunology.

**Lecture notes**
Original and review articles will be distributed by the lecturer.

**Literature**
Literaturunterlagen werden vor Beginn des Kurses auf folgender website zugänglich sein: Moodle Course https://moodle-app.let.ethz.ch/course/view.php?id=1002

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551-1303-00L  **Cellular Biochemistry of Health and Disease**  W  4 credits  2S  **P. Picotti, Y. Barral, V. Korkhov, B. Kornmann, R. Kroschewski, J. Matos, M. Peter, A. E. Smith, K. Weis**

**Abstract**
Milestones in Immunology: on old concepts and modern experiments

**Objective**
The course will cover six grand topics in immunology (B cells, innate immunity, antigen presentation, tumor immunity, thymus and T cells, cytotoxic T cells and NK cells, and tumor immunology).

**Content**
- The course will cover six grand topics in immunology (B cells, innate immunity, antigen presentation, tumor immunity, thymus and T cells, cytotoxic T cells and NK cells, and tumor immunology).

**Lecture notes**
Original and review articles will be distributed by the lecturer.

**Literature**
Literaturunterlagen werden vor Beginn des Kurses auf folgender website zugänglich sein: Moodle Course https://moodle-app.let.ethz.ch/course/view.php?id=1002
The course offers detailed information on selected foodborne pathogens and toxin producing organisms; the focus lies on relevant

Introduction  membrane operations  adsorption and chromatography   crystallization  overall process economics

3G

During this Masters level seminar style course, students will explore current research topics in cellular biochemistry focused on the

A list of references will be given at the beginning of the course for the different topics presented during this course.

C. Lacroix, T. de Wouters, L. Meile, W

Handouts during course

W. McDonald

Functional Microorganisms in Foods

Detailed and current status of research and insights into the molecular basis of foodborne diseases, with focus on interactions of the

Separations play an integral part of any biotechnological process. This course aims at enabling students specifically with a

The course is designed to provide an overview of the various aspects of functional microorganisms in foods, with an emphasis on the

Handouts during course

W. McDonald

Molecular Biology of Foodborne Pathogens

Detailed and current status of research and insights into the molecular basis of foodborne diseases, with focus on interactions of the

The course offers detailed information on selected foodborne pathogens and toxin producing organisms; the focus lies on relevant molecular biological aspects of pathogenicity and virulence, as well as on the occurrence and survival of these organisms in foods.

M. Loessner, M. Schupper

Separations in Biotechnology and Bioprocess

Prerequisites /

Economy

The course is designed to provide an overview of the various aspects of functional microorganisms in foods, with an emphasis on the

Lectures (2 hours) will be held as a single session of approximately 60+ minutes (10:15 until approx. 11:15 h), with no break !

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Lectures (2 hours) will be held as a single session of approximately 60+ minutes (10:15 until approx. 11:15 h), with no break !
Course description: Plant Pathology I will focus on pathogen-plant interactions, epidemiology, disease assessment, and disease development in agroecosystems. Themes will include: 1) how pathogens attack plants and; 2) how plants defend themselves against pathogens; 3) factors driving the development of epidemics in agroecosystems. Topics under the first theme will include pathogen life cycles, disease cycles, and an overview of plant pathogenic nematodes, viruses, bacteria, and fungi. Topics under the second theme will include plant defense strategies, host range, passive and active defenses, and chemical and structural defenses. Topics under the third theme will include the disease triangle and cultural control strategies.

Lecture Topics and Tentative Schedule

<table>
<thead>
<tr>
<th>Week</th>
<th>Topics</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No Lecture: First day of autumn semester</td>
</tr>
<tr>
<td>2</td>
<td>The nature of plant diseases, symbiosis, parasites, mutualism, biotrophs and necrotrophs, disease cycles and pathogen life cycles. Nematode attack strategies and types of damage.</td>
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<tr>
<td>5</td>
<td>Symptoms and signs of fungal infection. Example fungal diseases: potato late blight, wheat stem rust, grape powdery mildew, wheat Septoria leaf blotch.</td>
</tr>
<tr>
<td>6</td>
<td>Plant defense mechanisms, host range and non-host resistance. Passive structural and chemical defenses, preformed chemical defenses. Active structural defense, papillae, active chemical defense, hypersensitive response, pathogenesis-related (PR) proteins, phytoalexins and disease resistance.</td>
</tr>
<tr>
<td>7</td>
<td>Pisatin and pisatin demethylase. Local and systemic acquired resistance, signal molecules.</td>
</tr>
<tr>
<td>8</td>
<td>Pathogen effects on food quality and safety.</td>
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<tr>
<td>9</td>
<td>Epidemiology: historical epidemics, disease pyramid, environmental effects on epidemic development. Plant effects on development of epidemics, including resistance, physiology, density, uniformity.</td>
</tr>
<tr>
<td>10</td>
<td>Disease assessment: incidence and severity measures, keys, diagrams, scales, measurement errors. Correlations between incidence and severity.</td>
</tr>
<tr>
<td>11</td>
<td>Molecular detection and diagnosis of pathogens. Host indexing, serology, monoclonal and polyclonal antibodies. ELISA, PCR, rDNA and rep-PCR.</td>
</tr>
<tr>
<td>12</td>
<td>Strategies for minimizing disease risks: principles of disease control and management.</td>
</tr>
<tr>
<td>13</td>
<td>Disease control strategies: economic thresholds, physical control methods.</td>
</tr>
<tr>
<td>14</td>
<td>Cultural control methods: avoidance, tillage practices, crop sanitation, fertilizers, crop rotation.</td>
</tr>
</tbody>
</table>

Lecture notes

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

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
<th>Type</th>
<th>Instructor</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-1145-00L</td>
<td>Viral and non-Viral Vectors for Human Gene-Therapy - from Pathogens to Safe Medical Applications</td>
<td>2</td>
<td>W</td>
<td>University lecturers</td>
</tr>
<tr>
<td>636-0017-00L</td>
<td>Computational Biology</td>
<td>4</td>
<td>W</td>
<td>T. Stadler, C. Magnus</td>
</tr>
</tbody>
</table>

Abstract

Basic aspects of virology, the viral mechanisms for transfer of genetic material into cells, different vector-systems and target cells, animal models, specific applications for inborn diseases of the immune system and of metabolism, adverse effects, and new developments of vector systems will be taught.

Objective

Knowledge of important viral and non-viral vector systems.
Knowledge of application in human diseases.
Knowledge of limiting factors.

Content

- pathogen evolution
- epidemiology
- pathogen evolution
- macroevolution of species
- stochastic models in molecular evolution
- phylogenetic & phylodynamic inference
- maximum likelihood and Bayesian statistics
- host indexing, serology, monoclonal and polyclonal antibodies. ELISA, PCR, rDNA and rep-PCR.
- avoidance, tillage practices, crop sanitation, fertilizers, crop rotation.

The course consists of four parts. We first introduce modern genetic sequencing technology, and algorithms to obtain sequence alignments from the output of the sequencers. We then present methods to directly analyze this alignment (such as BLAST algorithm, GWAS approaches). Second, we introduce mechanisms and concepts of molecular evolution, i.e. we discuss how genetic sequences change over time. Third, we employs evolutionary concepts to infer ancestral relationships between organisms based on their genetic sequences, i.e. we discuss methods to infer genealogies and phylogenies. We finally introduce the field of phylodynamics. The aim of that field is to understand and quantify the population dynamic processes (such as transmission in epidemiology or speciation & extinction in macroevolution) based on a phylogeny. Throughout the class, the models and methods are illustrated on different datasets giving insight into the epidemiology and evolution of a range of infectious diseases (e.g. HIV, HCV, influenza, Ebola). Applications of the methods to the field of macroevolution provide insight into the evolution and ecology of different species clades. Students will be trained in the algorithms and their application both on paper and in silico as part of the exercises.
Lecture notes

Slides of the lecture will be available online.
https://www.bsse.ethz.ch/cevo/education/cb-materials.html

Literature

The course is not based on any of the textbooks below, but they are excellent choices as accompanying material:
* Yang, Z. 2006. Computational Molecular Evolution.
* Drummond, A. & Bouckaert, R. 2015. Bayesian evolutionary analysis with BEAST

Prerequisites / notice

Basic knowledge in linear algebra, analysis, and statistics will be helpful. Some programming experience will be useful for the exercises, but is not required. Programming skills will not be tested in the examination.

751-4805-00L Recent Advances in Biocommunication

Number of participants limited to 25

Abstract

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

Objective

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

Elective Concept Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>752-4005-00L Food Microbiology</td>
<td>W</td>
<td>3 credits</td>
<td>2V</td>
<td>M. Loessner</td>
<td></td>
</tr>
</tbody>
</table>

Abstract

This lecture is the first part of a one-year course. It offers insights into the fundamentals and applications of Food Microbiology. Contents include basic microbiology of the different bacteria, yeasts and molds present in foods, as well as the occurrence and control of foodborne pathogens and spoilage organisms.

Objective

The lecture offers insights into the basics, practical consequences and applications of Food Microbiology. Contents include basic microbiology of the different bacteria, yeasts, molds and protozoa in foods, as well as the occurrence and control of foodborne pathogens and spoilage organisms. The focus of this first part of the lecture will be on the organisms, but also on the factors which determine spoilage and foodborne disease.

Content

1. History of Food Microbiology
   1.1. Short synopsis of foodborne microorganisms
   1.2. Spoilage of Foods
   1.3. Foodborne Disease
   1.4. Food Preservation
   1.5. VIP's of Food Microbiology
2. Overview of Microorganisms in Foods
   2.1 Origin of foodborne Microorganisms
   2.2. Bacteria
   2.3. Yeasts
   2.4. Molds
3. Microbial Spoilage of Foods
   3.1. Intrinsic and Extrinsic Parameters
   3.2. Meats, Seafoods, Eggs
   3.3. Milk and Milk Products
   3.4. Vegetable and Fruit Products
   3.5. Miscellaneous (baked goods, nuts, spices, ready-to-eat products)
   3.6. Drinks and Canned Foods
4. Foodborne Disease
   4.1. Significance and Transmission of Foodborne pathogens
   4.2. Staphylococcus aureus
   4.3. Gram-positive Sporeformers (Bacillus & Clostridium)
   4.4. Listeria monocytogenes
   4.5. Salmonella, Shigella, Escherichia coli
   4.6. Vibrio, Yersinia, Campylobacter
   4.7. Brucella, Mycobacterium
   4.8. Parasites
   4.9. Viruses and Bacteriophages
   4.10. Mycotoxins
   4.11. Bioactive Amines
   4.12. Miscellaneous (Antibiotic-resistant Bacteria, Biofilms)

Lecture notes

Electronic copies of the presentation slides (PDF) and additional material will be made available for download.

Literature

Recommendations will be given in the first lecture

551-1295-00L Introduction to Bioinformatics: Concepts and Applications

W 6 credits 4G W. Gruissem, K. Bärenfaller, A. Callisch, G. Capitani, J. Fütterer, M. Robinson, A. Wagner

Abstract

Storage, handling and analysis of large datasets have become essential in biological research. The course will introduce students to a number of applications of bioinformatics in biology. Freely accessible software tools and databases will be explained and explored in theory and praxis.
**Objective**

Introduction to Bioinformatics I: Concepts and Applications (formerly Bioinformatics I) will provide students with the theoretical background of approaches to store and retrieve information from large databases. Concepts will be developed how DNA sequence information can be used to understand phylogenetic relationships, how RNA sequence relates to structure, and how protein sequence information can be used for genome annotation and to predict protein folding and structure. Students will be introduced to quantitative methods for measuring gene expression and how this information can be used to model gene networks. Methods will be discussed to construct protein interaction maps and how this information can be used to simulate dynamic molecular networks.

In addition to the theoretical background, the students will develop hands-on experiences with the bioinformatics methods through guided exercises. The course provides students from different backgrounds with basic training in bioinformatics approaches that have impact on biological, chemical and physics experimentation. Bioinformatics approaches draw significant expertise from mathematics, statistics and computational science.

Although "Introduction to Bioinformatics I" will focus on theory and praxis of bioinformatics approaches, the course provides an important foundation for the course "Introduction to Bioinformatics II: Fundamentals of computer science, modeling and algorithms" that will be offered in the following semester.

**Content**

Bioinformatics I will cover the following topics:

- From genes to databases and information
- BLAST searches
- Prediction of gene function and regulation
- RNA structure prediction
- Gene expression analysis using microarrays
- Protein sequence and structure databases
- WWW for bioinformatics
- Protein sequence comparisons
- Proteomics and de novo protein sequencing
- Protein structure prediction
- Cellular and protein interaction networks
- Molecular dynamics simulation

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**570-2413-00L**

**Evolutionary Genetics**

| W | 6 credits | T. Städler, A. Widmer, P. C. Brunner, M. C. Fischer |
---|---|---|

**Abstract**

The concept course 'Evolutionary Genetics' consists of two lectures that jointly provide an introduction to the fields of population and quantitative genetics (emphasis on basic concepts) and ecological genetics (more emphasis on evolutionary and ecological processes of adaptation and speciation).

**Objective**

The aim of the course is to provide students with a solid introduction to the fields of population genetics, quantitative genetics, and ecological genetics. The concepts and research methods developed in these fields have undergone profound transformations; they are of fundamental importance in our understanding of evolutionary processes, both past and present. Students should gain an appreciation for the concepts, methods and explanatory power of evolutionary genetics.

**Content**

Population genetics - Types and sources of genetic variation; randomly mating populations and the Hardy-Weinberg equilibrium; effects of inbreeding; natural selection; random genetic drift and effective population size; gene flow and hierarchical population structure; molecular population genetics: neutral theory of molecular evolution and basics of coalescent theory.

Quantitative genetics - Continuous variation; measurement of quant. characters; genes, environments and their interactions; measuring their influence; response to selection; inbreeding and crossbreeding, effects on fitness; Fisher's fundamental theorem.

Ecological Genetics - Concepts and methods for the study of genetic variation and its role in adaptation, reproductive isolation, hybridization and speciation.

**Lecture notes**

Handouts

**Literature**


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**551-0311-00L**

**Molecular Life of Plants**

| W | 6 credits | W. Gruissem, A. Rodriguez-Villalon, C. Sánchez-Rodríguez, O. Voinnet, S. C. Zeeman |
---|---|---|

**Abstract**

The advanced course introduces students to plants through a concept-based discussion of developmental processes that integrates physiology and biochemistry with genetics, molecular biology, and cell biology. The course follows the life of the plant, starting with the seed, progressing through germination to the seedling and mature plant, and ending with reproduction and senescence.

**Objective**

The new course "Molecular Life of Plants" reflects the rapid advances that are occurring in the field of experimental plant biology as well as the changing interests of students being trained in this discipline. Contemporary plant biology courses emphasize a traditional approach to experimental plant biology by discussing discrete topics that are removed from the context of the plant life cycle. The course will take an integrative approach that focuses on developmental concepts. Whereas traditional plant physiology courses were based on research carried out on intact plants or plant organs and were often based on phenomenological observations, current research in plant biology emphasizes work at the cellular, subcellular and molecular levels.

The goal of "Molecular Life of Plants" is to train students in integrative approaches to understand the function of plants in a developmental context. While the course focuses on plants, the training integrative approaches will also be useful for other organisms.

**Content**

The course "Molecular Life of Plants" will cover the following topics in a developmental context:

- Plant genome organization
- Seed anatomy
- Food reserves and mobilization
- Seedling emergence
- Heterotrophic to autotrophic growth
- Chlorophyll biosynthesis, photoreceptors
- Integration of metabolism
- Hormones
- Cell cycle
- Cell differentiation and expansion
- Environmental interactionsabiotic
- Environmental interactionsbiotic
- Flower development and fertilization
- Embryo and seed development
- Fruit development
- Senescence

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**551-0307-00L**

**Molecular and Structural Biology I: Protein Structure and Function**

| W | 3 credits | R. Glockshuber, K. Locher, E. Weber-Ban |
---|---|---|

*D-BIOL BSc students are obliged to take part I and part II*
Abstract
Biophysics of protein folding, membrane proteins and biophysics of membranes, enzymatic catalysis, catalytic RNA and RNAs, current topics in protein biophysics and structural biology.

Objective
Understanding of structure-function relationships in proteins and in protein folding, detailed understanding of biophysics and physical methods as well as modern methods for protein purification and microanalytics.

Lecture notes
Scripts on the individual topics can be found under http://www.mol.biol.ethz.ch/teaching.

Literature
Basics:
- Crainthwaite, T.E., Proteins, Freeman, (1993)
- Fersht, A., Enzyme, Structure and Mechanism in Protein Science (1999), Freeman.

Current topics: References will be given during the lectures.

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551-0309-00L Concepts in Modern Genetics W 6 credits 4V Y. Barral, D. Bopp, A. Hajnal, M. Stoffel, O. Vöönen

Abstract
Concepts of modern genetics and genomics, including principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

Objective
This course focuses on the concepts of classical and modern genetics and genomics.

Content
The topics include principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

Lecture notes
Scripts on the individual topics can be found under http://www.mol.biol.ethz.ch/teaching.

Prerequisites / notice
This course is a co-production of the University of Zurich and ETH Zurich, and will be taught in English. The course takes place on Monday afternoon at ETH Hoenggerberg, and on Tuesday morning at UZH Irchel.

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551-0319-00L Cellular Biochemistry (Part I) W 3 credits 2V U. Kutay, R. I. Enchev, B. Kornmann, M. Peter, I. Zemp, further lecturers

Abstract
Concepts and molecular mechanisms underlying the biochemistry of the cell, providing advanced insights into structure, function and regulation of individual cell components. Particular emphasis will be put on the spatial and temporal integration of different molecules and signaling pathways into global cellular processes such as intracellular transport, cell division & growth, and cell migration.

Objective
The full-year course (551-0319-00 & 551-0320-00) focuses on the molecular mechanisms and concepts underlying the biochemistry of cellular physiology, investigating how these processes are integrated to carry out highly coordinated cellular functions. The molecular characterisation of complex cellular functions requires a combination of approaches such as biochemistry, but also cell biology and genetics. This course is therefore the occasion to discuss these techniques and their integration in modern cellular biochemistry.

Content
Structural and functional details of individual cell components, regulation of their interactions, and various aspects of the regulation and compartmentalisation of biochemical processes.

Lecture notes
Recommended additional material will be provided during the semester. Please contact Dr. Alicia Smith for assistance with the learning materials. (alicia.smith@bc.biol.ethz.ch)

Literature
Recommended supplementary literature (review articles and selected primary literature) will be provided during the course.

Prerequisites / notice
To attend this course the students must have a solid basic knowledge in chemistry, biochemistry and general biology. The course will be taught in English.

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529-0731-00L Nucleic Acids and Carbohydrates W 6 credits 3G D. Hilvert, P. A. Kast, S. J. Sturla, H. Wennenemers

Abstract
Structure, function and chemistry of nucleic acids and carbohydrates. DNA/RNA structure and synthesis; recombinant DNA technology and PCR; DNA arrays and genomics; antisense approach and RNAi; polymerases and transcription factors; catalytic RNA; DNA damage and repair; carbohydrate structure and synthesis; carbohydrate arrays; cell surface engineering; carbohydrate vaccines

Objective
Structure, function and chemistry of nucleic acids and carbohydrates. DNA/RNA structure and synthesis; recombinant DNA technology and PCR; DNA arrays and genomics; antisense approach and RNAi; polymerases and transcription factors; catalytic RNA; DNA damage and repair; carbohydrate structure and synthesis; carbohydrate arrays; cell surface engineering; carbohydrate vaccines

Content
Structure, function and chemistry of nucleic acids and carbohydrates. DNA/RNA structure and synthesis; recombinant DNA technology and PCR; DNA arrays and genomics; antisense approach and RNAi; polymerases and transcription factors; catalytic RNA; DNA damage and repair; carbohydrate structure and synthesis; carbohydrate arrays; cell surface engineering; carbohydrate vaccines

Lecture notes
no script

Literature
Mainly based on recent original literature, a detailed list will be distributed during the first lecture.

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Elective Major: Cell Biology

Elective Compulsory Concept Courses

See D-BIOL Master Studies Guide

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<td>551-0319-00L</td>
<td>Cellular Biochemistry (Part I)</td>
<td>W</td>
<td>3</td>
<td>2</td>
<td>U. Kutay, R. I. Enchev, B. Kornmann, M. Peter, I. Zemp, further lecturers</td>
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Abstract
Concepts and molecular mechanisms underlying the biochemistry of the cell, providing advanced insights into structure, function and regulation of individual cell components. Particular emphasis will be put on the spatial and temporal integration of different molecules and signaling pathways into global cellular processes such as intracellular transport, cell division & growth, and cell migration.
Objective
The full-year course (551-0319-00 & 551-0320-00) focuses on the molecular mechanisms and concepts underlying the biochemistry of cellular physiology, investigating how these processes are integrated to carry out highly coordinated cellular functions. The molecular characterisation of complex cellular functions requires a combination of approaches such as biochemistry, but also cell biology and genetics. This course is therefore the occasion to discuss these techniques and their integration in modern cellular biochemistry. The students will be able to describe the structural and functional details of individual cell components, and the spatial and temporal regulation of their interactions. In particular, they will learn to explain the integration of different molecules and signaling pathways into complex and highly dynamic cellular processes such as intracellular transport, cytoskeletal rearrangements, cell motility, cell division and cell growth. In addition, they will be able to illustrate the relevance of particular signaling pathways for cellular pathologies such as cancer.

Content
Structural and functional details of individual cell components, regulation of their interactions, and various aspects of the regulation and compartmentalisation of biochemical processes.

Topics include: biophysical and electrical properties of membranes; viral membranes; structural and functional insights into intracellular transport and targeting; vesicular trafficking and phagocytosis; post-transcriptional regulation of gene expression.

Lecture notes
Scripts and additional material will be provided during the semester. Please contact Dr. Alicia Smith for assistance with the learning materials. (alicia.smith@bc.biolog.ethz.ch)

Prerequisites / notice
To attend this course the students must have a solid basic knowledge in chemistry, biochemistry and general biology. The course will be taught in English.

551-0309-00L Concepts in Modern Genetics

Abstract
Concepts of modern genetics and genomics, including principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

Objective
This course focuses on the concepts of classical and modern genetics and genomics.

Content
The topics include principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

Lecture notes
Scripts and additional material will be provided during the semester.

Prequisites / notice
This course is a co-production of the University of Zurich and ETH Zurich, and will be taught in English. The course takes place on Monday afternoon at ETH Hoenggerberg, and on Tuesday morning at UZH Irchel.

551-0317-00L Immunology I

Abstract
Introduction into structural and functional aspects of the immune system. Basic knowledge of the mechanisms and the regulation of an immune response.

Objective
Introduction into structural and functional aspects of the immune system. Basic knowledge of the mechanisms and the regulation of an immune response.

Content
- Introduction and historical background
- Innate and adaptive immunity. Cells and organs of the immune system
- B cells and antibodies
- Generation of diversity
- Antigen presentation and Major Histoincompatibility (MHC) antigens
- Thymus and T cell selection
- Autoimmunity
- Cytotoxic T cells and NK cells
- Th1 and Th2 cells, regulatory T cells
- Allergies
- Hypersensitivities
- Vaccines, immune-therapeutic interventions

Lecture notes
Electronic access to the documentation will be provided. The link can be found at "Lernmaterialien"

Literature

Prerequisites / notice
Immunology I (WS) and Immunology II (SS) will be examined as one learning entity in a "Sessionsprüfung".

551-1295-00L Introduction to Bioinformatics: Concepts and Applications

Abstract
Storage, handling and analysis of large datasets have become essential in biological research. The course will introduce students to a number of applications of bioinformatics in biology. Freely accessible software tools and databases will be explained and explored in theory and praxis.

Objective
Introduction to Bioinformatics I: Concepts and Applications (formerly Bioinformatics I) will provide students with the theoretical background of approaches to store and retrieve information from large databases. Concepts will be developed how DNA sequence information can be used to understand phylogenetic relationships, how RNA sequence relates to structure, and how protein sequence information can be used for genome annotation and to predict protein folding and structure. Students will be introduced to quantitative methods for measuring gene expression and how this information can be used to model gene networks. Methods will be discussed to construct protein interaction maps and how this information can be used to simulate dynamic molecular networks.

In addition to the theoretical background, the students will develop hands-on experiences with the bioinformatics methods through guided exercises. The course provides students from different backgrounds with basic training in bioinformatics approaches that have impact on biological, chemical and physical experimentation. Bioinformatics approaches draw significant expertise from mathematics, statistics and computational science.

Although "Introduction to Bioinformatics I" will focus on theory and praxis of bioinformatics approaches, the course provides an important foundation for the course "Introduction to Bioinformatics II: Fundamentals of computer science, modeling and algorithms" that will be offered in the following semester.
The lecture course aims at providing an advanced understanding of the physiology and metabolism of prokaryotes. Applied aspects of microbial biochemistry will be pointed out as well as research fields of current scientific interest.

Objective
- Recognize the universal principles underlying the development of different animal body plans.
- Explain how the genes encoding the molecular toolkit have evolved to create animal diversity.
- Relate changes in gene structure or function to evolutionary changes in animal development.
- Key skills:
  - By the end of this module, each student should be able to present and discuss a relevant evolutionary topic in an oral presentation.
  - Select and integrate key concepts in animal evolution from primary literature.
  - Participate in discussions on topics presented by others.

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Important biochemical processes specific to bacteria and archaea will be presented that contribute to the widespread occurrence of prokaryotes. Applied aspects of microbial biochemistry will be pointed out as well as research fields of current scientific interest. Emphasis is on concepts of energy generation and assimilation.

List of topics:
- Eating sugars and letting them in
- Challenging: Aromatics, xenobiotics, and oil
- Complex: (Ligno-)Cellulose and in demand for bioenergy
- Living on a diet and the anaerobic provocation
- Of climate relevance: The microbial C1 cycle
- What are AMO and Anammox?
- 20 amino acids: the making of
- Extending the genetic code
- The 21st and 22nd amino acid
- Some exotic biochemistry: nucleotides, cofactors
- Ancient biochemistry? Iron-sulfur clusters, polymers
- Secondary metabolites: playground of evolution
- A script will be provided during the course.

**Lecture notes**

**551-1105-00L Glycobiology**

*W*  4 credits  2V

M. Aebi, T. Hennet

**Abstract**

Structural principles, nomenclature and different classes of glycosylation. The different pathways of N- and O-linked protein glycosylation and glycolipid biosynthesis in prokaryotes and eukaryotes are discussed. Specific glycan binding proteins and their role in deciphering the glycan code are presented. The role of glycans in infectious diseases, antigen mimicry and autoimmunity are discussed.

**Objective**

Detailed knowledge in 1) the different areas of prokaryotic and eukaryotic glycobiology, in particular in the biosynthesis of glycoproteins and glycolipids; 2) the cellular machinery required for these pathways; 3) the principles of carbohydrate/protein interaction; 4) the function of lectins; 5) the role of glycans in infectious disease.

**Content**

- Structure and linkages; analytical approaches; N-linked protein glycosylation (ER, Golgi); glycan-assisted protein folding and quality control; O-linked protein glycosylation; glucosaminoglycans; glycolipids; prokaryotic glycosylation pathways; lectins; glycans and infectious disease

**Literature**

Introduction to Glycobiology; M.E.Taylor, K.Drickamer, Oxford University Press, 2003

**Prerequisites / notice**

The course will be in English. It will include the preparation of short essays (marked) about defined topics in Glycobiology.

**551-1117-00L Cutting Edge Topics: Immunology and Infection Biology**

*W*  2 credits  1S

A. Oxenius, B. Becher, C. Halin Winter, M. Kopf, S. R. Leibundgut, C. Münz, A. Trkola, M. van den Broek

**Abstract**

Weekly seminar about cutting edge topics in immunology and infection biology. Internationally renowned experts present their current research followed by an open discussion.

**Objective**

Weekly seminar about cutting edge topics in immunology and infection biology. Internationally renowned experts present their current research followed by an open discussion.

**Content**

- Immunology and infection biology
- The specific topics are variable and depend each semester on the list of invited experts.

**Literature**

The course extends many of the generally introduced concepts and methods of the Concept Course in Systems Biology. It requires a good knowledge of biochemistry and basics of mathematics and chemistry.

**Prerequisites / notice**

The course extends many of the generally introduced concepts and methods of the Concept Course in Systems Biology. It requires a good knowledge of biochemistry and basics of mathematics and chemistry.

**551-1153-00L Systems Biology of Metabolism**

*W*  4 credits  2V

U. Sauer, N. Zamboni, M. Zampieri

**Abstract**

Starting from contemporary biological problems related to metabolism, the course focuses on systems biological approaches to address them. In a problem-oriented, this-is-how-it-is-done manner, we thereby teach modern methods and concepts.

**Objective**

Develop a deeper understanding of how relevant biological problems can be solved, thereby providing advanced insights to key experimental and computational methods in systems biology.

**Content**

- The course will be given as a mixture of lectures, studies of original research and guided discussions that focus on current research topics.
- For each particular problem studied, we will work out how the various methods work and what their capabilities/limits are. The problem areas range from microbial metabolism to cancer cell metabolism and from metabolic networks to regulation networks in populations and single cells. Key methods to be covered are various modeling approaches, metabolic flux analyses, metabolomics and other omics.

**Literature**

Script and original publications will be supplied during the course.

**551-1171-00L Immunology: from Milestones to Current Topics**

*W*  4 credits  2S

B. Ludewig, J. Kisielow, M. Kopf, A. Oxenius, University lecturers

**Abstract**

Milestones in Immunology: on old concepts and modern experiments

**Objective**

The course will cover six grand topics in immunology (B cells, innate immunity, antigen presentation, tumor immunity, thymus and T cells, cytotoxic T cells and NK cells) and for each grand topic four hours will be allocated. During the first double hour, historical milestone papers will be presented by the supervisor providing an overview on the development of the conceptual framework and critical technological advances. The students will also prepare themselves for this double lecture by reading the historical milestone papers and contributing to the discussion. In the following lecture up to four students will present each a recent high impact research paper which emerged from the landmark achievements of the previously discussed milestone concepts.

**Content**

- Milestones and current topics of innate immunity, antigen presentatino, B cells, thymus and T cells, cytotoxic T cells and NK cells, and tumor immunity.

**Literature**

Original and review articles will be distributed by the lecturer.

**551-1303-00L Cellular Biochemistry of Health and Disease**

*W*  4 credits  2S

P. Picotti, Y. Barral, V. Korkhov, B. Kommann, R. Kroschewski, J. Matos, M. Peter, A. E. Smith, K. Weis

**Abstract**

During this Masters level seminar style course, students will explore current research topics in cellular biochemistry focused on the structure, function and regulation of selected cell components, and the consequences of dysregulation for pathologies.
Objective

Students will work with experts toward a critical analysis of cutting-edge research in the domain of cellular biochemistry, with emphasis on normal cellular processes and the consequences of their dysregulation. At the end of the course, students will be able to introduce, present, evaluate, critically discuss and write about recent scientific articles in the research area of cellular biochemistry.

Content

Guided by an expert in the field, students will engage in classical round-table style discussions of current literature with occasional frontal presentations. Students will alternate as discussion leaders throughout the semester, with the student leader responsible to briefly summarize key general knowledge and context of the assigned primary research paper. Together with the faculty expert, all students will participate in discussion of the primary paper, including the foundation of the biological question, specific questions addressed, key methods, key results, remaining gaps and research implications.

Literature

The literature will be provided during the course.

Lecture notes

The course will be taught in English.

Prerequisites / notice

Active participation in the discussions is a prerequisite for this course.

529-0733-00L Enzymes

W 7 credits 3G D. Hilvert

Abstract

Principles of enzymatic catalysis, enzyme kinetics, mechanisms of enzyme catalyzed reactions (group transfer reactions, carbon-carbon bond formation, eliminations, isomerisations and rearrangements), cofactor chemistry, enzymes in organic synthesis and the biosynthesis of natural products, catalytic antibodies.

Objective

Overview of enzymes, enzyme-catalyzed reactions and metabolic processes.

Content

Principles of enzymatic catalysis, enzyme kinetics, mechanisms of enzyme catalyzed reactions (group transfer reactions, carbon-carbon bond formation, eliminations, isomerisations and rearrangements), cofactor chemistry, enzymes in organic synthesis and the biosynthesis of natural products, catalytic antibodies.

Lecture notes

A script will not be handed out.

Literature

General:


In addition, citations from the original literature relevant to the individual lectures will be assigned weekly.

551-1407-00L RNA Biology Lecture Series I: Transcription & Processing & Translation

W 4 credits 2V F. Allain, N. Ban, U. Kutay, further lecturers

Abstract

This course covers aspects of RNA biology related to gene expression at the posttranscriptional level. These include RNA transcription, processing, alternative splicing, editing, export and translation.

Objective

The students should obtain an understanding of these processes, which are at work during gene expression.

Content

Transcription & 3'end formation; splicing, alternative splicing, RNA editing; the ribosome & translation, translation regulation, RNP biogenesis & nuclear export, miRNA surveillance & mRNA turnover; signal transduction & RNA processing, alternative splicing, isomerisations and rearrangements).

Lecturers

F. Allain, N. Ban, U. Kutay, further lecturers

Prerequisites / notice

Basic knowledge of cell and molecular biology.

Elective Major: Molecular Health Sciences

Elective Compulsory Master Courses

551-0571-00L From DNA to Diversity (University of Zurich)

W 2 credits 2V A. Hajnal, D. Bopp, E. Hafen

Mind the enrolment deadlines at UZH: 

http://www.uzh.ch/studies/application/mobilitaet_en.html

Abstract

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.

UZH Module Code: BIO336

The evolution of the various body-plans is investigated by means of comparison of developmentally essential control genes of molecularly analysed model organisms.

Objective

By the end of this module, each student should be able to:
- recognize the universal principles underlying the development of different animal body plans.
- explain how the genes encoding the molecular toolkit have evolved to create animal diversity.
- relate changes in gene structure or function to evolutionary changes in animal development.

Key skills:
- By the end of this module, each student should be able to:
- present and discuss a relevant evolutionary topic in an oral presentation
- select and integrate key concepts in animal evolution from primary literature
- participate in discussions on topics presented by others

551-1303-00L Cellular Biochemistry of Health and Disease

W 4 credits 2S P. Picotti, Y. Barral, V. Korkhov, B. Kornmann, R. Kroschewski, J. Matos, M. Peter, A. E. Smith, K. Weis

Abstract

Number of participants limited to 15.

During this Masters level seminar style course, students will explore current research topics in cellular biochemistry focused on the structure, function and regulation of selected cell components, and the consequences of dysregulation for pathologies.

Objective

Students will work with experts toward a critical analysis of cutting-edge research in the domain of cellular biochemistry, with emphasis on normal cellular processes and the consequences of their dysregulation. At the end of the course, students will be able to introduce, present, evaluate, critically discuss and write about recent scientific articles in the research area of cellular biochemistry.
Content
Guided by an expert in the field, students will engage in classical round-table style discussions of current literature with occasional frontal presentations. Students will alternate as discussion leaders throughout the semester, with the student leader responsible to briefly summarize key general knowledge and context of the assigned primary research paper. Together with the faculty expert, all students will participate in discussion of the primary paper, including the foundation of the biological question, specific questions addressed, key methods, key results, remaining gaps and research implications.

Literature
The literature will be provided during the course

Prerequisites / notice
The course will be taught in English.

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551-0512-00L Current Topics in Molecular and Cellular Neurobiology W 2 credits 1S U. Suter

Abstract
The course is a literature seminar or "journal club". Each Friday a student, or a member of the Suter Lab in the Institute of Molecular Health Sciences, will present a paper from the recent literature.

Objective
The course introduces you to recent developments in the fields of cellular and molecular neurobiology. It also supports you to develop your skills in critically reading the scientific literature. You should be able to grasp what the authors wanted to learn i.e. their goals, why the authors chose the experimental approach they used, the strengths and weaknesses of the experiments and the data presented, and how the work fits into the wider literature in the field. You will present one paper yourself, which provides you with practice in public speaking.

Content
You will present one paper yourself. Give an introduction to the field of the paper, then show and comment on the main results (all the papers we present are available online, so you can show original figures with a beamer). Finish with a summary of the main points and a discussion of their significance.

You are expected to take part in the discussion and to ask questions. To prepare for this you should read all the papers beforehand (they will be announced a week in advance of the presentation).

Lecture notes
Presentations will be made available after the seminars.

Prerequisites / notice
You must attend at least 80% of the journal clubs, and give a presentation of your own. At the end of the semester there will be a 30 minute oral exam on the material presented during the semester. The grade will be based on the exam (45%), your presentation (45%), and a contribution based on your active participation in discussion of other presentations (10%).

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551-1153-00L Systems Biology of Metabolism W 4 credits 2V U. Sauer, N. Zamboni, M. Zampieri

Abstract
Starting from contemporary biological problems related to metabolism, the course focuses on systems biological approaches to address them. In a problem-oriented, this-is-how-it-is-done manner, we thereby teach modern methods and concepts.

Objective
Develop a deeper understanding of how relevant biological problems can be solved, thereby providing advanced insights to key experimental and computational methods in systems biology.

Content
The course will be given as a mixture of lectures, studies of original research and guided discussions that focus on current research topics. For each particular problem studied, we will work out how the various methods work and what their capabilities/limits are. The problem areas range from microbial metabolism to cancer cell metabolism and from metabolic networks to regulation networks in populations and single cells. Key methods to be covered are various modeling approaches, metabolic flux analyses, metabolomics and other omics.

Lecture notes
Script and original publications will be supplied during the course.

Prerequisites / notice
The course extends many of the generally introduced concepts and methods of the Concept Course in Systems Biology. It requires a good knowledge of biochemistry and basics of mathematics and chemistry.

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551-1105-00L Glycobiology W 4 credits 2V M. Aebi, T. Henriet

Abstract
Structural principles, nomenclature and different classes of glycosylation. The different pathways of N- and O-linked protein glycosylation and glycoprotein biosynthesis in prokaryotes and eukaryotes are discussed. Specific glycan binding proteins and their role in deciphering the glycan code are presented. The role of glycans in infectious diseases, antigen mimicry and autoimmune diseases are discussed.

Objective
Detailed knowledge in 1) the different areas of prokaryotic and eukaryotic glycobiology, in particular in the biosynthesis of glycoproteins and glycolipids, 2) the cellular machinery required for these pathways, 3) the principles of carbohydrate/protein interaction, 4) the function of lectins, 5) the role of glycans in infectious disease.

Content
Structure and linkages; analytical approaches; N-linked protein glycosylation (ER, Golgi); glycan-assisted protein folding and quality control; O-linked protein glycosylation; glucosaminoglycans; glycolipids; prokaryotic glycosylation pathways; lectins; glycans and infectious disease.

Lecture notes
handouts

Literature

Prerequisites / notice
The course will be in English. It will include the preparation of short essays (marked) about defined topics in Glycobiology.

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551-1171-00L Immunology: from Milestones to Current Topics W 4 credits 2S B. Ludewig, J. Kisielow, M. Kopf, A. Owenius, University lecturers

Abstract
Milestones in Immunology: on old concepts and modern experiments

Objective
The course will cover six grand topics in immunology (B cells, innate immunity, antigen presentation, tumor immunity, thymus and T cells, cytotoxic T cells and NK cells) and for each grand topic four hours will be allocated. During the first double hour, historical milestone papers will be presented by the supervisor providing an overview on the development of the conceptual framework and critical technological advances. The students will also prepare themselves for this double lecture by reading the historical milestone papers and contributing to the discussion. In the following lecture up to four students will present each a recent high impact research paper which emerged from the landmark achievements of the previously discussed milestone concepts.

Content
Milestones and current topics of innate immunity, antigen presentation, B cells, thymus and T cells, cytotoxic T cells and NK cells, and tumor immunology.

Lecture notes
Original and review articles will be distributed by the lecturer.

Literature
Literaturunterlagen werden vor Beginn des Kurses auf folgender website zugänglich sein: Moodle Course https://moodle-app2.let.ethz.ch/course/view.php?id=1002

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752-6105-00L Epidemiology and Prevention W 3 credits 2V M. Puhan, R. Heusser

Abstract
The module Epidemiology and prevention describes the process of scientific discovery from the detection of a disease and its causes, to the development and evaluation of preventive and treatment interventions and to improved population health.

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<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Winter Semester 2015</th>
<th>Credit</th>
<th>Lecture Time</th>
<th>Lecturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>636-0003-00L</td>
<td>Translational Science for Health and Medicine</td>
<td>6</td>
<td>3</td>
<td>2G</td>
<td>J. Goldhahn, C. Wolfrum</td>
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<tr>
<td>636-0507-00L</td>
<td>Synthetic Biology II</td>
<td>4</td>
<td>4</td>
<td>S. Panke, Y. Benenson, J. Stelling</td>
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<tr>
<td>752-4009-00L</td>
<td>Molecular Biology of Foodborne Pathogens</td>
<td>3</td>
<td>2</td>
<td>M. Loessner, M. Schuppler</td>
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<tr>
<td>752-5101-00L</td>
<td>Dietary Etiologies of Chronic Disease</td>
<td>3</td>
<td>2</td>
<td>M. B. Zimmermann</td>
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<tr>
<td>752-6101-00L</td>
<td>Biophysical Manufacturing I. Introduction to Process Development</td>
<td>3</td>
<td>2</td>
<td>M. Fussenegger</td>
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<tr>
<td>752-4009-00L</td>
<td>Biophysical Manufacturing II. Up-stream Development</td>
<td>3</td>
<td>2</td>
<td>M. Fussenegger</td>
<td></td>
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<tr>
<td>752-4009-00L</td>
<td>Biophysical Manufacturing IV. Pharma Development</td>
<td>3</td>
<td>2</td>
<td>M. Fussenegger</td>
<td></td>
</tr>
</tbody>
</table>

The overall goal of the course is to introduce students to epidemiological thinking and methods, which are critical pillars for medical and public health research. Students will also become aware on how epidemiological facts are used in prevention, practice and politics.

The module Epidemiology and prevention follows an overall framework that describes the course of scientific discovery from the detection of a disease to the development of prevention and treatment interventions and their evaluation in clinical trials and real world settings. We will discuss study designs in the context of existing knowledge and the type of evidence needed to advance knowledge. Examples form nutrition, chronic and infectious diseases will be used in order to show the underlying concepts and methods.

The course offers detailed information on selected foodborne pathogens and toxin producing organisms; the focus lies on relevant molecular biological aspects of pathogenecity and virulence, as well as on the occurrence and survival of these organisms in foods.

To have the student gain understanding of the links between the diet and the etiology and progression of chronic diseases, including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

The students are supposed to acquire a deep understanding of the process of biological design including model representation of a biological system, its thorough analysis, and the subsequent experimental implementation of the system and the related problems.

Translational science is a cross disciplinary scientific research that is motivated by the need for practical applications that help people. The course should help to clarify basics of translational science, illustrate successful applications and should enable students to integrate key features into their future projects.

After completing this course, students will be able to understand: Principles of translational science (including project planning, ethics application, basics of resource management and interdisciplinary communication)

This project takes place between end of Spring Semester and beginning of Autumn Semester. Registration in April.

Please note that the number of ECTS credits and the actual work load are disconnected.

Data: 06.03.2019 12:57
Autumn Semester 2016
**Content**

What is translational science and what is it not?

- How to identify need?
- Disease concepts and consequences for research
- Basics about incidence, prevalence etc., and orphan indications
- How to choose the appropriate research type and methodology
- Ethical considerations including ethics application
- Pros and cons of different types of research
- Coordination of complex approaches incl. timing and resources
- How to measure success?
- Outcome variables
- Improving the translational process
- Challenges of communication?
- How independent is translational science?
- Academic boundary conditions vs. industrial influences

Positive and negative examples will be illustrated by distinguished guest speakers.

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**Number** 551-1145-00L

**Title** Viral and non-Viral Vectors for Human Gene-Therapy - from Pathogens to Safe Medical Applications

**ECTS** 2 credits

**Hours** 3V

**Lecturers** University lecturers

**Abstract**

Basic aspects of virology, the viral mechanisms for transfer of genetic material into cells, different vector-systems and target cells, animal models, specific applications for inborn diseases of the immune system and of metabolism, adverse effects, and new developments of vector systems will be taught.

---

**Number** 551-1407-00L

**Title** RNA Biology Lecture Series I: Transcription & Processing & Translation

**ECTS** 4 credits

**Hours** 2V

**Lecturers** F. Allain, N. Ban, U. Kutay, further lecturers

**Abstract**

This course covers aspects of RNA biology related to gene expression at the posttranscriptional level. These include RNA transcription, processing, alternative splicing, editing, export and translation.

---

**Objective**

Knowledge of important viral and non-viral vector systems.

Knowledge of application in human diseases.

Knowledge of limiting factors.

---

**Notice**

Mind the enrolment deadlines at UZH:

http://www.uzh.ch/studies/application/mobilitaet_en.html

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**Notice**

Positive and negative examples will be illustrated by distinguished guest speakers.

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**Notice**

To attend this course the students must have a solid basic knowledge in chemistry, biochemistry and general biology. The course will be taught in English.

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**Objective**

Basic knowledge of cell and molecular biology.

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**Abstract**

The students should obtain an understanding of these processes, which are at work during gene expression.

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**Notice**

Recommended supplementary literature (review articles and selected primary literature) will be provided during the course.

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**Notice**

To attend this course the students must have a solid basic knowledge in chemistry, biochemistry and general biology. The course will be taught in English.

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**Objective**

The full-year course (551-0319-00 & 551-0320-00) focuses on the molecular mechanisms and concepts underlying the biochemistry of the cell, providing advanced insights into structure, function and regulation of individual cell components. Particular emphasis will be put on the spatial and temporal integration of different molecules and signaling pathways into global cellular processes such as intracellular transport, cell division & growth, and cell migration.

---

**Objective**

The full-year course (551-0319-00 & 551-0320-00) focuses on the molecular mechanisms and concepts underlying the biochemistry of cellular physiology, investigating how these processes are integrated to carry out highly coordinated cellular functions. The molecular characterisation of complex cellular functions requires a combination of approaches such as biochemistry, but also cell biology and genetics. This course is therefore the occasion to discuss these techniques and their integration in modern cellular biochemistry. The students will be able to describe the structural and functional details of individual cell components, and the spatial and temporal regulation of their interactions. In particular, they will learn to explain the integration of different molecules and signaling pathways into complex and highly dynamic cellular processes such as intracellular transport, cytokinetic rearrangements, cell motility, cell division and cell growth. In addition, they will be able to illustrate the relevance of particular signaling pathways for cellular pathologies such as cancer.

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**Objective**

Structural and functional details of individual cell components, regulation of their interactions, and various aspects of the regulation and compartmentalisation of biochemical processes.

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**Lecture notes**

Scripts and additional material will be provided during the semester. Please contact Dr. Alicia Smith for assistance with the learning materials. (alia.smith@bc.biol.ethz.ch)

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**Prerequisites / notice**

To attend this course the students must have a solid basic knowledge in chemistry, biochemistry and general biology. The course will be taught in English.

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**Objective**

During this Masters level seminar style course, students will explore current research topics in cellular biochemistry focused on the structure, function and regulation of selected cell components, and the consequences of dysregulation for pathologies.

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**Objective**

Students will work with experts toward a critical analysis of cutting-edge research in the domain of cellular biochemistry, with emphasis on normal cellular processes and the consequences of their dysregulation. At the end of the course, students will be able to introduce, present, evaluate, critically discuss and write about recent scientific articles in the research area of cellular biochemistry.
The lecture course aims at providing an advanced understanding of the physiology and metabolism of microorganisms. Emphasis is on molecular and structural biology.

Guided by an expert in the field, students will engage in classical round-table style discussions of current literature with occasional frontal lectures. The literature will be provided during the course. The course will be taught in English.

### Elective Compulsory Concept Courses

**See D-BIOL Master Studies Guide**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-0307-00L</td>
<td>Molecular and Structural Biology I: Protein Structure and Function (next semester) as a two-semester course</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>R. Glockshuber, K. Locher, E. Weber-Ban</td>
</tr>
<tr>
<td>551-0309-00L</td>
<td>Concepts in Modern Genetics</td>
<td>W</td>
<td>6</td>
<td>4V</td>
<td>Y. Barral, D. Bopp, A. Hajnal, M. Stoffel, O. Voinnet</td>
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<tr>
<td>529-0733-00L</td>
<td>Enzymes</td>
<td>W</td>
<td>7</td>
<td>3G</td>
<td>D. Hilvert</td>
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<tr>
<td>551-1105-00L</td>
<td>Glycobiology</td>
<td>W</td>
<td>4</td>
<td>2V</td>
<td>M. Aebi, T. Henret</td>
</tr>
<tr>
<td>551-1103-00L</td>
<td>Microbial Biochemistry</td>
<td>W</td>
<td>4</td>
<td>2V</td>
<td>J. Vorholt-Zambelli, J. Piel</td>
</tr>
</tbody>
</table>

### Content

- **Abstract**: Biophysics of protein folding, membrane proteins and biophysics of membranes, enzymatic catalysis, catalytic RNA and RNAi, current topics in protein biophysics and structural biology.
- **Objective**: Understanding of structure-function relationships in proteins and in protein folding, detailed understanding of biophysics and physical methods as well as modern methods for protein purification and microanalytics.
- **Lecture notes**: Scripts on the individual topics can be found under http://www.mol.biol.ethz.ch/teaching.

### Literature

- Creighton, T.E., Proteins, Freeman, (1993)
- Fersht, A., Enzyme, Structure and Mechanism in Protein Science (1999), Freeman.

### Prerequisites / notice

Current topics: References will be given during the lectures.

### Elective Compulsory Master Courses

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</tr>
</tbody>
</table>

### Content

- **Abstract**: Principles of enzymatic catalysis, enzyme kinetics, mechanisms of enzyme-catalyzed reactions (group transfer reactions, carbon-carbon bond formation, eliminations, isomerisations and rearrangements), cofactor chemistry, enzymes in organic synthesis and the biosynthesis of natural products, catalytic antibodies.
- **Objective**: Overview of enzymes, enzyme-catalyzed reactions and metabolic processes.
- **Content**: Principles of enzymatic catalysis, enzyme kinetics, mechanisms of enzyme catalyzed reactions (group transfer reactions, carbon-carbon bond formation, eliminations, isomerisations and rearrangements), cofactor chemistry, enzymes in organic synthesis and the biosynthesis of natural products, catalytic antibodies.

### Literature


In addition, citations from the original literature relevant to the individual lectures will be assigned weekly.

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Content

Important biochemical processes specific to bacteria and archaea will be presented that contribute to the widespread occurrence of prokaryotes. Applied aspects of microbial biochemistry will be pointed out as well as research fields of current scientific interest. Emphasis is on concepts of energy generation and assimilation.

List of topics:
- Eating sugars and letting them in
- Challenging: Aromatics, xenobiotics, and oil
- Complex: (Ligno-)Cellulose and in demand for bioenergy
- Living on a diet and the anaerobic provocation
- Of climate relevance: The microbial C1 cycle
- What are AMO and Anammox?
- 20 amino acids: the making of
- Extending the genetic code
- The 21st and 22nd amino acid
- Some exotic biochemistry: nucleotides, cofactors
- Ancient biochemistry? Iron-sulfur clusters, polymers
- Secondary metabolites: playground of evolution

Lecture notes
A script will be provided during the course.

551-1153-00L Systems Biology of Metabolism
Number of participants limited to 15.

Abstract
Starting from contemporary biological problems related to metabolism, the course focuses on systems biological approaches to address them. In a problem-oriented, this-is-how-it-is-done manner, we thereby teach modern methods and concepts.

Objective
Develop a deeper understanding of how relevant biological problems can be solved, thereby providing advanced insights to key experimental and computational methods in systems biology.

Content
The course will be given as a mixture of lectures, studies of original research and guided discussions that focus on current research topics.

For each particular problem studied, we will work out how the various methods work and what their capabilities/limits are. The problem areas range from microbial metabolism to cancer cell metabolism and from metabolomic networks to regulation networks in populations and single cells. Key methods to be covered are various modeling approaches, metabolic flux analyses, metabolomics and other omics.

Lecture notes
A script and original publications will be supplied during the course.

Prerequisites / notice
The course extends many of the generally introduced concepts and methods of the Concept Course in Systems Biology. It requires a good knowledge of biochemistry and basics of mathematics and chemistry.

636-0001-00L Separations in Biotechnology and Bioprocess

Economy
Separations play an integral part of any biotechnological process. This course aims at enabling students specifically with a chemistry/biology background to select & roughly design suitable separation processes for typical biotechnological products such as monoclonal antibodies, antibiotics, and fine chemicals and at providing a basic set of purification operations & judge on process economy.

Objective
Students should be able to select for a given biotechnological product a suitable set of purification operations and judge on process economy.

Content
Introduction membrane operations adsorption and chromatography crystallization overall process economics

Lecture notes
Handouts during course

636-0007-00L Computational Systems Biology

Abstract
Study of fundamental concepts, models and computational methods for the analysis of complex biological networks. Topics: Systems approaches in biology, biology and reaction network fundamentals, modeling and simulation approaches (topological, probabilistic, stoichiometric, qualitative, linear / nonlinear ODEs, stochastic), and systems analysis (complexity reduction, stability, identification).

Objective
The aim of this course is to provide an introductory overview of mathematical and computational methods for the modeling, simulation and analysis of biological networks.

Content
Biological systems have witnessed an unprecedented increase in experimental data and, correspondingly, an increased need for computational methods to analyze this data. The explosion of sequenced genomes, and subsequently, of bioinformatics methods for the storage, analysis and comparison of genetic sequences provides a prominent example. Recently, however, an additional area of research, captured by the label "Systems Biology", focuses on how networks, which are more than the mere sum of their parts' properties, establish biological functions. This is essentially a task of reverse engineering. The aim of this course is to provide an introductory overview of corresponding computational methods for the modeling, simulation and analysis of biological networks.

We will start with an introduction into the basic units, functions and design principles that are relevant for biology at the level of individual cells. Making extensive use of example systems, the course will then focus on methods and tools that allow one to investigate the biological networks with increasing detail. These include (i) graph theoretical approaches for revealing large-scale network organization, (ii) probabilistic (Bayesian) network representations, (iii) structural network analysis based on reaction stoichiometries, (iv) qualitative methods for dynamic modeling and simulation (Boolean and piece-wise linear approaches), (v) mechanistic modeling using ordinary differential equations (ODEs) and finally (vi) stochastic simulation methods.

Lecture notes


401-0649-00L Applied Statistical Regression

Abstract
This course offers a practically oriented introduction into regression modeling methods. The basic concepts and some mathematical background are included, with the emphasis lying in learning "good practice" that can be applied in every student's own projects and daily work life. A special focus will be laid in the use of the statistical software package R for regression analysis.

Objective
The students acquire advanced practical skills in linear regression analysis and are also familiar with its extensions to generalized linear modeling.

Content
The course starts with the basics of linear modeling, and then proceeds to parameter estimation, tests, confidence intervals, residual analysis, model choice, and prediction. More rarely touched but practically relevant topics that will be covered include variable transformations, multicollinearity problems and model interpretation, as well as general modeling strategies.

The last third of the course is dedicated to an introduction to generalized linear models: this includes the generalized additive model, logistic regression for binary response variables, binomial regression for grouped data and poisson regression for count data.

Lecture notes
A script will be available.

Literature
Faraway (2005): Linear Models with R
Faraway (2006): Extending the Linear Model with R
Draper & Smith (1998): Applied Regression Analysis
Fox (2008): Applied Regression Analysis and GLMs
Montgomery et al. (2006): Introduction to Linear Regression Analysis

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In the Mathematics Bachelor and Master programmes, the two course units 401-0649-00L "Applied Statistical Regression" and 401-3622-00L "Regression" are mutually exclusive. Registration for the examination of one of these two course units is only allowed if you have not registered for the examination of the other course unit.

**636-0003-00L Biological Engineering and Biotechnology**

**Abstract**

Biological Engineering and Biotechnology will cover the latest biotechnological advances as well as their industrial implementation to engineer mammalian cells for use in human therapy. This lecture will provide forefront insights into key scientific aspects and the main points in industrial decision-making to bring a therapeutic from target to market.

**Objective**

1. Insight Into The Mammalian Cell Cycle. Cycling, The Balance Between Proliferation and Cancer - Implications For Biopharmaceutical Manufacturing.
2. The Licence To Kill. Apoptosis Regulatory Networks - Engineering of Survival Pathways To Increase Robustness of Production Cell Lines.
5. From Target To Market. An Antibody’s Journey From Cell Culture to Biologic and Malign Applications. Do Life Sciences Enable the "7. Functional Food. Enjoy your Meal!"

**Lecture notes**

Handsout during the course.

**529-0041-00L Modern Mass Spectrometry, Hyphenated Methods, and Chemometrics**

**Abstract**

Modern mass spectrometry, hyphenated analytical methods, speciation, methods of surface analysis, chemometrics.

**Objective**

Comprehensive knowledge about the analytical methods introduced in this course, and their applications.

**Content**

Coupling of separation with identification methods such as GC-MS, LC-MS, GC-IR, LC-IR, LC-NMR etc.; importance of speciation.

Modern mass spectrometry: Time of flight and ion cyclotron resonance mass spectrometry, ICP-MS. Soft ionization methods, desorption methods, spray methods.

Methods of surface analysis (ESCA, Auger, SIMS, raster microscopy methods).

Employment of computer science for processing data in chemical analysis (chemometrics).

**Literature**

Lecture notes will be available in the lecture at production cost.

Information about relevant literature will be available in the lecture & in the lecture notes.

**Prerequisites / notice**

Exercises are an integral part of the lecture.

Prerequisites:

- 529-0051-00 "Analytische Chemie I (3. Semester)"
- 529-0058-00 "Analytische Chemie II (4. Semester)" (or equivalent)

**551-1407-00L RNA Biology Lecture Series I: Transcription & Processing & Translation**

**Abstract**

This course covers aspects of RNA biology related to gene expression at the posttranscriptional level. These include RNA transcription, processing, alternative splicing, editing, export and translation.

**Objective**

Transcription & 3'end formation; splicing, alternative splicing, RNA editing; the ribosome & translation, translation regulation, RNP biogenesis & nuclear export, mRNA surveillance & mRNA turnover; signal transduction & RNA.

**Content**

Understanding of structure-function relationships in proteins and in protein folding, detailed understanding of biophysics and physical methods as well as modern methods for protein purification and microanalytcs.

**Lecture notes**

Lectures are an integral part of the course.”

**551-0307-00L Molecular and Structural Biology I: Protein Structure and Function**

**Abstract**

Biophysics of protein folding, membrane proteins and biophysics of membranes, enzymatic catalysis, catalytic RNA and RNA, current topics in protein biophysics and structural biology.

**Objective**

Students should obtain an understanding of these processes, which are at work during gene expression.

**Content**

Biophysics of protein folding, membrane proteins and biophysics of membranes, enzymatic catalysis, catalytic RNA and RNA, current topics in protein biophysics and structural biology.

**Lecture notes**

Scripts on the individual topics can be found under http://www.mol.biol.ethz.ch/teaching.

Basics:

- Creighton, T.E., Proteins, Freeman, (1993)
- Fersht, A., Enzyme, Structure and Mechanism in Protein Science (1999), Freeman.

Current topics: References will be given during the lectures.

**551-0309-00L Concepts in Modern Genetics**

**Abstract**

Concepts of modern genetics and genomics, including principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

**Objective**

This course focuses on the concepts of classical and modern genetics and genomics.

**Content**

The topics include principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

**Lecture notes**

Scripts and additional material will be provided during the semester.
This course is a co-production of the University of Zurich and ETH Zurich, and will be taught in English. The course takes place on Monday afternoon at ETH Hoenggerberg, and on Tuesday morning at UZH Irchel.

551-0313-00L Microbiology (Part I) W 3 credits 2V W.D. Hardt, L. Ebert, H.M. Fischer, J. Piel, M. Pilhofer

Abstract
Advanced lecture class providing a broad overview on bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

Objective
This concept class will be based on common concepts and introduce to the enormous diversity among bacteria and archaea. It will cover the current research on bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

Content
Advanced class covering the state of the research in bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

Lecture notes
Updated handouts will be provided during the class.

Literature
Current literature references will be provided during the lectures.

Prerequisites / notice
English

The lecture "Grundlagen der Biologie II: Mikrobiologie" is the basis for this advanced lecture.

551-0317-00L Immunology I W 3 credits 2V A. Oxenius, M. Kopf

Abstract
Introduction into structural and functional aspects of the immune system.

Objective
Basic knowledge of the mechanisms and the regulation of an immune response.

Content
- Introduction and historical background
- Innate and adaptive immunity, Cells and organs of the immune system
- B cells and antibodies
- Generation of diversity
- Antigen presentation and Major Histoincompatibility (MHC) antigens
- Thymus and T cell selection
- Autoimmunity
- Cytotoxic T cells and NK cells
- Th1 and Th2 cells, regulatory T cells
- Allergies
- Hypersensitivities
- Vaccines, immune-therapeutic interventions

Lecture notes
Electronic access to the documentation will be provided. The link can be found at "Lernmaterialien"

Literature

Prerequisites / notice
Immunology I (WS) and Immunology II (SS) will be examined as one learning entity in a "Sessionsprüfung".


Abstract
Storage, handling and analysis of large datasets have become essential in biological research. The course will introduce students to a number of applications of bioinformatics in biology. Freely accessible software tools and databases will be explained and explored in theory and praxis.

Objective
Introduction to Bioinformatics: Concepts and Applications (formerly Bioinformatics I) will provide students with the theoretical background of approaches to store and retrieve information from large databases. Concepts will be developed how DNA sequence information can be used to understand phylogenetic relationships, how RNA sequence relates to structure, and how protein sequence information can be used for genome annotation and to predict protein folding and structure. Students will be introduced to quantitative methods for measuring gene expression and how this information can be used to model gene networks. Methods will be discussed to construct protein interaction maps and how this information can be used to simulate dynamic molecular networks.

In addition to the theoretical background, the students will develop hands-on experiences with the bioinformatics methods through guided exercises. The course provides students from different backgrounds with basic training in bioinformatics approaches that have impact on biological, chemical and physics experimentation. Bioinformatics approaches draw significant expertise from mathematics, statistics and computational science.

Although "Introduction to Bioinformatics I" will focus on theory and praxis of bioinformatics approaches, the course provides an important foundation for the course "Introduction to Bioinformatics II: Fundamentals of computer science, modeling and algorithms" that will be offered in the following semester.

Content
Bioinformatics I will cover the following topics:

- From genes to databases and information
- BLAST searches
- Prediction of gene function and regulation
- RNA structure prediction
- Gene expression analysis using microarrays
- Protein sequence and structure databases
- WWW for bioinformatics
- Protein sequence comparisons
- Proteomics and de novo protein sequencing
- Protein structure prediction
- Cellular and protein interaction networks
- Molecular dynamics simulation


Abstract
Structure, function and chemistry of nucleic acids and carbohydrates. DNA/RNA structure and synthesis; recombinant DNA technology and PCR; DNA arrays and genomics; antisense approach and RNAi; polymerases and transcription factors; catalytic RNA; DNA damage and repair; carbohydrate structure and synthesis; carbohydrate arrays; cell surface engineering; carbohydrate vaccines

Objective
Structure, function and chemistry of nucleic acids and carbohydrates. DNA/RNA structure and synthesis; recombinant DNA technology and PCR; DNA arrays and genomics; antisense approach and RNAi; polymerases and transcription factors; catalytic RNA; DNA damage and repair; carbohydrate structure and synthesis; carbohydrate arrays; cell surface engineering; carbohydrate vaccines

Content
Structure, function and chemistry of nucleic acids and carbohydrates. DNA/RNA structure and synthesis; recombinant DNA technology and PCR; DNA arrays and genomics; antisense approach and RNAi; polymerases and transcription factors; catalytic RNA; DNA damage and repair; carbohydrate structure and synthesis; carbohydrate arrays; cell surface engineering; carbohydrate vaccine

Lecture notes
no script

Literature
Mainly based on recent original literature, a detailed list will be distributed during the first lecture
The advanced course introduces students to plants through a concept-based discussion of developmental processes that integrates physiology and biochemistry with genetics, molecular biology, and cell biology. The course follows the life of the plant, starting with the seed, progressing through germination to the seedling and mature plant, and ending with reproduction and senescence.

The new course "Molecular Life of Plants" reflects the rapid advances that are occurring in the field of experimental plant biology as well as the changing interests of students being trained in this discipline. Contemporary plant biology courses emphasize a traditional approach to experimental plant biology by discussing discrete topics that are removed from the context of the plant life cycle. The course will take an integrative approach that focuses on developmental concepts. Whereas traditional plant physiology courses were based on research carried out on intact plants or plant organs and were often based on phenomenological observations, current research in plant biology emphasizes work at the cellular, subcellular and molecular levels.

The goal of "Molecular Life of Plants" is to train students in integrative approaches to understand the function of plants in a developmental context. While the course focuses on plants, the training integrative approaches will also be useful for other organisms.

The course "Molecular Life of Plants" will cover the following topics in a developmental context:

- Plant genome organization
- Seed anatomy
- Food reserves and mobilization
- Seedling emergence
- Heterotrophic to autotrophic growth
- Chlorophyll biosynthesis, photoreceptors
- Integration of metabolism
- Hormones
- Cell cycle
- Cell differentiation and expansion
- Environmental interactions
- Environmental interactions
- Flower development and fertilization
- Embryo and seed development
- Fruit development
- Senescence

Concepts of modern genetics and genomics, including principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

The topics include principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

This course is a co-production of the University of Zurich and ETH Zurich, and will be taught in English. The course takes place on Monday afternoon at ETH Hoenggerberg, and on Tuesday morning at UZH Irchel.

The lecture "Grundlagen der Biologie II: Mikrobiologie" is the basis for this advanced lecture.
Abstract
Concepts and molecular mechanisms underlying the biochemistry of the cell, providing advanced insights into structure, function and regulation of individual cell components. Particular emphasis will be put on the spatial and temporal integration of different molecules and signaling pathways into global cellular processes such as intracellular transport, cell division & growth, and cell migration.

Objective
The full-year course (551-0319-00 & 551-0320-00) focuses on the molecular mechanisms and concepts underlying the biochemistry of cellular physiology, investigating how these processes are integrated to carry out highly coordinated cellular functions. The molecular characterisation of complex cellular functions requires a combination of approaches such as biochemistry, but also cell biology and genetics. This course is therefore the occasion to discuss these techniques and their integration in modern cellular biochemistry.

The students will be able to describe the structural and functional details of individual cell components, and the spatial and temporal regulation of their interactions. In particular, they will learn to explain the integration of different molecules and signaling pathways into complex and highly dynamic cellular processes such as intracellular transport, cytoskeletal rearrangements, cell motility, cell division and cell growth. In addition, they will be able to illustrate the relevance of particular signaling pathways for cellular pathologies such as cancer.

Content
Structural and functional details of individual cell components, regulation of their interactions, and various aspects of the regulation and compartmentalisation of biochemical processes.

Topics include: biophysical and electrical properties of membranes; viral membranes; structural and functional insights into intracellular transport and targeting; vesicular trafficking and phagocytosis; post-transcriptional regulation of gene expression.

Lecturers
Dr. U. Kutay, B. Kommann, M. Peter, I. Zemp, further lecturers

Lectures notes
Scripts and additional material will be provided during the semester. Please contact Dr. Alicia Smith for assistance with the learning materials. (alicia.smith@bc.biolog.ethz.ch)

Literature
Recommended supplementary literature (review articles and selected primary literature) will be provided during the course.

Prerequisites / notice
To attend this course the students must have a solid basic knowledge in chemistry, biochemistry and general biology. The course will be taught in English.

Introduction to Bioinformatics: Concepts and Applications W 6 credits 4G

Abstract
Storage, handling and analysis of large datasets have become essential in biological research. The course will introduce students to a number of applications of bioinformatics in biology. Freely accessible software tools and databases will be explained and explored in theory and practice.

Objective
Introduction to Bioinformatics I: Concepts and Applications (formerly Bioinformatics I) will provide students with the theoretical background of approaches to store and retrieve information from large databases. Concepts will be developed how DNA sequence information can be used to understand phylogenetic relationships, how RNA sequence relates to structure, and how protein sequence information can be used for genome annotation and to predict protein folding and structure. Students will be introduced to quantitative methods for measuring gene expression and how this information can be used to model gene networks. Methods will be discussed to construct protein interaction maps and how this information can be used to simulate dynamic molecular networks.

In addition to the theoretical background, the students will develop hands-on experiences with the bioinformatics methods through guided exercises. The course provides students from different backgrounds with basic training in bioinformatics approaches that have impact on biological, chemical and physics experimentation. Bioinformatics approaches draw significant expertise from mathematics, statistics and computational science.

Although "Introduction to Bioinformatics I" will focus on theory and praxis of bioinformatics approaches, the course provides an important foundation for the course "Introduction to Bioinformatics II: Fundamentals of computer science, modeling and algorithms" that will be offered in the following semester.

Content
Bioinformatics I will cover the following topics:

- From genes to databases and information
- BLAST searches
- Prediction of gene function and regulation
- RNA structure prediction
- Gene expression analysis using microarrays
- Protein sequence and structure databases
- WWW for bioinformatics
- Protein sequence comparisons
- Proteomics and de novo protein sequencing
- Protein structure prediction
- Cellular and protein interaction networks
- Molecular dynamics simulation

Evolutionary Genetics W 6 credits 4V

Abstract
The concept course 'Evolutionary Genetics' consists of two lectures that jointly provide an introduction to the fields of population and quantitative genetics (emphasis on basic concepts) and ecological genetics (more emphasis on evolutionary and ecological processes of adaptation and speciation).

Objective
The aim of the course is to provide students with a solid introduction to the fields of population genetics, quantitative genetics, and ecological genetics. The concepts and research methods developed in these fields have undergone profound transformations; they are of fundamental importance in our understanding of evolutionary processes, both past and present. Students should gain an appreciation for the concepts, methods and explanatory power of evolutionary genetics.

Content
Population genetics - Types and sources of genetic variation; randomly mating populations and the Hardy-Weinberg equilibrium; effects of inbreeding; natural selection; random genetic drift and effective population size; gene flow and hierarchical population structure; molecular population genetics: neutral theory of molecular evolution and basics of coalescent theory.

Quantitative genetics - Continuous variation; measurement of quant. characters; genes, environments and their interactions; measuring their influence; response to selection; inbreeding and crossbreeding; effects on fitness; Fisher's fundamental theorem.

Ecological Genetics - Concepts and methods for the study of genetic variation and its role in adaptation, reproductive isolation, hybridization and speciation

Lectures notes
Handouts

Literature

Prerequisites / notice
There will be 5 optional extra sessions for the population genetics part (following lectures 2-6) for computer simulations, designed to help understand the course material.
The focus is on the potential to assess strategies and tactics of pest management, taking into account the demands from the economy, the environment and the society. Significant agricultural approaches will be explained using practical examples, including prevention using natural resources, surveillance and forecasting, resistance management, as well as product registration, incl. ecotoxicology.

The students gain a good understanding of fundamental aspects of pest management in agroecosystems. They will have the ability to assess options for action in view of requirements from the economy, the ecology and the society. Further, they will learn to perform searches on relevant issues in pest management, and to critically evaluate case studies.

551-1105-00L Glycobiology W 4 credits 2V M. Aebi, T. Hennet

Abstract
Structural principles, nomenclature and different classes of glycosylation. The different pathways of N- and O-linked protein glycosylation and glycolipid biosynthesis in prokaryotes and eukaryotes are discussed. Specific glycan binding proteins and their role in deciphering the glycan code are presented. The role of glycans in infectious diseases, antigen mimicry and autoimmunity are discussed.

Objective
Detailed knowledge in 1) the different areas of prokaryotic and eukaryotic glycosylation, in particular in the biosynthesis of glycoproteins and glycolipids, 2) the cellular machinery required for these pathways, 3) the principles of carbohydrate/protein interaction, 4) the function of lectins, 5) the role of glycans in infectious disease.

Content
Structure and linkages; analytical approaches; N-linked protein glycosylation (ER, Golgi); glycan-assisted protein folding and quality control; O-linked protein glycosylation; glucosaminoglycans; glycolipids; prokaryotic glycosylation pathways; lectins; glycans and infectious disease

Lecture notes
handouts

Literature
Introduction to Glycobiology; M.E.Taylor, K.Drickamer, Oxford University Press, 2003

Prerequisites / notice
The course will be in English. It will include the preparation of short essays (marked) about defined topics in Glycobiology.

551-1103-00L Microbial Biochemistry W 4 credits 2V J. Vorholt-Zambelli, J. Piel

Abstract
The lecture course aims at providing an advanced understanding of the physiology and metabolism of microorganisms. Emphasis is on processes that are specific to bacteria and archaea and that contribute to the widespread occurrence of prokaryotes. Applied aspects of microbial biochemistry will be pointed out as well as research fields of current scientific interest.

Objective
The lecture course aims at providing an advanced understanding of the physiology and metabolism of microorganisms.

Content
Important biochemical processes specific to bacteria and archaea will be presented that contribute to the widespread occurrence of prokaryotes. Applied aspects of microbial biochemistry will be pointed out as well as research fields of current scientific interest. Emphasis is on concepts of energy generation and assimilation.

List of topics:
- Eating sugars and letting them in
- Challenging: Aromatics, xenobiotics, and oil
- Complex: (Ligno-)Cellulose and in demand for bioenergy
- Living on a diet and the anaerobic provocation
- Of climate relevance: The microbial C1 cycle
- What are AMO and Anammox?
- 20 amino acids: the making of
- Extending the genetic code
- The 21st and 22nd amino acid
- Some exotic biochemistry: nucleotides, cofactors
- Ancient biochemistry? Iron-sulfur clusters, polymers
- Secondary metabolites: playground of evolution

Lecture notes
A script will be provided during the course.

529-0733-00L Enzymes W 7 credits 3G D. Hilvert

Abstract
Principles of enzymatic catalysis, enzyme kinetics, mechanisms of enzyme-catalyzed reactions (group transfer reactions, carbon-carbon bond formation, eliminations, isomerisations and rearrangements), cofactor chemistry, enzymes in organic synthesis and the biosynthesis of natural products, catalytic antibodies.

Objective
Overview of enzymes, enzyme-catalyzed reactions and metabolic processes.

Content
Principles of enzymatic catalysis, enzyme kinetics, mechanisms of enzyme-catalyzed reactions (group transfer reactions, carbon-carbon bond formation, eliminations, isomerisations and rearrangements), cofactor chemistry, enzymes in organic synthesis and the biosynthesis of natural products, catalytic antibodies.

Lecture notes
A script will not be handed out.

Literature
General:

In addition, citations from the original literature relevant to the individual lectures will be assigned weekly.

751-5121-00L Insect Ecology W 2 credits 2V R. R. Kariyat Ramachandran, C. De Moraes, M. Mescher

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

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

Lecture notes
Provided to students through ILIAS

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

551-1153-00L Systems Biology of Metabolism W 4 credits 2V U. Sauer, N. Zamboni, M. Zampieri

Abstract
Starting from contemporary biological problems related to metabolism, the course focuses on systems biological approaches to address them. In a problem-oriented, this-is-how-it-is-done manner, we thereby teach modern methods and concepts.

Objective
Develop a deeper understanding of how relevant biological problems can be solved, thereby providing advanced insights to key experimental and computational methods in systems biology.

Content
The course will be given as a mixture of lectures, studies of original research and guided discussions that focus on current research topics. For each particular problem studied, we will work out how the various methods work and what their capabilities/limits are. The problem areas range from microbial metabolism to cancer cell metabolism and from metabolic networks to regulation networks in populations and single cells. Key methods to be covered are various modeling approaches, metabolic flux analyses, metabolomics and other omics.

Lecture notes
Script and original publications will be supplied during the course.
### Prerequisites / notice

The course extends many of the generally introduced concepts and methods of the Concept Course in Systems Biology. It requires a good knowledge of biochemistry and basics of mathematics and chemistry.

### 751-4504-00L

<table>
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<tr>
<td>Plant Pathology I</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>B. McDonald</td>
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**Abstract**

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

**Objective**

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

**Content**

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

**Lecture Topics and Tentative Schedule**

Week 1: No Lecture: First day of autumn semester

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


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

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

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

Week 8: Pathogen effects on food quality and safety.

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

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

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

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

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

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

**Lecture notes**

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

### 751-4805-00L

**Recent Advances in Biocommunication**

**Number of participants limited to 25**

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<tr>
<td>Recent Advances in Biocommunication</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>C. De Moraes</td>
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</table>

**Abstract**

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

**Objective**

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

**Lecture notes**

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

### 551-1407-00L

**RNA Biology Lecture Series I: Transcription & Processing & Translation**

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<th>Lecturers</th>
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<td>W</td>
<td>4</td>
<td>2V</td>
<td>F. Allain, N. Ban, U. Kutay, further lecturers</td>
</tr>
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</table>

**Abstract**

This course covers aspects of RNA biology related to gene expression at the posttranscriptional level. These include RNA transcription, processing, alternative splicing, editing, export and translation.

**Objective**

The students should obtain an understanding of these processes, which are at work during gene expression.

**Content**

Transcription & 3’end formation; splicing, alternative splicing, RNA editing; the ribosome & translation, translation regulation, RNP biogenesis & nuclear export, miRNA surveillance & miRNA turnover; signal transduction & RNA.

**Prerequisites / notice**

Basic knowledge of cell and molecular biology.

### Elective Concept Courses

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<tr>
<th>Number</th>
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<tr>
<td>551-0307-00L</td>
<td>Molecular and Structural Biology I: Protein Structure and Function</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>R. Glockshuber, K. Locher, E. Weber-Ban</td>
</tr>
</tbody>
</table>

**Abstract**

Biophysics of protein folding, membrane proteins and biophysics of membranes, enzymatic catalysis, catalytic RNA and RNAi, current topics in protein biophysics and structural biology.
Advanced lecture class providing a broad overview on bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis. Concepts and molecular mechanisms underlying the biochemistry of the cell, providing advanced insights into structure, function and regulation of individual cell components. Particular emphasis will be put on the spatial and temporal integration of different molecules and signaling pathways into global cellular processes such as intracellular transport, cell division & growth, and cell migration. The lecture "Grundlagen der Biologie II: Mikrobiologie" is the basis for this advanced lecture.

**551-0309-00L**  Concepts in Modern Genetics  
W 6 credits 4V  
Y. Barral, D. Bopp, A. Hajnai, M. Stoffel, O. Voigt

**Abstract**
- Concepts of modern genetics and genomics, including principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

**Objective**
- This course focuses on the concepts of classical and modern genetics and genomics. The topics include principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

**Content**
- Advanced class covering the state of the research in bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

**Lecture notes**
- Scripts and additional material will be provided during the semester.

**Prerequisites / notice**
- This course is a co-production of the University of Zurich and ETH Zurich, and will be taught in English. The course takes place on Monday afternoon at ETH Hoenggerberg, and on Tuesday morning at UZH Irchel.

**551-0313-00L**  Microbiology (Part I)  
W 3 credits 2V  
W.D. Hardt, L. Eberl, H.M. Fischer, J. Piel, M. Pilhofer

**Abstract**
- Advanced lecture class providing a broad overview on bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

**Objective**
- This concept class will be based on common concepts and introduce to the enormous diversity among bacteria and archaea. It will cover the current research on bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

**Content**
- Advanced class covering the state of the research in bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

**Lecture notes**
- Updated handouts will be provided during the class.

**Literature**
- Current literature references will be provided during the lectures.

**Prerequisites / notice**
- English
- The lecture "Grundlagen der Biologie II: Mikrobiologie" is the basis for this advanced lecture.

**551-0319-00L**  Cellular Biochemistry (Part I)  
W 3 credits 2V  
U. Kutay, R. I. Enchev, B. Kommann, M. Peter, I. Zemp, further lecturers

**Abstract**
- Concepts and molecular mechanisms underlying the biochemistry of the cell, providing advanced insights into structure, function and regulation of individual cell components. Particular emphasis will be put on the spatial and temporal integration of different molecules and signaling pathways into global cellular processes such as intracellular transport, cell division & growth, and cell migration.

**Objective**
- The students will be able to describe the structural and functional details of individual cell components, and the spatial and temporal regulation of their interactions. In particular, they will learn to explain the integration of different molecules and signaling pathways into complex and highly dynamic cellular processes such as intracellular transport, cytoskeletal rearrangements, cell motility, cell division and cell growth. In addition, they will be able to illustrate the relevance of particular signaling pathways for cellular pathologies such as cancer.

**Content**
- Structural and functional details of individual cell components, regulation of their interactions, and various aspects of the regulation and compartmentalisation of biochemical processes.

**Lecture notes**
- Scripts and additional material will be provided during the semester. Please contact Dr. Alicia Smith for assistance with the learning materials. (alicia.smith@bc.biol.ethz.ch)

**Literature**
- Recommended supplementary literature (review articles and selected primary literature) will be provided during the course.

**Prerequisites / notice**
- To attend this course the students must have a solid basic knowledge in chemistry, biochemistry and general biology. The course will be taught in English.

**551-1295-00L**  Introduction to Bioinformatics: Concepts and Applications  
W 6 credits 4G  
W. Gruissem, K. Bärenfaller, A. Callisch, G. Captani, J. Fütterer, M. Robinson, A. Wagner

**Abstract**
- Storage, handling and analysis of large datasets have become essential in biological research. The course will introduce students to a number of applications of bioinformatics in biology. Freely accessible software tools and databases will be explained and explored in theory and praxis.

**Objective**
- Introduction to Bioinformatics I: Concepts and Applications (formerly Bioinformatics I) will provide students with the theoretical background of approaches to store and retrieve information from large databases. Concepts will be developed how DNA sequence information can be used to understand phylegentic relationships, how RNA sequence relates to structure, and how protein sequence information can be used for genome annotation and to predict protein folding and structure. Students will be introduced to quantitative methods for measuring gene expression and how this information can be used to model gene networks. Methods will be discussed to construct protein interaction maps and how this information can be used to simulate dynamic molecular networks.

**Content**
- Students will develop hands-on experiences with the bioinformatics methods through guided exercises. The course provides students from different backgrounds with basic training in bioinformatics approaches that have impact on biological, chemical and physics experimentation. Bioinformatics approaches draw significant expertise from mathematics, statistics and computational science.

**Prerequisites**
- Knowledge of biology and computer science.

**Further lecturer**
- Further lecturers: M. Robinson, A. Wagner

**Further reading**
- Recommended supplementary literature (review articles and selected primary literature) will be provided during the course.

**Notice**
- Further instructions and updates will be provided during the course.

**Additional information**
- The course is offered in the following semester.

Data: 06.03.2019 12:57  
Autumn Semester 2016  
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Content: Bioinformatics I will cover the following topics:

- From genes to databases and information
- BLAST searches
- Prediction of gene function and regulation
- RNA structure prediction
- Gene expression analysis using microarrays
- Protein sequence and structure databases
- WWW for bioinformatics
- Protein sequence comparisons
- Proteomics and de novo protein sequencing
- Protein structure prediction
- Cellular and protein interaction networks
- Molecular dynamics simulation

Elective Major: Systems Biology

Elective Compulsory Concept Courses

See D-BIOL Master Studies Guide

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<tr>
<th>Number</th>
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<th>Type</th>
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<tr>
<td>551-0319-00L</td>
<td>Cellular Biochemistry (Part I)</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>U. Kutay, R. I. Enchev,</td>
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<td>B. Kommann, M. Peter, I. Zemp,</td>
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<td>further lecturers</td>
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</tbody>
</table>

Abstract: Concepts and molecular mechanisms underlying the biochemistry of the cell, providing advanced insights into structure, function and regulation of individual cell components. Particular emphasis will be put on the spatial and temporal integration of different molecules and signaling pathways into global cellular processes such as intracellular transport, cell division & growth, and cell migration.

Objective: The full-year course (551-0319-00 & 551-0320-00) focuses on the molecular mechanisms and concepts underlying the biochemistry of cellular physiology, investigating how these processes are integrated to carry out highly coordinated cellular functions. The molecular characterisation of complex cellular functions requires a combination of approaches such as biochemistry, but also cell biology and genetics. This course is therefore the occasion to discuss these techniques and their integration in modern cellular biochemistry. The students will be able to describe the structural and functional details of individual cell components, and the spatial and temporal regulation of their interactions. In particular, they will learn to explain the integration of different molecules and signaling pathways into complex and highly dynamic cellular processes such as intracellular transport, cytoskeletal rearrangements, cell motility, cell division and cell growth. In addition, they will be able to illustrate the relevance of particular signaling pathways for cellular pathologies such as cancer.

Content: Structural and functional details of individual cell components, regulation of their interactions, and various aspects of the regulation and compartmentalisation of biochemical processes.

Topics include: biophysical and electrical properties of membranes; viral membranes; structural and functional insights into intracellular transport and targeting; vesicular trafficking and phagocytosis; post-transcriptional regulation of gene expression.

Lecture notes: Scripts and additional material will be provided during the semester. Please contact Dr. Alicia Smith for assistance with the learning materials. (alicia.smith@bc.biol.ethz.ch)

Literature: Recommended supplementary literature (review articles and selected primary literature) will be provided during the course.

Prerequisites / notice: To attend this course the students must have a solid basic knowledge in chemistry, biochemistry and general biology. The course will be taught in English.

551-0309-00L Concepts in Modern Genetics

Abstract: Concepts of modern genetics and genomics, including principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

Objective: This course focuses on the concepts of classical and modern genetics and genomics.

Content: The topics include principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

Lecture notes: Scripts and additional material will be provided during the semester.

Prerequisites / notice: This course is a co-production of the University of Zurich and ETH Zurich, and will be taught in English. The course takes place on Monday afternoon at ETH Hoenggerberg, and on Tuesday morning at UZH Irchel.

551-0313-00L Microbiology (Part I)

Abstract: Advanced lecture class providing a broad overview on bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

Objective: This concept class will be based on common concepts and introduce to the enormous diversity among bacteria and archaea. It will cover the current research on bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

Content: Advanced class covering the state of the research in bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

Lecture notes: Updated handouts will be provided during the class.

Literature: Current literature references will be provided during the lectures.

Prerequisites / notice: English

The lecture “Grundlagen der Biologie II: Mikrobiologie” is the basis for this advanced lecture.

551-1295-00L Introduction to Bioinformatics: Concepts and Applications

Abstract: Storage, handling and analysis of large datasets have become essential in biological research. The course will introduce students to a number of applications of bioinformatics in biology. Freely accessible software tools and databases will be explained and explored in theory and praxis.
Objective

Introduction to Bioinformatics I: Concepts and Applications (formerly Bioinformatics I) will provide students with the theoretical background of approaches to store and retrieve information from large databases. Concepts will be developed how DNA sequence information can be used to understand phylogenetic relationships, how RNA sequence relates to structure, and how protein sequence information can be used for genome annotation and to predict protein folding and structure. Students will be introduced to quantitative methods for measuring gene expression and how this information can be used to model gene networks. Methods will be discussed to construct protein interaction maps and how this information can be used to simulate dynamic molecular networks.

In addition to the theoretical background, the students will develop hands-on experiences with the bioinformatics methods through guided exercises. The course provides students from different backgrounds with basic training in bioinformatics approaches that have impact on biological, chemical and physics experimentation. Bioinformatics approaches draw significant expertise from mathematics, statistics and computational science.

Although "Introduction to Bioinformatics I" will focus on theory and praxis of bioinformatics approaches, the course provides an important foundation for the course "Introduction to Bioinformatics II: Fundamentals of computer science, modeling and algorithms" that will be offered in the following semester.

Content

Bioinformatics I will cover the following topics:

- From genes to databases and information
- BLAST searches
- Prediction of gene function and regulation
- RNA structure prediction
- Gene expression analysis using microarrays
- Protein sequence and structure databases
- WWW for bioinformatics
- Protein sequence comparisons
- Proteomics and de novo protein sequencing
- Protein structure prediction
- Cellular and protein interaction networks
- Molecular dynamics simulation

Elective Compulsory Master Courses I: Computation

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<tr>
<td>Abstract</td>
<td>Study of fundamental concepts, models and computational methods for the analysis of complex biological networks. Topics: Systems approaches in biology, biology and reaction network fundamentals, modeling and simulation approaches (topological, probabilistic, stoichiometric, qualitative, linear / nonlinear ODEs, stochastic), and systems analysis (complexity reduction, stability, identification).</td>
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<tr>
<td>Objective</td>
<td>The aim of this course is to provide an introductory overview of mathematical and computational methods for the modeling, simulation and analysis of biological networks.</td>
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<tr>
<td>Content</td>
<td>Biology has witnessed an unprecedented increase in experimental data and, correspondingly, an increased need for computational methods to analyze this data. The explosion of sequenced genomes, and subsequently, of bioinformatics methods for the storage, analysis and comparison of genetic sequences provides a prominent example. Recently, however, an additional area of research, captured by the label &quot;Systems Biology&quot;, focuses on networks, which are more than the mere sum of their parts' properties, establish biological functions. This is essentially a task of reverse engineering. The aim of this course is to provide an introductory overview of corresponding computational methods for the modeling, simulation and analysis of biological networks. We will start with an introduction into the basic units, functions and design principles that are relevant for biology at the level of individual cells. Making extensive use of example systems, the course will then focus on methods and algorithms that allow for the investigation of biological networks with increasing detail. These include (i) graph theoretical approaches for revealing large-scale network organization, (ii) probabilistic (Bayesian) network representations, (iii) structural network analysis based on reaction stoichiometries, (iv) qualitative methods for dynamic modeling and simulation (Boolean and piece-wise linear approaches), (v) mechanistic modeling using ordinary differential equations (ODEs) and finally (vi) stochastic simulation methods.</td>
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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>636-0706-00L</td>
<td>Spatio-Temporal Modelling in Biology</td>
<td>W</td>
<td>5</td>
<td>credits</td>
<td>3G</td>
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<td></td>
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<td></td>
<td></td>
<td>D. Iber</td>
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<tr>
<td>Abstract</td>
<td>This course focuses on modeling spatio-temporal problems in biology, in particular on the cell and tissue level. A wide range of mathematical techniques will be presented as part of the course, including concepts from non-linear dynamics (ODE and PDE models), stochastic techniques (SDE, Master equations, Monte Carlo simulations), and thermodynamic descriptions.</td>
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<tr>
<td>Objective</td>
<td>The aim of the course is to introduce students to state-of-the-art mathematical modelling of spatio-temporal problems in biology. Students will learn how to choose from a wide range of modelling techniques and how to apply these to further our understanding of biological mechanisms. The course aims at equipping students with the tools and concepts to conduct successful research in this area; both classical as well as recent research work will be discussed.</td>
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<tr>
<td>Content</td>
<td>1. Introduction to Modelling in Biology</td>
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<td>2. Morphogen Gradients</td>
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<td>3. Turing Pattern</td>
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<td>4. Travelling Waves &amp; Wave Pinning</td>
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<td>5. Application Example 1: Dorso-ventral axis formation</td>
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<td>6. Chemotaxis, Cell Adhesion &amp; Migration</td>
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<td>7. Introduction to Numerical Methods</td>
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<td>8. Simulations on Growing Domains</td>
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<td>9. Image-Based Modelling</td>
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<td>10. Branching Processes</td>
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<td></td>
<td>11. Cell-based Simulation Frameworks</td>
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<td>12. Application Example 2: Limb Development</td>
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<td>13. Summary</td>
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<tr>
<td>Lecture notes</td>
<td>All lecture material will be made available online <a href="https://www.bsse.ethz.ch/obli/education/636-0706-00L_Spatial_Modelling_in_Biology.html">https://www.bsse.ethz.ch/obli/education/636-0706-00L_Spatial_Modelling_in_Biology.html</a></td>
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The course builds on introductory courses in Computational Biology. The course assumes no background in biology but a good foundation regarding mathematical and computational techniques.

### Elective Compulsory Master Courses II: Biology

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>551-1103-00L</td>
<td>Microbial Biochemistry</td>
<td>W</td>
<td>4</td>
<td>2V</td>
<td>J. Vorholt-Zambelli, J. Piel</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td></td>
<td>The lecture course aims at providing an advanced understanding of the physiology and metabolism of microorganisms. Emphasis is on processes that are specific to bacteria and archaea and that contribute to the widespread occurrence of prokaryotes. Applied aspects of microbial biochemistry will be pointed out as well as research fields of current scientific interest.</td>
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<tr>
<td>Objective</td>
<td>The lecture course aims at providing an advanced understanding of the physiology and metabolism of microorganisms.</td>
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<tr>
<td>Content</td>
<td>Important biochemical processes specific to bacteria and archaea will be presented that contribute to the widespread occurrence of prokaryotes. Applied aspects of microbial biochemistry will be pointed out as well as research fields of current scientific interest. Emphasis is on concepts of energy generation and assimilation.</td>
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<tr>
<td>Lecture notes</td>
<td>A script will be provided during the course.</td>
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</table>

| 551-1153-00L    | Systems Biology of Metabolism                   | W    | 4    | 2V    | U. Sauer, N. Zamboni, M. Zampieri |
|                 | **Abstract**                                     |      |      |       |                            |
|                 | Starting from contemporary biological problems related to metabolism, the course focuses on systems biological approaches to address them. In a problem-oriented, this-is-how-it-is-done manner, we thereby teach modern methods and concepts. |
| Objective       | Develop a deeper understanding of how relevant biological problems can be solved, thereby providing advanced insights to key experimental and computational methods in systems biology. |
| Content         | The course will be given as a mixture of lectures, studies of original research and guided discussions that focus on current research topics. For each particular problem studied, we will work out how the various methods work and what their capabilities/limits are. The problem areas range from microbial metabolism to cancer cell metabolism and from metabolic networks to regulation networks in populations and single cells. Key methods to be covered are various modeling approaches, metabolic flux analyses, metabolomics and other omics. |
| Lecture notes   | Script and original publications will be supplied during the course. |

| 636-0001-00L    | Separations in Biotechnology and Bioprocess     | W    | 6    | 3G    | S. Panke                   |
|                 | **Economy**                                     |      |      |       |                            |
|                 | Separations play an integral part of any biotechnological process. This course aims at enabling students specifically with a chemistry/biology background to select & roughly design suitable separation processes for typical biotechnological products such as monoclonal antibodies, antibiotics, and fine chemicals and at providing a basic set of purification operations & judge on process economy. |
| Objective       | Students should be able to select for a given biotechnological product a suitable set of purification operations and judge on process economy. |
| Content         | Introduction membrane operations adsorption and chromatography crystallization overall process economics |
| Lecture notes   | Handouts during course                          |

| 636-0507-00L    | Synthetic Biology II                            | W    | 4    | 4A    | S. Panke, Y. Benenson, J. Stelling |
|                 | **Abstract**                                     |      |      |       |                            |
|                 | 7 months biological design project, during which the students are required to give presentations on advanced topics in synthetic biology (specifically genetic circuit design) and then select their own biological system to design. The system is subsequently modeled, analyzed, and experimentally implemented. Results are presented at an international student competition at the MIT (Cambridge). |
| Objective       | The students are supposed to acquire a deep understanding of the process of biological design including model representation of a biological system, its thorough analysis, and the subsequent experimental implementation of the system and the related problems. |
| Content         | Presentations on advanced synthetic biology topics (eg genetic circuit design, adaptation of systems dynamics, analytical concepts, large scale de novo DNA synthesis, project selection, modeling of selected biological system, design space exploration, sensitivity analysis, conversion into DNA sequence, (DNA synthesis external,) implementation and analysis of design, summary of results in form of scientific presentation and poster, presentation of results at the iGEM international student competition (www.igem.org). |
| Lecture notes   | Handouts during course                          |

| 551-0571-00L    | From DNA to Diversity (University of Zurich)    | W    | 2    | 2V    | A. Hajnal, D. Bopp, E. Hafen |
|                 | **Notice**                                       |      |      |       |                            |
|                 | The final presentation of the project is typically at the MIT (Cambridge, US). Other competing schools include regularly Imperial College, Cambridge University, Harvard University, UC Berkeley, Princeton University, CalTech, etc. |
|                 | This project takes place between end of Spring Semester and beginning of Autumn Semester. Registration in April. Please note that the number of ECTS credits and the actual work load are disconnected. |

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**Prerequisites / Notice**

Murray, Mathematical Biology, Springer
Forgacs and Newman, Biological Physics of the Developing Embryo, CUP
Keener and Sneyd, Mathematical Physiology, Springer
Fall et al, Computational Cell Biology, Springer
Szalasi et al, System Modeling in Cellular Biology, MIT Press
Wolkenhauer, Systems Biology
Kreyszig, Engineering Mathematics, Wiley

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**Prerequisites / Notice**

Mind the enrolment deadlines at UZH:
The evolution of the various body-plans is investigated by means of comparison of developmentally essential control genes of molecularly analysed model organisms.

By the end of this module, each student should be able to:
- recognize the universal principles underlying the development of different animal body plans.
- explain how the genes encoding the molecular toolkit have evolved to create animal diversity.
- relate changes in gene structure or function to evolutionary changes in animal development.

Key skills:
By the end of this module, each student should be able to:
- present and discuss a relevant evolutionary topic in an oral presentation
- select and integrate key concepts in animal evolution from primary literature
- participate in discussions on topics presented by others

Evolutionary Dynamics

Evolutionary dynamics is concerned with the mathematical principles according to which life has evolved. This course offers an introduction to mathematical modeling of evolution, including deterministic and stochastic models.

The goal of this course is to understand and to appreciate mathematical models and computational methods that provide insight into the evolutionary process.

Evolution is the one theory that encompasses all of biology. It provides a single, unifying concept to understand the living systems that we observe today. We will introduce several types of mathematical models of evolution to describe gene frequency changes over time in the context of different biological systems, focusing on asexual populations. Viruses and cancer cells provide the most prominent examples of such systems and they are at the same time of great biomedical interest. The course will cover some classical mathematical population genetics and population dynamics, and also introduce several new approaches. This is reflected in a diverse set of mathematical concepts which make their appearance throughout the course, all of which are introduced from scratch. Topics covered include the quasispecies equation, evolution of HIV, evolutionary game theory, birth-death processes, evolutionary stability, evolutionary graph theory, somatic evolution of cancer, stochastic tunneling, cell differentiation, hematopoietic tumor stem cells, genetic progression of cancer and the speed of adaptation, diffusion theory, fitness landscapes, neutral networks, branching processes, evolutionary escape, and epistasis.

Prerequisites: Basic mathematics (linear algebra, calculus, probability)

551-0307-00L Molecular and Structural Biology I: Protein Structure and Function

D-BIOL BSc students are obliged to take part I and part II (next semester) as a two-semester course

Biophysics of protein folding, membrane proteins and biophysics of membranes, enzymatic catalysis, catalytic RNA and RNAi, current topics in protein biophysics and structural biology.

Understanding of structure-function relationships in proteins and in protein folding, detailed understanding of biophysics and physical methods as well as modern methods for protein purification and microanalytics.

Basics:
- Creighton, T.E., Proteins, Freeman, (1993)
- Fersht, A., Enzyme, Structure and Mechanism in Protein Science (1999), Freeman.

- Molecular and Structural Biology I: Protein Structure and Function
- Evolutionary Dynamics

- Creighton, T.E., Proteins, Freeman, (1993)
- Fersht, A., Enzyme, Structure and Mechanism in Protein Science (1999), Freeman.

Current topics: References will be given during the lectures.

551-0319-00L Cellular Biochemistry (Part I)

The full-year course (551-0319-00 & 551-0320-00) focuses on the molecular mechanisms and concepts underlying the biochemistry of the cell, providing advanced insights into structure, function and regulation of individual cell components. Particular emphasis will be put on the spatial and temporal integration of different molecules and signaling pathways into global cellular processes such as intracellular transport, cell division & growth, and cell migration.

The students will be able to describe the structural and functional details of individual cell components, and the spatial and temporal regulation of their interactions. In particular, they will learn to explain the integration of different molecules and signaling pathways into complex and highly dynamic cellular processes such as intracellular transport, cytoskeletal rearrangements, cell motility, cell division and cell growth. In addition, they will be able to illustrate the relevance of particular signaling pathways for cellular pathologies such as cancer.

Structural and functional details of individual cell components, regulation of their interactions, and various aspects of the regulation and compartmentalisation of biochemical processes.

Topics include: biophysical and electrical properties of membranes; viral membranes; structural and functional insights into intracellular transport and targeting; vesicular trafficking and phagocytosis; post-transcriptional regulation of gene expression.

636-0009-00L Evolutionary Dynamics

Evolutionary dynamics is concerned with the mathematical principles according to which life has evolved. This course offers an introduction to mathematical modeling of evolution, including deterministic and stochastic models.

The goal of this course is to understand and to appreciate mathematical models and computational methods that provide insight into the evolutionary process.

Evolution is the one theory that encompasses all of biology. It provides a single, unifying concept to understand the living systems that we observe today. We will introduce several types of mathematical models of evolution to describe gene frequency changes over time in the context of different biological systems, focusing on asexual populations. Viruses and cancer cells provide the most prominent examples of such systems and they are at the same time of great biomedical interest. The course will cover some classical mathematical population genetics and population dynamics, and also introduce several new approaches. This is reflected in a diverse set of mathematical concepts which make their appearance throughout the course, all of which are introduced from scratch. Topics covered include the quasispecies equation, evolution of HIV, evolutionary game theory, birth-death processes, evolutionary stability, evolutionary graph theory, somatic evolution of cancer, stochastic tunneling, cell differentiation, hematopoietic tumor stem cells, genetic progression of cancer and the speed of adaptation, diffusion theory, fitness landscapes, neutral networks, branching processes, evolutionary escape, and epistasis.

Prerequisites: Basic mathematics (linear algebra, calculus, probability)

Elective Major: Structural Biology and Biophysics

Elective Compulsory Concept Courses
Lecture notes: Scripts and additional material will be provided during the semester. Please contact Dr. Alicia Smith for assistance with the learning materials. (alicia.smith@bc.biol.ethz.ch)

Literature: Recommended supplementary literature (review articles and selected primary literature) will be provided during the course.

Prerequisites / notice: To attend this course the students must have a solid basic knowledge in chemistry, biochemistry and general biology. The course will be taught in English.

529-0731-00L Nucleic Acids and Carbohydrates

W 6 credits 3G D. Hilvert, P. A. Kast, S. J. Sturla, H. Wennemers

Abstract: Structure, function and chemistry of nucleic acids and carbohydrates. DNA/RNA structure and synthesis; recombinant DNA technology and PCR; DNA arrays and genomics; antisense approach and RNA; polymerases and transcription factors; catalytic RNA; DNA damage and repair; carbohydrate structure and synthesis; carbohydrate arrays; cell surface engineering; carbohydrate vaccines

Objective: Structure, function and chemistry of nucleic acids and carbohydrates. DNA/RNA structure and synthesis; recombinant DNA technology and PCR; DNA arrays and genomics; antisense approach and RNA; polymerases and transcription factors; catalytic RNA; DNA damage and repair; carbohydrate structure and synthesis; carbohydrate arrays; cell surface engineering; carbohydrate vaccines

Content: Structure, function and chemistry of nucleic acids and carbohydrates. DNA/RNA structure and synthesis; recombinant DNA technology and PCR; DNA arrays and genomics; antisense approach and RNA; polymerases and transcription factors; catalytic RNA; DNA damage and repair; carbohydrate structure and synthesis; carbohydrate arrays; cell surface engineering; carbohydrate vaccine

Lecture notes: Scripts and additional material will be provided during the semester. Please contact Dr. Alicia Smith for assistance with the learning materials. (alicia.smith@bc.biol.ethz.ch)

Literature: Recommended supplementary literature (review articles and selected primary literature) will be provided during the course.

551-0313-00L Microbiology (Part I)

W 3 credits 2V W.D. Hardt, L. Eberl, H.M. Fischer, J. Piel, M. Pilhofer

Abstract: Advanced class providing a broad overview on bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

Objective: Advanced class providing a broad overview on bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

Content: Advanced class covering the state of the research in bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

Lecture notes: Updated handouts will be provided during the class.

Literature: Current literature references will be provided during the lectures.

Prerequisites / notice: English

The lecture “Grundlagen der Biologie II: Mikrobiologie” is the basis for this advanced lecture.

551-1295-00L Introduction to Bioinformatics: Concepts and Applications

W 6 credits 4G W. Gruissem, K. Bärenfeller, A. Caflisch, G. Capitani, J. Fütterer, M. Robinson, A. Wagner

Abstract: Storage, handling and analysis of large datasets have become essential in biological research. The course will introduce students to a number of applications of bioinformatics in biology. Freely accessible software tools and databases will be explained and explored in theory and praxis.

Objective: Introduction to Bioinformatics I: Concepts and Applications (formerly Bioinformatics I) will provide students with the theoretical background of approaches to store and retrieve information from large databases. Concepts will be developed how DNA sequence information can be used to understand phylogenetic relationships, how RNA sequence relates to structure, and how protein sequence information can be used for genome annotation and to predict protein folding and structure. Students will be introduced to quantitative methods for measuring gene expression and how this information can be used to model gene networks. Methods will be discussed to construct protein interaction maps and how this information can be used to simulate dynamic molecular networks.

In addition to the theoretical background, the students will develop hands-on experiences with the bioinformatics methods through guided exercises. The course provides students from different backgrounds with basic training in bioinformatics approaches that have impact on biological, chemical and physics experimentation. Bioinformatics approaches draw significant expertise from mathematics, statistics and computational science.

Although "Introduction to Bioinformatics I" will focus on theory and praxis of bioinformatics approaches, the course provides an important foundation for the course "Introduction to Bioinformatics II: Fundamentals of computer science, modeling and algorithms*" that will be offered in the following semester.

Content: Bioinformatics I will cover the following topics:

- From genes to databases and information
- BLAST searches
- Prediction of gene function and regulation
- RNA structure prediction
- Gene expression analysis using microarrays
- Protein sequence and structure databases
- WWW for bioinformatics
- Protein sequence comparisons
- Proteomics and de novo protein sequencing
- Protein structure prediction
- Cellular and protein interaction networks
- Molecular dynamics simulation

551-0309-00L Concepts in Modern Genetics

W 6 credits 4V Y. Barral, D. Bopp, A. Hajnal, M. Stoffel, O. Voßnet

Abstract: Concepts of modern genetics and genomics, including principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

Objective: This course focuses on the concepts of classical and modern genetics and genomics.

Content: The topics include principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

Lecture notes: Scripts and additional material will be provided during the semester.

Prerequisites / notice: This course is a co-production of the University of Zurich and ETH Zurich, and will be taught in English. The course takes place on Monday afternoon at ETH Hönggerberg, and on Tuesday morning at UZH Irchel.

Elective Compulsory Master Courses

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
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<th>Lecturers</th>
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<tr>
<td>529-0733-00L</td>
<td>Enzymes</td>
<td>W</td>
<td>7</td>
<td>3G</td>
<td>D. Hilvert</td>
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Data: 06.03.2019 12:57 Autumn Semester 2016 Page 276 of 1571
Principles of enzymatic catalysis, enzyme kinetics, mechanisms of enzyme-catalyzed reactions (group transfer reactions, carbon-carbon bond formation, eliminations, isomerisations and rearrangements), cofactor chemistry, enzymes in organic synthesis and the biosynthesis of natural products, catalytic antibodies.

Overview of enzymes, enzyme-catalyzed reactions and metabolic processes.

Principles of enzymatic catalysis, enzyme kinetics, mechanisms of enzyme catalyzed reactions (group transfer reactions, carbon-carbon bond formation, eliminations, isomerisations and rearrangements), cofactor chemistry, enzymes in organic synthesis and the biosynthesis of natural products, catalytic antibodies.

A script will not be handed out.


In addition, citations from the original literature relevant to the individual lectures will be assigned weekly.

551-1105-00L Glycobiology W 4 credits 2V M. Aebi, T. Hennet
Abstract Structural principles, nomenclature and different classes of glycosylation. The different pathways of N- and O-linked protein glycosylation and glycolipid biosynthesis in prokaryotes and eukaryotes are discussed. Specific glycan binding proteins and their role in deciphering the glycan code are presented. The role of glycans in infectious diseases, antigen mimicry and autoimmunity are discussed.

Objective Detailed knowledge in 1) the different areas of prokaryotic and eukaryotic glyobiology, in particular in the biosynthesis of glycoproteins and glycolipids, 2) the cellular machinery required for these pathways, 3) the principles of carbohydrate/protein interaction, 4) the function of lectins, 5) the role of glycans in infectious disease.

Content Structure and linkages; analytical approaches; N-linked protein glycosylation (ER, Golgi); glycan-assisted protein folding and quality control; O-linked protein glycosylation; glucosaminoglycans; glycolipids; prokaryotic glycosylation pathways; lectins; glycans and infectious disease

Lecture notes Slides and references will be available on OLAT server.

551-1103-00L Microbial Biochemistry W 4 credits 2V J. Vorholt-Zambelli, J. Piel
Abstract The lecture course aims at providing an advanced understanding of the physiology and metabolism of microorganisms. Emphasis is on processes that are specific to bacteria and archaee and that contribute to the widespread occurrence of prokaryotes. Applied aspects of microbial biochemistry will be pointed out as well as research fields of current scientific interest.

Objective The lecture course aims at providing an advanced understanding of the physiology and metabolism of microorganisms.

Content Important biochemical processes specific to bacteria and archaee will be covered that contribute to the widespread occurrence of prokaryotes. Applied aspects of microbial biochemistry will be pointed out as well as research fields of current scientific interest. Emphasis is on concepts of energy generation and assimilation.

List of topics:
- Eating sugars and letting them in
- Challenging: Aromatics, xenobiotics, and oil
- Complex: (Ligno-)Cellulose and in demand for bioenergy
- Living on a diet and the anaerobic provocation
- Of climate relevance: The microbial C1 cycle
- What are AMO and Anammox?
- 20 amino acids: the making of
- Extending the genetic code
- The 21st and 22nd amino acid
- Some exotic biochemistry: nucleotides, cofactors
- Ancient biochemistry? Iron-sulfur clusters, polymers
- Secondary metabolites: playground of evolution

A script will be provided during the course.

551-1401-00L Advanced Protein Engineering (University of Zurich) W 2 credits 2G A. Plückthun
Abstract No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: BCH420

Objective To understand current research strategies in protein science.

Content Proteins have become an object of intense study in modern science, ranging from their use as therapeutics to elucidating their structure and function in the cell. Moreover, it is now possible to engineer and evolve tailor-made proteins, opening up many new areas of science. This course will attempt to cover the frontiers and remaining challenges, emphasizing the biochemical foundations of the various approaches.

Lecture notes Slides and references will be available on OLAT server. https://www.olat.uzh.ch/olat/auth/repo/go?rid=600670219

Prerequisites / notice Solid knowledge in biochemistry strongly recommended

551-1153-00L Systems Biology of Metabolism W 4 credits 2V U. Sauer, N. Zamboni, M. Zampieri
Abstract Starting from contemporary biological problems related to metabolism, the course focuses on systems biological approaches to address them. In a problem-oriented, this-is-how-it-is-done manner, we thereby teach model methods and concepts.

Objective Develop a deeper understanding of how relevant biological problems can be solved, thereby providing advanced insights to key experimental and computational methods in systems biology.

Content The course will be given as a mixture of lectures, studies of original research and guided discussions that focus on current research topics.

For each particular problem studied, we will work out how the various methods work and what their capabilities/limits are. The problem areas range from microbial metabolism to cancer cell metabolism and from metabolic networks to regulation networks in populations and single cells. Key methods to be covered are various modeling approaches, metabolic flux analyses, metabolomics and other omics.

Lecture notes Script and original publications will be supplied during the course.

Data: 06.03.2019 12:57 Autumn Semester 2016 Page 277 of 1571
<table>
<thead>
<tr>
<th>Course Code: 529-0004-00L</th>
<th>Course Title: Modern Mass Spectrometry, Hyphenated Methods, and Chemometrics</th>
<th>Credits: 6</th>
<th>Hours: 3G</th>
<th>Prerequisite / Notice: None</th>
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<tbody>
<tr>
<td><strong>Abstract</strong></td>
<td>Modern mass spectrometry, hyphenated analytical methods, speciation, methods of surface analysis, chemometrics.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>Comprehensive knowledge about the analytical methods introduced in this course, and their applications.</td>
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<tr>
<td><strong>Content</strong></td>
<td>Coupling of separation with identification methods such as GC-MS, LC-MS, GC-IR, LC-IR, LC-NMR etc.; importance of speciation. Modern mass spectrometry: Time of flight and ion cyclotron resonance mass spectrometry, ICP-MS. Soft ionization methods, desorption methods, spray methods. Methods of surface analysis (ESCA, Auger, SIMS, raster microscopy methods). Employment of computer science for processing data in chemical analysis (chemometrics).</td>
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<tr>
<td><strong>Literature</strong></td>
<td>See: <a href="http://www.csms.ethz.ch/education/CSCBP">www.csms.ethz.ch/education/CSCBP</a></td>
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<tr>
<td><strong>Prerequisites / notice</strong></td>
<td>Since the exercises on the computer do convey and test essentially different skills as those being conveyed during the lectures and tested at the oral exam, the results of the exercises are taken into account when evaluating the results of the exam.</td>
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</table>

For more information: www.csms.ethz.ch/education/CSCBP
The goal is to discuss cutting edge research in the structural, molecular, and biochemical study of cellular macromolecules. Student participation is an essential component of the course and will contribute to the exam grade. The students should obtain an understanding of these processes, which are at work during gene expression. Lecture notes will be available in the lecture at production cost. Handsout during the course. A script will not be handed out.


In addition, citations from the original literature relevant to the individual lectures will be assigned weekly.

Lectures:

P. Hünenberger
M. Fussenegger
D. Hilvert
E. Weber-Ban
R. Glockshuber, M. Pilhofer, E. Weber-Ban

Lecturers
Biological Engineering and Biotechnology
3V

The course will only take place with a minimum of 6 participants.

The course covers aspects of RNA biology related to gene expression at the posttranscriptional level. These include RNA transcription, processing, alternative splicing, editing, export and translation. The goal is to discuss cutting edge research in the structural, molecular, and biochemical study of cellular macromolecules. Students will also have an opportunity to present and discuss recent breakthroughs relevant to the research fields presented by the faculty teaching the course (see http://www.mol.biol.ethz.ch/research.html for details on the topics).

Basic knowledge of cell and molecular biology.

Mainly based on recent original literature, a detailed list will be distributed during the first lecture.

Elective Major: Biological Chemistry

Compulsory Concept Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0731-00L</td>
<td>Nucleic Acids and Carbohydrates</td>
<td>O</td>
<td>6</td>
<td>3G</td>
<td>D. Hilvert, P. A. Kast, S. J. Sturla, H. Wennemers</td>
</tr>
</tbody>
</table>

Structure, function and chemistry of nucleic acids and carbohydrates. DNA/RNA structure and synthesis; recombinant DNA technology and PCR; DNA arrays and genomics; antisense approach and RNA; polymerases and transcription factors; catalytic RNA; DNA damage and repair; carbohydrate structure and synthesis; carbohydrate arrays; cell surface engineering; carbohydrate vaccines

Overview of enzymes, enzyme-catalyzed reactions and metabolic processes.

Enzymes

Principles of enzymatic catalysis, enzyme kinetics, mechanisms of enzyme-catalyzed reactions (group transfer reactions, carbon-carbon bond formation, eliminations, isomerisations and rearrangements), cofactor chemistry, enzymes in organic synthesis and the biosynthesis of natural products, catalytic antibodies.

Overview of enzymes, enzyme-catalyzed reactions and metabolic processes.

Biological Engineering and Biotechnology
6 credits

Biological Engineering and Biotechnology will cover the latest technological advances as well as their industrial implementation to engineer mammalian cells for use in human therapy. This lecture will provide forefront insights into key scientific aspects and the main points in industrial decision-making to bring a therapeutic from target to market.

1. Insight Into The Mammalian Cell Cycle. Cycling, The Balance Between Proliferation and Cancer - Implications For Biopharmaceutical Manufacturing
2. The Licence To Kill. Apoptosis Regulatory Networks - Engineering of Survival Pathways To Increase Robustness of Production Cell Lines.
5. From Target To Market. An Antibody's Journey From Cell Culture to Biology and Malign Applications. Do Life Sciences Enable the 6. Functional Food. Enjoy your Meal!

Biochemical Manufacturing II. Up- stream Development

Biochemical Manufacturing I. Introduction to Process Development

Biochemical Manufacturing III. Downstream Development

Biochemical Manufacturing IV. Pharma Development

Hands out during the course.

Computer Simulation in Chemistry, Biology and Physics

7 credits

P. H. Hünenberger

Elective Compulsory Master Courses

Autumn Semester 2016

Page 279 of 1571
### 3G Comprehensive knowledge about the analytical methods introduced in this course, and their applications.

**Objective**
Introduction to computer simulation of (bio)molecular systems, development of skills to carry out and interpret computer simulations of biomolecular systems.

**Content**
- Molecular models, Force fields, Spatial boundary conditions, Calculation of Coulomb forces, Molecular dynamics, Analysis of trajectories, Quantum-mechanical simulation, Structure refinement, Application to real systems. Exercises: Analysis of papers on computer simulation, Molecular simulation in practice, Validation of molecular dynamics simulation.

**Lecture notes**
Available (copies of powerpoint slides distributed before each lecture).

**Literature**
See: www.csms.ethz.ch/education/CSCBP

**Prerequisites / notice**
Since the exercises on the computer do convey and test essentially different skills as those being conveyed during the lectures and tested at the oral exam, the results of the exercises are taken into account when evaluating the results of the exam.

---

### 529-0241-00L Advanced Methods and Strategies in Synthesis

**Abstract**
Advanced Modern Methods and Strategies in Synthesis

**Objective**
Knowledge of modern methods in asymmetric stereocontrol, enantioselective catalysis, and organic reaction mechanisms.

**Content**
- Current trends in methods for and approaches to synthesis of complex natural products, pharmaceuticals, and biological molecules; fragment coupling and protecting group strategies; chemical ligation and biomolecules synthesis; enantioselective catalysis including ligand design and optimization; cross coupling reactions from preactivated precursors; C-H activation and oxidation chemistry; building block synthesis with chiral auxiliaries and reagents; new concepts in asymmetric catalysis. Analysis of key primarily literature including identification of trends, key precedents, and emerging topics will be emphasized.

**Lecture notes**
will be provided in class and online.

**Literature**
Suggesting Textbooks

---

### 529-0233-00L Organic Synthesis: Methods and Strategies

**Abstract**
The complex relation between structural analysis, methods leading to desired transformations, and insight into reaction mechanisms is exemplified. Relations between retrosynthetic analysis of target structures, synthetic methods and their combination in a synthetic strategy.

**Objective**
Extension and deepening of the knowledge in organic synthesis.

**Content**

**Literature**

---

### 529-0243-00L Reactive Intermediates

**Abstract**
Advanced physical organic chemistry. Methods for the elucidation of reaction mechanisms. Reactive intermediates, Thermochemistry; isotope labeling; cross-over experiments; kinetic isotope effects; thermodynamics-kinetics correlations; solvation and ion pairs; radical reactions; electron transfer; spectroscopic methods.

**Objective**
Methods for the elucidation of organic reaction mechanisms.

**Content**

**Literature**
A printed script are handed out in the course. This material is also available for download from the web page of the course (as pdf files).

**Prerequisites / notice**
- Required level: Courses in organic and physical chemistry of the first and second year.
- Each participant is expected to contribute to a 30 min. seminar (prepared by groups of 2-4 students), presented in the last weeks of the semester.

---

### 529-0041-00L Modern Mass Spectrometry, Hyphenated Methods, and Chemometrics

**Abstract**
Modern mass spectrometry, hyphenated analytical methods, speciation, methods of surface analysis, chemometrics.

**Objective**
Comprehensive knowledge about the analytical methods introduced in this course, and their applications.

**Content**
- Coupling of separation with identification methods such as GC-MS, LC-MS, GC-IR, LC-IR, LC-NMR etc.; importance of speciation. Modern mass spectrometry: Time of flight and ion cyclotron resonance mass spectrometry, ICP-MS. Soft ionization methods, desorption methods, spray methods.
- Methods of surface analysis (ESCA, Auger, SIMS, raster microscopy methods).
- Employment of computer science for processing data in chemical analysis (chemometrics).

**Literature**
- Lecture notes will be available in the lecture at production cost.
- Information about relevant literature will be available in the lecture & in the lecture notes.
- Exercises are an integral part of the lecture.

**Prerequisites / notice**
- Exercises: 529-0051-00 "Analytische Chemie I (3. Semester)"
- 529-0058-00 "Analytische Chemie II (4. Semester)" (or equivalent)

---

### 551-1407-00L RNA Biology Lecture Series I: Transcription & Processing & Translation

**Abstract**
This course covers aspects of RNA biology related to gene expression at the posttranscriptional level. These include RNA transcription, processing, alternative splicing, editing, export and translation.

**Objective**
The students should obtain an understanding of these processes, which are at work during gene expression.

**Content**
- Transcription & 3'end formation; splicing, alternative splicing, RNA editing; the ribosome & translation, translation regulation, RNP biogenesis & nuclear export, mRNA surveillance & mRNA turnover; signal transduction & RNA.

**Prerequisites / notice**
Basic knowledge of cell and molecular biology.
An advanced course on the synthesis, properties and function of peptides in chemistry and biology.

Knowledge of the properties and function of peptides in chemistry and biology.

Advanced peptide synthesis, conformational properties, combinatorial chemistry, therapeutic peptides, peptide based materials, peptides in nanotechnology, peptides in asymmetric catalysis.

Citations from the original literature relevant to the individual lectures will be assigned weekly.


### Elective Concept Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-0307-00L</td>
<td>Molecular and Structural Biology I: Protein Structure and Function</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>R. Glockshuber, K. Locher, E. Weber-Ban</td>
</tr>
</tbody>
</table>

**Abstract**

Biophysics of protein folding, membrane proteins and biophysics of membranes, enzymatic catalysis, catalytic RNA and RNAi, current topics in protein biophysics and structural biology.

**Objective**

Understanding of structure-function relationships in proteins and in protein folding, detailed understanding of biophysics and physical methods as well as modern methods for protein purification and microanalytics.

**Lecture notes**

Scripts on the individual topics can be found under http://www.mol.biol.ethz.ch/teaching.

**Literature**

Basics:
- Creighton, T.E., Proteins, Freeman, (1993)
- Fersht, A., Enzyme, Structure and Mechanism in Protein Science (1999), Freeman.

Current topics: References will be given during the lectures.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-0319-00L</td>
<td>Cellular Biochemistry (Part I)</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>U. Kutay, R. I. Enchev, B. Kornmann, M. Peter, I. Zemp, further lecturers</td>
</tr>
</tbody>
</table>

**Abstract**

Concepts and molecular mechanisms underlying the biochemistry of the cell, providing advanced insights into structure, function and regulation of individual cell components. Particular emphasis will be put on the spatial and temporal integration of different molecules and signaling pathways into global cellular processes such as intracellular transport, cell division & growth, and cell migration.

**Objective**

The full-year course (551-0319-00 & 551-0320-00) focuses on the molecular mechanisms and concepts underlying the biochemistry of cellular physiology, investigating how these processes are integrated to carry out highly coordinated cellular functions. The molecular characterisation of complex cellular functions requires a combination of approaches such as biochemistry, but also cell biology and genetics. This course is therefore the occasion to discuss these techniques and their integration in modern cellular biochemistry.

The students will be able to describe the structural and functional details of individual cell components, and the spatial and temporal regulation of their interactions. In particular, they will learn to explain the integration of different molecules and signaling pathways into complex and highly dynamic cellular processes such as intracellular transport, cytoskeletal rearrangements, cell motility, cell division and cell growth. In addition, they will be able to illustrate the relevance of particular signaling pathways for cellular pathologies such as cancer.

**Content**

Structural and functional details of individual cell components, regulation of their interactions, and various aspects of the regulation and compartmentalisation of biochemical processes.

Topics include: biophysical and electrical properties of membranes; viral membranes; structural and functional insights into intracellular transport and targeting; vesicular trafficking and phagocytosis; post-transcriptional regulation of gene expression.

**Lecture notes**

Scripts and additional material will be provided during the semester. Please contact Dr. Alicia Smith for assistance with the learning materials (alicia.smith@bc.biol.ethz.ch)

**Literature**

Recommended supplementary literature (review articles and selected primary literature) will be provided during the course.

**Prerequisites / notice**

To attend this course the students must have a solid basic knowledge in chemistry, biochemistry and general biology. The course will be taught in English.

### Recommended Elective Courses (for all Master Majors)

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0180-00L</td>
<td>Research Ethics ■ Particulary suitable for students of D-BIOL, D-CHAB, D-HEST</td>
<td>W+</td>
<td>2</td>
<td>2G</td>
<td>G. Achermann</td>
</tr>
</tbody>
</table>

**Abstract**

This course has its focus on the responsible conduct of research (RCR) and the ethical dimensions of the biological and biomedical sciences.

**Objective**

The main goal of this course is to enhance the student's ability to:
- recognize and identify ethical issues and conflicts,
- analyze and develop well-reasoned responses to the kinds of ethical problems a scientist is likely to encounter.

Additionally, students will become familiar with regulations and ethical guidelines relevant for their research field on the international, governmental, institutional and professional level.

To achieve these objectives, teaching methods will include lectures, discussions, case study work (alone and in groups), moral games, paper work and exercises.
I. Ethics & the Process of Ethical Inquiry

---------------------------------------
Introduction in Ethics and Research Ethics
- What is ethics? What ethics is not...
- Awareness: what constitutes an ethical question? Distinguishing ethical questions from other kinds of questions; Science & ethics: a comparison;
- The ethics movement in the biological and health sciences;
- What is research ethics and why is it important?
- Values (personal, cultural & ethical) in science & principles for ethical conduct in research;
- Professional codes of conduct: functions and limitations

Ethical approaches in the conduct of research (Normative Ethics)
- Overview over important theories for research ethics: virtue theories, duty-based theories (rights theory, categorical imperative, prima facie duties), consequentialist theories, other theories);
- The plurality of ethical theories and its consequences;
- The concept of dignity

Moral reasoning I: Arguments
- Why arguments? What is a good argument? The structure of (moral) arguments;
- Deductive and inductive arguments; Validity and soundness;
- Assessing moral arguments

Moral reasoning II: Decision-making
- How (not) to approach ethical issues...; Is there a correct method for answering moral questions?
- Models of method in Applied Ethics: a) Top-down approaches; b) the reflective equilibrium; c) a bottom-up approach: casuistry (or reasoning-by-analogy);
- Is there a right answer?

II. Research Ethics / Responsible Conduct of Research (RCR)

---------------------------------------
Integrity in Research & Research Misconduct
- What is "integrity" in scientific research? What is research misconduct (falsification, fabrication, plagiarism - FFP) and questionable research practices (QRP)?
- Factors leading to misconduct; Procedure for responding to allegations of research misconduct;
- The confidant of ETH Zurich

Data Management
- Data collection and recordkeeping; Analysis and selection of data;
- Ownership of data; retention and sharing of data;
- Falsification and fabrication of data

Research involving animals
- The moral status of animals; Ethical approaches to animal experimentation: Animal welfare (Peter Singer) and Animal rights (Tom Regan);
- The 3 Rs (replacement, reduction, refinement);
- Ethical assessment of conflicting issues in animal experimentation;
- The dignity of animals in the Swiss constitution;

Research involving human subjects
- History & guidelines (Nuremberg Code; Declaration of Helsinki; Belmont Report; International Ethical Guidelines for Biomedical Research Involving Human Subjects (CIOMS Guidelines); Convention on Human Rights and Biomedicine (Oviedo Convention);
- Informed consent; confidentiality and anonymity; research risks and benefits; vulnerable subjects;
- Clinical trials;
- Biobanks;
- Ethics Committees / Institutional Review Boards (IRB)

Authorship & Peer review
- Criteria for authorship;
- Plagiarism;
- Challenges to openness and freedom in scientific publication;
- Open access;
- Peer review

Social responsibility
- What is social responsibility? Social responsibility: whose obligation?
- Public advocacy by researchers

Lecture notes
Course material (handouts, case studies, exercises, surveys and papers) will be available during the lectures and on the course homepage.

Literature
Recommended literature:
- "Introduction to the Responsible Conduct of Research" (http://ori.dhhs.gov/education/products/RCRintro/)

Detailed literature lists for the different topics of the course will be provided in the script/handout or on the course work space.

Research Projects (for all Master Majors)

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>551-1801-00L</td>
<td>Research Project I</td>
<td>O</td>
<td>15 credits</td>
<td>34A</td>
<td>Lecturers</td>
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</tbody>
</table>

Abstract
Research projects, with themes from the chosen scientific fields of interest, are intended to familiarise candidates with scientific procedures and operational methodologies through supervised participation in current research work.
### Master's Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-1800-00L</td>
<td>Master's Thesis</td>
<td>O</td>
<td>30 credits</td>
<td>64D</td>
<td>Lecturers</td>
</tr>
</tbody>
</table>

Abstract

Only students who fulfill the following criteria are allowed to begin with their master thesis:

- a. successful completion of the bachelor programme;
- b. fulfilling of any additional requirements necessary to gain admission to the master programme;
- c. have acquired at least 30 credits in the category "research projects".

The Master research will be carried out on a theme in the chosen subject area and must be completed with a written report (Thesis) within six months.

### Master's Examination

see Study Regulations 2006 for the Master-curriculum Biology, Art. 38

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<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>551-1800-01L</td>
<td>Master's Examination</td>
<td>O</td>
<td>4 credits</td>
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<td>Lecturers</td>
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</table>

Abstract

The Master examination comprises a written part and an oral part. Both parts will receive an evaluation mark. The Master examination is passed when the arithmetic mean of both evaluation marks is at least 4. The Master examination must be taken within three months of submitting the thesis.

### GESS Science in Perspective

Recommended GESS Science in Perspective (Type B) for D-BIOL.

- see GESS Science in Perspective: Type A: Enhancement of Reflection Capability
- see GESS Science in Perspective: Language Courses ETH/UZH

### Biology Master - Key for Type

| O | Compulsory |
| W+ | Eligible for credits and recommended |
| W | Eligible for credits |

| E- | Recommended, not eligible for credits |
| Z | Courses outside the curriculum |
| Dr | Suitable for doctorate |

### Key for Hours

| V | lecture |
| G | lecture with exercise |
| U | exercise |
| S | seminar |
| K | colloquium |

| P | practical/laboratory course |
| A | independent project |
| D | diploma thesis |
| R | revision course / private study |

### ECTS

European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
### Microrobotics

**Number**: 151-0604-00L  
**Title**: Microrobotics  
**Type**: W  
**ECTS**: 4  
**Hours**: 3G  
**Lecturers**: B. Nelson

**Abstract**
Microrobotics is an interdisciplinary field that combines aspects of robotics, micro and nanotechnology, biomedical engineering, and materials science. The aim of this course is to expose students to the fundamentals of this emerging field. Throughout the course students are expected to submit assignments. The course concludes with an end-of-semester examination.

**Objective**
The objective of this course is to expose students to the fundamental aspects of the emerging field of microrobotics. This includes a focus on physical laws that predominate at the microscale, technologies for fabricating small devices, bio-inspired design, and applications of the field.

**Content**
Main topics of the course include:
- Scaling laws at micro/nano scales
- Electrostatics
- Electromagnetism
- Low Reynolds number flows
- Observation tools
- Materials and fabrication methods
- Applications of biomedical microrobots

**Lecture notes**
The powerpoint slides presented in the lectures will be made available in hardcopy and as pdf files. Several readings will also be made available electronically.

**Prerequisites / notice**
The lecture will be taught in English.

### Nanosystems

**Number**: 151-0605-00L  
**Title**: Nanosystems  
**Type**: W  
**ECTS**: 4  
**Hours**: 4G  
**Lecturers**: A. Stemmer, J.N. Tissierant

**Abstract**
From atoms to molecules to condensed matter: characteristic properties of simple nanosystems and how they evolve when moving towards complex ensembles. Intermolecular forces, their macroscopic manifestations, and ways to control such interactions. Self-assembly and directed assembly of 2D and 3D structures. Special emphasis on the emerging field of molecular electronic devices.

**Objective**
Familiarize students with basic science and engineering principles governing the nano domain.

**Content**
The course addresses basic science and engineering principles ruling the nano domain. We particularly work out the links between topics that are traditionally taught separately.

**Topics**
Topics are treated in 2 blocks:

(I) From Quantum to Continuum
From atoms to molecules to condensed matter: characteristic properties of simple nanosystems and how they evolve when moving towards complex ensembles.

(II) Interaction Forces on the Micro and Nano Scale
Intermolecular forces, their macroscopic manifestations, and ways to control such interactions.

**Literature**

**Prerequisites / notice**
Lectures and Mini-Review presentations: Thursday 10-13, ML F 36

**Course format:**
Homework: Mini-Reviews
Students select a paper (list distributed in class) and expand the topic into a Mini-Review that illuminates the particular field beyond the immediate results reported in the paper.

**Homework:** Mini-Reviews
Students select a paper (list distributed in class) and expand the topic into a Mini-Review that illuminates the particular field beyond the immediate results reported in the paper.

**Lecturers**: A. Stemmer, J.N. Tissierant

**Abstract**
Introduction to Microsystems Technology (MST) and micro electro mechanical systems (MEMS)

**Objective**
- Basic silicon technologies: Thermal oxidation, photolithography and etching, diffusion and ion implantation, thin film deposition.
- Basic microsystems technologies: Bulk and surface micromachining, dry and wet etching, isotropic and anisotropic etching, beam and membrane formation, wafer bonding, thin film mechanical and thermal properties, piezoelectric and piezoresistive materials.
- Selected microsystems: Mechanical sensors and actuators, microresonators, thermal sensors and actuators, system integration and encapsulation.

**Content**
- Introduction to Microsystems technology (MST) and micro electro mechanical systems (MEMS)
- Basic silicon technologies: Thermal oxidation, photolithography and etching, diffusion and ion implantation, thin film deposition.
- Basic microsystems technologies: Bulk and surface micromachining, dry and wet etching, isotropic and anisotropic etching, beam and membrane formation, wafer bonding, thin film mechanical and thermal properties, piezoelectric and piezoresistive materials.
- Selected microsystems: Mechanical sensors and actuators, microresonators, thermal sensors and actuators, system integration and encapsulation.

**Lecture notes**
Handouts (available online)

**Literature**
- S.M. Sze: Semiconductor Devices, Physics and Technology
- W. Menz, J. Mohr, O.Paul: Microsystems Technology
- G. Kovacs: Micromachined Transducer Sourcebook

**Autumn Semester 2016**

**Data**: 06.03.2019 12:57
### Prerequisites / notice

**Prerequisites:** Physics I and II

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Type</th>
<th>Credits</th>
<th>Semester</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0385-10L</td>
<td>Biomedical Imaging</td>
<td>W</td>
<td>6</td>
<td>S. Kozerke, K. P. Prüssmann, M. Rudin</td>
<td></td>
</tr>
</tbody>
</table>

**Abstract**

Introduction and analysis of medical imaging technology including X-ray procedures, computed tomography, nuclear imaging techniques using single photon and positron emission tomography, magnetic resonance imaging and ultrasound imaging techniques.

**Objective**

To understand the physical and technical principles underlying X-ray imaging, computed tomography, single photon and positron emission tomography, magnetic resonance imaging, ultrasound and Doppler imaging techniques. The mathematical framework is developed to describe image encoding/decoding, point-spread function/modular transfer function, signal-to-noise ratio, contrast behavior for each of the methods. Matlab exercises are used to implement and study basic concepts.

**Content**

- X-ray imaging
- Computed tomography
- Single photon emission tomography
- Positron emission tomography
- Magnetic resonance imaging
- Ultrasound/Doppler imaging

**Lecture notes**

Lecture notes and handouts

**Literature**

Webb A, Smith N.B. Introduction to Medical Imaging: Physics, Engineering and Clinical Applications; Cambridge University Press 2011

Analysis, Linear Algebra, Physics, Basics of Signal Theory, Basic skills in Matlab programming

### Prerequisites / notice

**Analysis, Linear Algebra, Physics, Basics of Signal Theory, Basic skills in Matlab programming**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Type</th>
<th>Credits</th>
<th>Semester</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0386-00L</td>
<td>Biomedical Engineering</td>
<td>W</td>
<td>4</td>
<td>J. Vörös, S. J. Ferguson, S. Kozerke, U. Moser, M. Rudin, M. P. Wolf, M. Zenobi-Wong</td>
<td></td>
</tr>
</tbody>
</table>

**Abstract**

Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The focus is on learning the concepts that govern common medical instruments and the most important organs from an engineering point of view. In addition, the most recent achievements and trends of the field of biomedical engineering are also outlined.

**Objective**

Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The course provides an overview of the various topics of the different tracks of the biomedical engineering master course and helps orienting the students in selecting their specialized classes and project locations.

**Content**


Practical and theoretical exercises in small groups in the laboratory.

**Lecture notes**

Introduction to Biomedical Engineering by Enderle, Banchard, and Bronzino

AND

https://www1.ethz.ch/lbb/Education/BME

### Prerequisites / notice

**Analysis, Linear Algebra, Physics, Basics of Signal Theory, Basic skills in Matlab programming**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Type</th>
<th>Credits</th>
<th>Semester</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0393-10L</td>
<td>Bioelectronics and Biosensors</td>
<td>W</td>
<td>6</td>
<td>J. Vörös, M. F. Yanik, T. Zambelli</td>
<td></td>
</tr>
</tbody>
</table>

**Abstract**

New course. Not to be confounded with 227-0393-00L last offered in the Spring Semester 2015.

The course introduces the concepts of bioelectricity and biosensing. The sources and use of electrical fields and currents in the context of biological systems and problems are discussed. The fundamental challenges of measuring biological signals are introduced. The most important biosensing techniques and their physical concepts are introduced in a quantitative fashion.

**Objective**

During this course the students will:

- learn the basic concepts in biosensing and bioelectronics
- be able to solve typical problems in biosensing and bioelectronics
- learn about the remaining challenges in this field
The course is an introduction to some basic topics in signal processing, detection/estimation theory, and machine learning. Understanding computation by neurons and neuronal circuits is one of the great challenges of science. Many different disciplines can contribute their tools and concepts to solving mysteries of neural computation. The goal of this introductory course is to introduce the fundamental properties of neurons. Particularly the description of membrane electrical properties across synapses, which can be modified by experience. We need an understanding of the action of inhibitory and excitatory neurotransmitters and neuromodulators, so that the dynamics and logic of synapses can be interpreted. Finally, the neural architectures of feedforward and recurrent networks will be discussed in the context of co-ordination, control, and integration of sensory and motor information in neural networks.
Introduction to molecules used for biomaterials, molecular interactions between different materials and biological systems (molecules, cells, tissues). The concept of biocompatibility is discussed and important techniques from biomaterials research and development are introduced.

Objective
The class consists of three parts:
1. Introduction into molecular characteristics of molecules involved in the materials-to-biology interface. Molecular design of biomaterials.
2. The concept of biocompatibility.
3. Introduction into methodology used in biomaterials research and application.

Content
Introduction into native and polymeric biomaterials used for medical applications. The concepts of biocompatibility, biodegradation and the consequences of degradation products are discussed on the molecular level. Diffuse applications in tissue engineering and drug delivery are introduced. Strong focus lies on the molecular interactions between materials having very different bulk and/or surface chemistry with living cells, tissues and organs. In particular the interface between the materials surfaces and the eukaryotic cell surface and possible reactions of the cells with an implant material are elucidated. Techniques to design, produce and characterize materials in vitro as well as in vivo analysis of implanted and explanted materials are discussed. In addition, a link between academic research and industrial entrepreneurship is established by external guest speakers.

Literature
Handouts can be accessed online.

Physics in Medical Research: From Atoms to Cells
B. K. R. Müller

Handouts provided during the classes and references therein.

Recommended Elective Courses
These courses are particularly recommended for the Bioelectronics track. Please consult your track advisor if you wish to select other subjects.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>227-0186-00L</td>
<td>Analog Integrated Circuits</td>
<td>W</td>
<td>6</td>
<td>2+2</td>
<td>Q. Huang</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
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<td></td>
<td>Integrated circuits are responsible for much of the progress in electronics in the last 50 years, particularly the revolutions in the Information and Communications Technologies we witnessed in recent years. Analog integrated circuits play a crucial part in the highly integrated systems that power the popular electronic devices we use daily. Understanding their design is beneficial to both future designers and users of such systems. The basic elements, design issues and techniques for analog integrated circuits will be taught in this course.</td>
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<tr>
<td></td>
<td>Content</td>
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<tr>
<td></td>
<td>Review of bipolar and MOS devices and their small-signal equivalent circuit models; Building blocks in analog circuits such as current sources, active load, current mirrors, supply independent biasing etc; Amplifiers: differential amplifiers, cascode amplifier, high gain structures, output stages, gain bandwidth product of op-amps; Stability; Comparators; Second-order effects in analog circuits such as mismatch, noise and offset; A/D and D/A converters; Introduction to switched capacitor circuits. The exercise sessions aim to reinforce the lecture material by well guided step-by-step design tasks. The circuit simulator SPECTRE is used to facilitate the tasks. There is also an experimental session on op-amp measurements.</td>
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<td></td>
<td>Lecture notes</td>
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<tr>
<td></td>
<td>Handouts of presented slides. No script but an accompanying textbook is recommended.</td>
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<tr>
<td></td>
<td>Literature</td>
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Data: 06.03.2019 12:57 Autumn Semester 2016 Page 287 of 1571
Cross-disciplinary collaboration between engineers and medical doctors is indispensable for innovation in health care. This course will introduce students to the challenges of such interdisciplinary work in a project-based learning environment.

### Abstract


### Objective

- Overview of the most important concepts of image formation, perception and analysis, and Computer Vision. Gaining own experience through practical computer and programming exercises.

### Content

The first part of the course starts off from an overview of existing and emerging applications that need computer vision. It shows that the realm of image processing is no longer restricted to the factory floor, but is entering several fields of our daily life. First it is investigated how the parameters of the electromagnetic waves are related to our perception. Also the interaction of light with matter is considered. The most important hardware components of technical vision systems, such as cameras, optical devices and illumination sources are discussed. The course then turns to the steps that are necessary to arrive at the discrete images that serve as input to algorithms. The next part describes necessary preprocessing steps of image analysis, that enhance image quality and/or detect specific features. Linear and non-linear filters are introduced for that purpose. The course will continue by analyzing procedures allowing to extract additional types of basic information from multiple images, with motion and depth as two important examples. The estimation of image velocities (optical flow) will get due attention. Methods for object tracking will be presented. Several techniques are discussed to extract three-dimensional information about objects and scenes. Finally, approaches for the recognition of specific objects as well as object classes will be discussed and analyzed.

### Lecture notes

- Course material Script, computer demonstrations, exercises and problem solutions
- Basics concepts of mathematical analysis and linear algebra. The computer exercises are based on Linux and C. The course language is English.

### Prerequisites / notice

- Recommended (but not required): Stochastic models and signal processing, Communication Electronics, Analog Integrated Circuits, Transmission Lines and Filters.

### 227-0468-00L Analog Signal Processing and Filtering

**Suitable for Master Students as well as Doctoral Students.**

**W 6 credits 2V+2U**  
H. Schmid

**Abstract**

This lecture provides a wide overview over analog filters (continuous-time and discrete-time), signal-processing systems, and sigma-delta conversion, and gives examples with sensor interfaces and class-D audio drivers. All systems and circuits are treated using a signal-flow view. The lecture is suitable for both analog and digital designers.

**Objective**

This lecture provides a wide overview over analog filters (continuous-time and discrete-time), signal-processing systems, and sigma-delta conversion, and gives examples with sensor interfaces and class-D audio drivers. All systems and circuits are treated using a signal-flow view. The lecture is suitable for both analog and digital designers. The way the exam is done allows for the different interests of the two groups.

**Content**

The learning goal is that the students can apply signal-flow graphs and can understand the signal flow in such circuits and systems (including non-ideal effects) well enough to gain an understanding of further circuits and systems by themselves.

**Lecture notes**

The base for these lectures are lecture notes and two or three published scientific papers. From these papers we will together develop the technical content.

**Details:** [https://people.ee.ethz.ch/~haschmid/asfwiki/](https://people.ee.ethz.ch/~haschmid/asfwiki/)

Some material is protected by password; students from ETHZ who are interested can write to haschmid@ethz.ch to ask for the password even if they do not attend the lecture.

**Prerequisites / notice**

- **Prerequisites:** Recommended (but not required): Stochastic models and signal processing, Communication Electronics, Analog Integrated Circuits, Transmission Lines and Filters.

### 227-0981-00L Cross-Disciplinary Research and Development in Medicine and Engineering

**W 4 credits 2V+2A**  
V. Kurtcuoglu, D. de Julien de Zelicourt, M. Mebodi, M. Schmid Daners, O. Ullrich

**Abstract**

Cross-disciplinary collaboration between engineers and medical doctors is indispensable for innovation in health care. This course will bring together engineering students from ETH Zurich and medical students from the University of Zurich to experience the rewards and challenges of such interdisciplinary work in a project-based learning environment.

**Objective**

The main goal of this course is to demonstrate the differences in communication between the fields of medicine and engineering. Since such differences become the most evident during actual collaborative work, the course is based on a current project in physiology research that combines medicine and engineering. For the engineering students, the specific aims of the course are to:

- Acquire a working understanding of the anatomy and physiology of the investigated system;
- Identify the engineering challenges in the project and communicate them to the medical students;
- Develop and implement, together with the medical students, solution strategies for the identified challenges;
- Present the found solutions to a cross-disciplinary audience.

**Content**

After a general introduction to interdisciplinary communication and detailed background on the collaborative project, the engineering students will receive tailored lectures on the anatomy and physiology of the relevant system. They will then team up with medical students who have received a basic introduction to engineering methodology to collaborate on said project. In the process, they will be coached both by lecturers from ETH Zurich and the University of Zurich, receiving lectures customized to the project. The course will end with each team presenting their solution to a cross-disciplinary audience.

**Lecture notes**

Handouts and relevant literature will be provided.

### 227-1033-00L Neuromorphic Engineering I

**W 6 credits 2V+3U**  
T. Delbruck, G. Indiveri, S.C. Liu

**Abstract**

This course covers analog circuits with emphasis on neuromorphic engineering: MOS transistors in CMOS technology, static circuits, dynamic circuits, systems (silicon neuron, silicon retina, silicon cochlea) with an introduction to multi-chip systems. The lectures are accompanied by weekly laboratory sessions.

**Objective**

Understanding of the characteristics of neuromorphic circuit elements.
Content

Neuromorphic circuits are inspired by the organizing principles of biological neural circuits. Their computational primitives are based on physics of semiconductor devices. Neuromorphic architectures often rely on collective computation in parallel networks. Adaptation, learning and memory are implemented locally within the individual computational elements. Transistors are often operated in weak inversion (below threshold), where they exhibit exponential I-V characteristics and low currents. These properties lead to the feasibility of high-density, low-power implementations of functions that are computationally intensive in other paradigms. Application domains of neuromorphic circuits include silicon retinas and cochleas for machine vision and audition, real-time emulation of networks of biological neurons, and the development of autonomous robotic systems. This course covers devices in CMOS technology (MOS transistor below and above threshold, floating-gate MOS transistor, phototransducers), static circuits (differential pair, current mirror, transconductance amplifiers, etc.), dynamic circuits (linear and nonlinear filters, adaptive circuits), systems (silicon neuron, silicon retina and cochlea) and an introduction to multi-chip systems that communicate events analogous to spikes. The lectures are accompanied by weekly laboratory sessions on the characterization of neuromorphic circuits, from elementary devices to systems.

Literature


Prerequisites / notice

Particular: The course is highly recommended for those who intend to take the spring semester course ‘Neuromorphic Engineering II’, that teaches the conception, simulation, and physical layout of such circuits with chip design tools.

Prerequisites: Background in basics of semiconductor physics helpful, but not required.

227-2037-00L

Physical Modelling and Simulation

Abstract

This module consists of (a) an introduction to fundamental equations of electromagnetics, mechanics and heat transfer, (b) a detailed overview of numerical methods for field simulations, and (c) practical examples solved in form of small projects.

Objective

Basic knowledge of the fundamental equations and effects of electromagnetics, mechanics, and heat transfer. Knowledge of the main concepts of numerical methods for physical modelling and simulation. Ability (a) to develop own simple field simulation programs, (b) to select an appropriate field solver for a given problem, (c) to perform field simulations, (d) to evaluate the obtained results, and (e) to interactively improve the models until sufficiently accurate results are obtained.

Content

The module begins with an introduction to the fundamental equations and effects of electromagnetics, mechanics, and heat transfer. After the introduction follows a detailed overview of the available numerical methods for solving electromagnetic, thermal and mechanical boundary value problems. This part of the course contains a general introduction into numerical methods, differential and integral forms, linear equation systems, Finite Difference Method (FDM), Boundary Element Method (BEM), Method of Moments (MoM), Multiple Multipole Program (MMP) and Finite Element Method (FEM). The theoretical part of the course finishes with a presentation of multiphysics simulations through several practical examples of HF-engineering such as coupled electromagnetic-mechanical and electromagnetic-thermal analysis of MEMS.

In the second part of the course the students will work in small groups on practical simulation problems. For solving practical problems the students can develop and use own simulation programs or chose an appropriate commercial field solver for their specific problem. This practical simulation work of the students is supervised by the lecturers.

151-0255-00L

Energy Conversion and Transport in Biosystems

Abstract

Theory and application of thermodynamics and energy conversion in biological systems with focus on the cellular level.

Objective

Theory and application of energy conversion at the cellular level. Understanding of the basic features governing solutes transport in the building blocks of life. Ability (a) to develop a deeper understanding of energy conversion and transport in biological systems, (b) to apply the knowledge to design and optimize new energy conversion and transport systems.

Content


Lecture notes

Material in the form of hand-outs will be distributed.

Literature

Lecture notes and references therein.

151-0509-00L

Microscale Acoustofluidics

Abstract

In this lecture the basics as well as practical aspects (from modelling to design and fabrication ) are described from a solid and fluid mechanics perspective with applications to microsystems and lab on a chip devices.

Objective

Understanding acoustophoresis, the design of devices and potential applications.

Content

Linear and nonlinear acoustics, foundations of fluid and solid mechanics and piezoelectricity. Gorkov potential, numerical modelling, acoustic streaming, applications from ultrasonic microbiorobotics to surface acoustic wave devices.

Lecture notes


Literature


Solid and fluid continuum mechanics. Notice: The exercise part is a mixture of presentation, lab session and hand in homework.

376-1103-00L

Frontiers in Nanotechnology

Abstract

Many disciplines are meeting at the nanoscale, from physics, chemistry to engineering, from the life sciences to medicine. The course will prepare students to communicate more effectively across disciplinary boundaries, and will provide them with deep insights into the various frontiers.

Objective

Building upon advanced technologies to create, visualize, analyze and manipulate nano-structures, as well as to probe their nano-chemistry, nano-mechanics and other properties within mammade and living systems, many exciting discoveries are currently made. They change the way we do science and result in so many new technologies.

Content

The goal of the course is to give Master and Graduate students from all interested departments an overview of what nanotechnology is all about, from analytical techniques to nanosystems, from physics to biology. Students will start to appreciate the extent to which scientific communities are meeting at the nanoscale. They will learn about the specific challenges and what is currently sizzling in the respective fields, and learn the vocabulary that is necessary to communicate effectively across departmental boundaries.

Each lecturer will first give an overview of the state-of-the-art in his/her field, and then describe the research highlights in his/her own research group. While preparing their Final Projects and discussing them in front of the class, the students will deepen their understanding of how to apply a range of new technologies to solve specific scientific problems and technical challenges. Exposure to the different frontiers will also improve their ability to conduct effective nanoscale research, recognize the broader significance of their work and to start collaborations.

Content

Starting with the fabrication and analysis of nanoparticles and nanostructured materials that enable a variety of scientific and technical applications, we will transition to discussing biological nanosystems, how they work and what bioinspired engineering principles can be derived, to finally discussing biomedical applications and potential health-related issues as well as the many of the emerging technologies will be covered that start impacting so many aspects of our lives. This includes new phenomena in physics, advanced materials, novel technologies and new methods to address major medical challenges.

Lecture notes

All the enrolled students will get access to a password protected website where they can find pdf files of the lecture notes, and typically 1-2 journal articles per lecture that cover selected topics.

376-1219-00L

Rehabilitation Engineering II: Rehabilitation of...
Sensory and Vegetative Functions

L. Marchal Crespo

Abstract

Rehabilitation Engng is the application of science and technology to ameliorate the handicaps of individuals with disabilities to reintegrate them into society. The goal is to present classical and new rehabilitation engineering principles applied to compensate or enhance motor, sensory, and cognitive deficits. Focus is on the restoration and treatment of the human sensory and vegetative system.

Objective

Provide knowledge on the anatomy and physiology of the human sensory system, related dysfunctions and pathologies, and how rehabilitation engineering can provide sensory restoration and substitution.

This lecture is independent from Rehabilitation Engineering I. Thus, both lectures can be visited in arbitrary order.

Content

Introduction, problem definition, overview

Rehabilitation of visual function
- Anatomy and physiology of the visual sense
- Technical aids (glasses, sensor substitution)
- Retina and cortex implants

Rehabilitation of hearing function
- Anatomy and physiology of the auditory sense
- Hearing aids
- Cochlea implants

Rehabilitation and use of kinesthetic and tactile function
- Anatomy and physiology of the kinesthetic and tactile sense
- Tactile/haptic displays for motion therapy (incl. electrical stimulation)
- Role of displays in motor learning

Rehabilitation of vestibular function
- Anatomy and physiology of the vestibular sense
- Rehabilitation strategies and devices (e.g. BrainPort)

Rehabilitation of vegetative Functions
- Cardiac Pacemaker
- Phrenic stimulation, artificial breathing aids
- Bladder stimulation, artificial sphincter
- Brain stimulation and recording
- Deep brain stimulation for patients with Parkinson, epilepsy, depression
- Brain-Computer Interfaces

Literature

Introductory Books:


Selected Journal Articles and Web Links:


VideoTact, ForeThought Development, LLC. http://my.execpc.com/?dwysocki/videotac.html
Lecture handouts, background literature, problem sheets and notes will be provided electronically.

Microfluidics describes the behaviour, control and manipulation of fluids that are geometrically constrained within sub-microliter environments. The use of microfluidic devices offers an opportunity to control physical and chemical processes with unrivalled precision, and in turn provides a route to performing chemistry and biology in an ultra-fast and high-efficiency manner.

In the course students will investigate the theoretical concepts behind microfluidic device operation, the methods of microfluidic device manufacture and the application of microfluidic architectures to important problems faced in modern day chemical and biological analysis. A design workshop will allow students to develop new microscale flow processes by appreciating the dominant physics at the microscale. The application of these basic ideas will primarily focus on biological problems and will include a treatment of diagnostic devices for use at the point-of-care, advanced functional material synthesis, DNA analysis, proteomics and cell-based assays. Lectures, assignments and the design workshop will acquaint students with the state-of-the-art in applied microfluidics.

Number of participants limited to 30.

1. Theoretical Concepts
   Features of mass and thermal transport on the microscale
   Key scaling laws
2. Microfluidic Device Manufacture
   Conventional lithographic processing of rigid materials
   Soft lithographic processing of plastics and polymers
   Mass fabrication of polymeric devices
3. Unit operations and functional components
   Analytical separations (electrophoresis and chromatography)
   Chemical and biological synthesis
   Sample pre-treatment (filtration, SPE, pre-concentration)
   Molecular detection
4. Design Workshop
   Design of microfluidic architectures for PCR, distillation & mixing
5. Contemporary Applications in Biological Analysis
   Microarrays
   Cellular analyses (single cells, enzymatic assays, cell sorting)
   Proteomics
6. System integration
   Applications in radiochemistry, diagnostics and high-throughput experimentation

Lecture notes
Lecture handouts, background literature, problem sheets and notes will be provided electronically.

Lecture handouts, background literature, problem sheets and notes will be provided electronically.

This course is an introduction to techniques in micro/nanotechnology and to microfluidics. It reviews how many familiar devices are built and can be used for research and biomedical applications. Transistors for DNA sequencing, beamers for patterning proteins, hard-disk technology for biosensing and scanning microfluidics for analyzing tissue sections are just a few examples of the covered topics.

The main objective of the course is to introduce micro/nanotechnology and microfluidics to students having a background in the life sciences. The course should familiarize the students with the techniques used in micro/nanotechnology and show them how micro/nanotechnology pervades throughout life sciences. Microfluidics will be emphasized due to their increasing importance in research and medical applications. The second objective is to have life science students less intimidated by micro/nanotechnology and make them able to link instruments and techniques to specific problems that they might have in their projects/studies. This will also help students getting access to the ETHZ/IBM Nanotech Center infrastructure if needed.

Mostly formal lectures (2 × 45 min), with a 2 hour visit and introduction to cleanroom and micro/nanotechnology instruments, last 3 sessions would be dedicated to the presentation and evaluation of projects by students (3 students per team).

Prerequisites / notice
Nanotechnology center and lab visit at IBM would be mandatory, as well as attending the student project presentations.

Prerequisites / notice

Objective

Abstract

Content

Prerequisites / notice

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Content

This course offers an introduction into the structure and function of the human body, and how these are interlinked with one another. Focusing on physiology, the visualization of anatomy is supported by 3D-animation, Computed Tomography and Magnetic Resonance imaging.

To understand basic principles and structure of the human body in consideration of the clinical relevance and the medical terminology used in medical work and research.

This lecture is independent from Rehabilitation Engineering I. Thus, both lectures can be visited in arbitrary order.
Content - The Human Body: nomenclature, orientations, tissues
- Musculoskeletal system, Muscle contraction
- Blood vessels, Heart, Circulation
- Blood, Immune system
- Respiratory system
- Acid-Base-Homeostasis

Lecture notes Lecture notes and handouts

Literature Silbernagl S., Despopoulos A. Color Atlas of Physiology; Thieme 2008
Faller A., Schuenike M. The Human Body; Thieme 2004
Netter F. Atlas of human anatomy; Elsevier 2014

227-0945-00L Cell and Molecular Biology for Engineers | W 3 credits 3G C. Frei

Abstract The course gives an introduction into cellular and molecular biology, specifically for students with a background in engineering. The focus will be on the basic organization of eukaryotic cells, molecular mechanisms and cellular functions. Textbook knowledge will be combined with results from recent research and technological innovations in biology.

Objective After completing this course, engineering students will be able to apply their previous training in the quantitative and physical sciences to modern biology. Students will also learn the principles how biological models are established, and how these models can be tested. Lectures will include the following topics: DNA, chromosomes, RNA, protein, genetics, gene expression, membrane structure and function, vesicular traffic, cellular communication, energy conversion, cytoskeleton, cell cycle, cellular growth, apoptosis, autophagy, cancer, development and stem cells.

In addition, three journal clubs will be held, where one/two publications will be discussed (part I: 1 Journal club, part II: 2 Journal Clubs). For each journal club, students (alone or in groups of up to three students) have to write a summary and discussion of the publication. These written documents will be graded and count as 25% for the final grade.

Lecture notes Scripts of all lectures will be available.


227-0949-00L Biological Methods for Engineers (Basic Lab) | W 2 credits 4P C. Frei

Abstract The course during 4 afternoons (13h to 18h) covers basic laboratory skills and safety, cell culture, protein analysis, RNA/DNA Isolation and RT-PCR. Each topic will be introduced, followed by practical work at the bench. Presence during the course is mandatory.

Objective The goal of this laboratory course is to give students practical exposure to basic techniques of cell and molecular biology.

Content The goal of this laboratory course is to give students practical exposure to basic techniques of cell and molecular biology.

Prerequisites / notice Enrollment is limited and students from the Master's programme in Biomedical Engineering (BME) have priority.

Bioimaging

Track Core Courses

During the Master program, a minimum of 12 CP must be obtained from track core courses.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>227-0385-10L</td>
<td>Biomedical Imaging</td>
<td>W</td>
<td>6 credits</td>
<td>5G</td>
<td>S. Kozerke, K. P. Prüssmann, M. Rudin</td>
</tr>
<tr>
<td>227-0386-00L</td>
<td>Biomedical Engineering</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>J. Vörös, S. J. Ferguson, S. Kozerke, U. Moser, M. Rudin, M. P. Wolf, M. Zenobi-Wong</td>
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<tr>
<td>227-0447-00L</td>
<td>Image Analysis and Computer Vision</td>
<td>W</td>
<td>6 credits</td>
<td>3V+1U</td>
<td>L. Van Gool, O. Göksel,</td>
</tr>
</tbody>
</table>
Abstract


Objective

Overview of the most important concepts of image formation, perception and analysis, and Computer Vision. Gaining own experience through practical computer and programming exercises.

Content

The first part of the course starts off from an overview of existing and emerging applications that need computer vision. It shows that the realm of image processing is no longer restricted to the factory floor, but is entering several fields of our daily life. First it is investigated how the parameters of the electromagnetic waves are related to our perception. Also the interaction of light with matter is considered. The most important hardware components of technical vision systems, such as cameras, optical devices and illumination sources are discussed. The course then turns to the steps that are necessary to arrive at the discrete images that serve as input to algorithms. The next part describes necessary preprocessing steps of image analysis, that enhance image quality and/or detect specific features. Linear and non-linear filters are introduced for that purpose. The course will continue by analyzing procedures allowing to extract additional types of basic information from multiple images, with motion and depth as two important examples. The estimation of image velocities (optical flow) will get due attention and methods for object tracking will be presented. Several techniques are discussed to extract three-dimensional information about objects and scenes. Finally, approaches for the recognition of specific objects as well as object classes will be discussed and analyzed.

Lecture notes

Course material Script, computer demonstrations, exercises and problem solutions

Prerequisites /

Prerequisites: Basic concepts of mathematical analysis and linear algebra. The computer exercises are based on Linux and C. The course language is English.

Recommended Elective Courses

These courses are particularly recommended for the Bioimaging track. Please consult your track advisor if you wish to select other subjects.

<table>
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<th>Number</th>
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<tbody>
<tr>
<td>227-0389-00L</td>
<td>Advanced Topics in Magnetic Resonance Imaging</td>
<td>Z</td>
<td>0 credits</td>
<td>1V</td>
<td>K. P. Prüssmann</td>
</tr>
</tbody>
</table>

Abstract

This course is geared towards master and PhD students with a focus on bioimaging. It covers advanced topics in magnetic resonance imaging in biennial rotation, including the electromodynamics of MR signal detection, noise mechanisms, image reconstruction, radiofrequency pulse design, RF pulse trains, as well as advanced contrast mechanisms.

Objective

see above

227-0391-00L | Medical Image Analysis | W | 3 credits | 2G | P. C. Cattin, M. A. Reyes Aguirre |

Abstract

It is the objective of this lecture to introduce the basic concepts used in Medical Image Analysis. In particular the lecture focuses on shape representation schemes, segmentation techniques, and the various image registration methods commonly used in Medical Image Analysis applications.

Objective

This lecture aims to give an overview of the basic concepts of Medical Image Analysis and its application areas.

Prerequisites / notice

Basic knowledge of computer vision would be helpful.

227-0455-00L | Terahertz: Technology & Applications | W | 3 credits | 2V | K. Sankaran |

Abstract

This course will provide a solid foundation for understanding physical principles of THz applications. We will discuss various building blocks of THz technology - components dealing with generation, manipulation, and detection of THz electromagnetic radiation. We will introduce THz applications in the domain of imaging, communications, and energy harvesting.

Objective

This is an introductory course on Terahertz (THz) technology and applications. Devices operating in THz frequency range (0.1 to 10 THz) have been increasingly studied in the recent years. Progress in nonlinear optical materials, ultrafast optical and electronic techniques has strengthened research in THz application developments. Due to unique interaction of THz waves with materials, applications with new capabilities can be developed. In theory, they can penetrate somewhat like X-rays, but are not considered harmful radiation, because THz energy level is low. They should be able to provide resolution as good or better than magnetic resonance imaging (MRI), possibly with simpler equipment. Imaging, very-high bandwidth communication, and energy harvesting are the most widely explored THz application areas. We will study the basics of THz generation, manipulation, and detection. Our emphasis will be on the physical principles and applications of THz in the domain of imaging, communication and energy harvesting.
INTRODUCTION
Chapter 1: Introduction to THz Physics
Chapter 2: Components of THz Technology

THz TECHNOLOGY MODULES
Chapter 3: THz Generation
Chapter 4: THz Detection
Chapter 5: THz Manipulation

APPLICATIONS
Chapter 6: THz Imaging
Chapter 7: THz Communication
Chapter 8: THz Energy Harvesting

Literature
- Yun-Shik Lee, Principles of Terahertz Science and Technology, Springer 2009

Prerequisites / notice
Whenever we deviate from the main material discussed in these books, softcopy of lectures notes will be provided.

Good foundation in electromagnetics & knowledge of microwave or optical communication is helpful.

227-0967-00L
Computational Neuroimaging Clinic
W 3 credits 2V K. Stephan

Abstract
This seminar teaches problem solving skills for computational neuroimaging, based on joint analyses of neuroimaging and behavioural data. It deals with a wide variety of real-life problems that are brought to this seminar from the neuroimaging community at Zurich, e.g. mass-univariate and multivariate analyses of fMRI/EEG data, or generative models of fMRI, EEG, or behavioural data.

Objective
1. Consolidation of theoretical knowledge (obtained in the following courses: 'Methods & models for fMRI data analysis', 'Translational Neuroimaging', 'Computational Psychiatry') in a practical setting.
2. Acquisition of practical problem solving strategies for computational modeling of neuroimaging data.

Content
This seminar teaches problem solving skills for computational neuroimaging, based on joint analyses of neuroimaging and behavioural data. It deals with a wide variety of real-life problems that are brought to this seminar from the neuroimaging community at Zurich, e.g. mass-univariate and multivariate analyses of fMRI/EEG data, or generative models of fMRI, EEG, or behavioural data.

Prerequisites / notice
The participants are expected to have successfully completed at least one of the following courses: 'Methods & models for fMRI data analysis', 'Translational Neuroimaging', 'Computational Psychiatry'.

227-0969-00L
Methods & models for fMRI Data Analysis
W 6 credits 4V K. Stephan

Abstract
This course teaches methods and models for fMRI data analysis, covering all aspects of statistical parametric mapping (SPM), incl. preprocessing, the general linear model, statistical inference, multiple comparison corrections, event-related designs, and Dynamic Causal Modelling (DCM), a Bayesian framework for identification of nonlinear neuronal systems from neurophysiological data.

Objective
To obtain in-depth knowledge of the theoretical foundations of SPM and DCM and of their application to empirical fMRI data.

Content
This course teaches state-of-the-art methods and models for fMRI data analysis. It covers all aspects of statistical parametric mapping (SPM), incl. preprocessing, the general linear model, frequentist and Bayesian inference, multiple comparison corrections, and event-related designs, and Dynamic Causal Modelling (DCM), a Bayesian framework for identification of nonlinear neuronal systems from neurophysiological data. A particular emphasis of the course will be on methodological questions arising in the context of studies in psychiatry, neurology and neuroeconomics.

227-0971-00L
Computational Psychiatry
W 3 credits 4S K. Stephan

Abstract
This five-day course teaches state-of-the-art methods in computational psychiatry. It covers various computational models of cognition (e.g., learning and decision-making) and brain physiology (e.g., effective connectivity) of relevance for psychiatric disorders. The course not only provides theoretical background, but also demonstrates open source software in application to concrete examples.

Objective
This course aims at bridging the gap between mathematical modelers and clinical neuroscientists by teaching computational techniques in the context of clinical applications. The hope is that the acquisition of a joint language and tool-kit will enable more effective communication and joint translational research between fields that are usually worlds apart.

Content
This five-day course teaches state-of-the-art methods in computational psychiatry. It covers various computational models of cognition (e.g., learning and decision-making) and brain physiology (e.g., effective connectivity) of relevance for psychiatric disorders. The course not only provides theoretical background, but also demonstrates open source software in application to concrete examples.

227-2037-00L
Physical Modelling and Simulation
W 5 credits 4G C. Hafner, J. Leuthold, J. Smajic

Abstract
This module consists of (a) an introduction to fundamental equations of electromagnetics, mechanics and heat transfer, (b) a detailed overview of numerical methods for field simulations, and (c) practical examples solved in form of small projects.

Objective
Basic knowledge of the fundamental equations and effects of electromagnetics, mechanics, and heat transfer. Knowledge of the main concepts of numerical methods for physical modelling and simulation. Ability (a) to develop own simple field simulation programs, (b) to select an appropriate field solver for a given problem, (c) to perform field simulations, (d) to evaluate the obtained results, and (e) to interactively improve the models until sufficiently accurate results are obtained.

Content
The module begins with an introduction to the fundamental equations and effects of electromagnetics, mechanics, and heat transfer. After the introduction follows a detailed overview of the available numerical methods for solving electromagnetic, thermal and mechanical boundary value problems. This part of the course contains a general introduction into numerical methods, differential and integral forms, linear equation systems, Finite Difference Method (FDM), Boundary Element Method (BEM), Method of Moments (MoM), Multiple Multipole Program (MMP) and Finite Element Method (FEM). The theoretical part of the course finishes with a presentation of multiphysics simulations through several practical examples of HF-engineering such as coupled electromagnetic-mechanical and electromagnetic-thermal analysis of MEMS.

In the second part of the course the students will work in small groups on practical simulation problems. For solving practical problems the students can develop and use own simulation programs or chose an appropriate commercial field solver for their specific problem. This practical simulation work of the students is supervised by the lecturers.

151-0105-00L
Quantitative Flow Visualization
W 4 credits 2V+1U T. Rösgen

Abstract
The course provides an introduction to digital image analysis in modern flow diagnostics. Different techniques which are discussed include image velocimetry, laser induced fluorescence, liquid crystal theranography and interferometry. The physical foundations and measurement configurations are explained. Image analysis algorithms are presented in detail and programmed during the exercises.

Objective
Introduction to modern imaging techniques and post processing algorithms with special emphasis on flow analysis and visualization. Understanding of hardware and software requirements and solutions.

Development of basic programming skills for (generic) imaging applications.
Virtual Reality has the potential to support medical training and therapy. This lecture will derive the technical principles of multi-modal input devices, displays and rendering techniques. Examples are presented in the fields of surgical training, intra-operative augmentation, and rehabilitation. The lecture is accompanied by practical courses and excursions.

Objective
Virtual Reality has the potential to provide descriptive and practical information for medical training and therapy while relieving the patient and/or the physician. Multi-modal interactions between the user and the virtual environment facilitate the generation of high-fidelity sensory impressions, by using not only visual and auditory modalities, but also kinesthetic, tactile, and even olfactory feedback. On the basis of the existing physiological constraints, this lecture will derive the technical requirements and principles of multi-modal input devices, displays, and rendering techniques. Several examples are presented that are currently being developed or already applied for surgical training, intra-operative augmentation, and rehabilitation. The lecture will be accompanied by several practical courses on graphical and haptic display devices as well as excursions to facilities equipped with large-scale VR equipment.

Target Group:
Students of higher semesters and PhD students of:
- D-HEST, D-MAVT, D-ITET, D-INFK, D-PHYS
- Robotics, Systems and Control Master
- Biomedical Engineering/Movement Science and Sport
- Medical Faculty, University of Zurich
- Students of other departments, faculties, courses are also welcome!

Language: German on request.

Prerequisites:
Fluidodynamics I, Numerical Mathematics, programming skills.

Course format:
Lectures and Mini-Review presentations: Thursday 10-13, ML F 36

Homework: Mini-Reviews
Students select a paper (list distributed in class) and expand the topic into a Mini-Review that illuminates the particular field beyond the immediate results reported in the paper.


From atoms to molecules to condensed matter: characteristic properties of simple nanosystems and how they evolve when moving towards complex ensembles.

Objective
Familiarize students with basic science and engineering principles governing the nano domain.

Content
The course addresses basic science and engineering principles ruling the nano domain. We particularly work out the links between topics that are traditionally taught separately.

Topics are treated in 2 blocks:

(I) From Quantum to Continuum
From atoms to molecules to condensed matter: characteristic properties of simple nanosystems and how they evolve when moving towards complex ensembles.

(II) Interaction Forces on the Micro and Nano Scale
Intermolecular forces, their macroscopic manifestations, and ways to control such interactions.

Pattern recognition and feature extraction, proper orthogonal decomposition.

Surface pressure and temperature measurements (fluorescent paints, liquid crystal imaging, infrared thermography).

The lecture will be accompanied by several practical courses on graphical and haptic display devices as well as excursions to facilities equipped with large-scale VR equipment.

Language: English. Basic experience in Information Technology and Computer Science will be of advantage. More details will be announced in the lecture.

Prerequisites:
Students of higher semesters and PhD students of:
- D-EST, D-MAT, D-ITET, D-INFK, D-PHYS
- Robotics, Systems and Control Master
- Biomedical Engineering/Movement Science and Sport
- Medical Faculty, University of Zurich
- Students of other departments, faculties, courses are also welcome!


From atoms to molecules to condensed matter: characteristic properties of simple nanosystems and how they evolve when moving towards complex ensembles.

Literature

Homework: Mini-Reviews
Students select a paper (list distributed in class) and expand the topic into a Mini-Review that illuminates the particular field beyond the immediate results reported in the paper.
This course covers fundamental concepts of modern computer graphics. Students will learn about 3D object representations and the
details of how to generate photorealistic images from digital representations of 3D scenes. Starting with an introduction to 3D shape
modeling and representation, texture mapping and ray-tracing, we will move on to accelerator structures, the physics of light transport,
appearance modeling and global illumination principles and algorithms. We will end with an overview of modern image-based image
synthesis techniques, covering topics such as lightfields and depth-image based rendering.

Lecture notes
Prerequisites / notice
Prerequisites:
Fundamentals of calculus and linear algebra, basic concepts of algorithms and data structures, programming skills in C++, Visual
Computing course recommended.
The programming assignments will be in C++. This will not be taught in the class.

402-0674-00L  Physics in Medical Research: From Atoms to Cells  W  6 credits  2V+1U  B. K. R. Müller
Abstract
Scanning probe and diffraction techniques allow studying activated atomic processes during early stages of epitaxial growth. For
quantitative description, rate equation analysis, mean-field nucleation and scaling theories are applied on systems ranging from simple
metallic to complex organic materials. The knowledge is expanded to optical and electronic properties as well as to proteins and cells.

Objective
The lecture series is motivated by an overview covering the skin of the crystals, roughness analysis, contact angle measurements, protein
absorption/activity and monocyte behaviour.

As the first step, real structures on clean surfaces including surface reconstructions and surface relaxations, defects in crystals are
presented, before the preparation of clean metallic, semiconducting, and organic surfaces are introduced.

The atomic processes on surfaces are activated by the increase of the substrate temperature. They can be studied using scanning
tunneling microscopy (STM) and atomic force microscopy (AFM). The combination with molecular beam epitaxy (MBE) allows determining
the sizes of the critical nuclei and the other activated processes in a hierarchical fashion. The evolution of the surface morphology is
characterized by the density and size distribution of the nanostructures that could be quantified by means of the rate equation analysis, the
mean-field nucleation theory, as well as the scaling theory. The surface morphology is further characterized by defects and nanostructure's
shapes, which are based on the strain relieving mechanisms and kinetic growth processes.

High-resolution electron diffraction is complementary to scanning probe techniques and provides exact mean values. Some phenomena
are quantitatively described by the kinetic theory and perfectly understood by means of Ewald construction. Other phenomena need
to be described by the more complex dynamical theory. Electron diffraction is not only associated with elastic scattering but also inelastic
excitation mechanisms that reflect the electronic structure of the surfaces studied. Low-energy electrons lead to phonon and high-energy
electrons to plasmon excitations. Both effects are perfectly described by dipole and impact scattering.

Thin-films of rather complex organic materials are often quantitatively characterized by photons with a broad range of wavelengths from
ultra-violet to infra-red light. Asymmetries and preferential orientations of the (anisotropic) molecules are verified using the optical dichroism
and second harmonic generation measurements. These characterization techniques are vital for optimizing the preparation of medical
implants and the determination of tissue's anisotropies within the human body.

Cell-surface interactions are related to the cell adhesion and the contractile cellular forces. Physical means have been developed to
quantify these interactions. Other physical techniques are introduced in cell biology, namely to count and sort cells, to study cell
proliferation and metabolism and to determine the relation between cell morphology and function.

3D scaffolds are important for tissue augmentation and engineering. Design, preparation methods, and characterization of these highly
porous 3D microstructures are also presented.

Visiting clinical research in a leading university hospital will show the usefulness of the lecture series.

227-1033-00L  Neurorhorphic Engineering I  W  6 credits  2V+3U  T. Delbrück, G. Indiveri, S.C. Liu
Registration in this class requires the permission of the instructors. Class size will be limited to available lab spots.
Preference is given to students that require this class as part of their major.

Abstract
This course covers analog circuits with emphasis on neuromorphic engineering: MOS transistors in CMOS technology, static circuits,
dynamic circuits, systems (silicon neuron, silicon retina, silicon cochlea) with an introduction to multi-chip systems. The lectures are
accompanied by weekly laboratory sessions.

Objective
Understanding the characteristics of neuromorphic circuit elements.

Content
Neuromorphic circuits are inspired by the organizing principles of biological neural circuits. Their computational primitives are based on
physics of semiconductor devices. Neuromorphic architectures often rely on collective computation in parallel networks. Adaptation,
learning and memory are implemented locally within the individual computational elements. Transistors are often operated in weak
inversion (below threshold), where they exhibit exponential I-V characteristics and low currents. These properties lead to the feasibility of
high-density, low-power implementations of functions that are computationally intensive in other paradigms. Application domains of
neuromorphic circuits include silicon retinas and cochleas for machine vision and audition, real-time emulations of networks of biological
neurons, and the development of autonomous robotic systems. This course covers devices in CMOS technology (MOS transistor below
and above threshold, floating-gate MOS transistor, phototransducers), static circuits (differential pair, current mirror, transconductance
amplifiers, etc.), dynamic circuits (linear and nonlinear filters, adaptive circuits), systems (silicon neuron, silicon retina and cochlea) and an
introduction to multi-chip systems that communicate events analogous to spikes. The lectures are accompanied by weekly laboratory
sessions on the characterization of neuromorphic circuits, from elementary devices to systems.

Literature
S.-C. Liu et al.: Analog VLSI Circuits and Principles; various publications.

Prerequisites / notice
Particular: The course is highly recommended for those who intend to take the spring semester course 'Neuromorphic Engineering II', that
teaches the conception, simulation, and physical layout of such circuits with chip design tools.

Prerequisites: Background in basics of semiconductor physics helpful, but not required.

227-1037-00L  Introduction to Neuroinformatics  W  6 credits  2V+1U  K. A. Martin, M. Cook, V. Mante, M. Pfeiffer

Abstract
The course provides an introduction to the functional properties of neurons. Particularly the description of membrane electrical properties
(action potentials, channels), neuronal anatomy, synaptic structures, and neuronal networks. Simple models of computation, learning, and
behavior will be explained. Some artificial systems (robot, chip) are presented.

Objective
Understanding computation by neurons and neuronal circuits is one of the great challenges of science. Many different disciplines can
contribute their tools and concepts to solving mysteries of neural computation. The goal of this introductory course is to introduce the
monocultures of physics, math, computer science, engineering, biology, psychology, and even philosophy and history, to discover the
enchantments and challenges that we all face in taking on this major 21st century problem and how each discipline can contribute to
discovering solutions.
This course considers the structure and function of biological neural networks at different levels. The function of neural networks lies fundamentally in their wiring and in the electro-chemical properties of nerve cell membranes. Thus, the biological structure of the nerve cell needs to be understood if biologically-realistic models are to be constructed. These simpler models are used to estimate the electrical current flow through dendritic cables and explore how a more complex geometry of neurons influences this current flow. The active properties of nerves are studied to understand both sensory transduction and the generation and transmission of nerve impulses along axons. The concept of local neuronal circuits arises in the context of the rules governing the formation of nerve connections and topographic projections within the nervous system. Communication between neurons in the network can be thought of as information flow across synapses, which can be modified by experience. We need an understanding of the action of inhibitory and excitatory neurotransmitters and neuromodulators, so that the dynamics and logic of synapses can be interpreted. Finally, the neural architectures of feedforward and recurrent networks will be discussed in the context of co-ordination, control, and integration of sensory and motor information in neural networks.

**Biology Courses**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>227-0399-10L</td>
<td>Physiology and Anatomy for Biomedical Engineers I</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>H. Niemann</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course offers an introduction into the structure and function of the human body, and how these are interlinked with one another. Focusing on physiology, the visualization of anatomy is supported by 3D-animation, Computed Tomography and Magnetic Resonance imaging.</td>
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<tr>
<td>Objective</td>
<td>To understand basic principles and structure of the human body in consideration of the clinical relevance and the medical terminology used in medical work and research.</td>
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<tr>
<td>Content</td>
<td>- The Human Body: nomenclature, orientations, tissues</td>
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<td></td>
<td>- Musculoskeletal system, Muscle contraction</td>
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<td></td>
<td>- Blood vessels, Heart, Circulation</td>
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<td>- Blood, Immune system</td>
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<td>- Respiratory system</td>
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<td></td>
<td>- Acid-Base-Homeostasis</td>
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<tr>
<td>Lecture notes</td>
<td>Lecture notes and handouts</td>
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<tr>
<td>Literature</td>
<td>Silbernagl S., Despopoulos A. Color Atlas of Physiology; Thiemie 2008</td>
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<td></td>
<td>Faller A., Schuennke M. The Human Body; Thiemie 2004</td>
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<td>Netter F. Atlas of human anatomy; Elsevier 2014</td>
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<tr>
<td>227-0945-00L</td>
<td>Cell and Molecular Biology for Engineers I</td>
<td>W</td>
<td>3</td>
<td>3G</td>
<td>C. Frei</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course gives an introduction into cellular and molecular biology, specifically for students with a background in engineering. The focus will be on the basic organization of eukaryotic cells, molecular mechanisms and cellular functions. Textbook knowledge will be combined with results from recent research and technological innovations in biology.</td>
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<tr>
<td>Objective</td>
<td>After completing this course, engineering students will be able to apply their previous training in the quantitative and physical sciences to modern biology. Students will also learn the principles how biological models are established, and how these models can be tested.</td>
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<td>Content</td>
<td>Lectures will include the following topics: DNA, chromosomes, RNA, protein, genetics, gene expression, membrane structure and function, vesicular traffic, cellular communication, energy conversion, cytoskeleton, cell cycle, cellular growth, apoptosis, autophagy, cancer, development and stem cells.</td>
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<td>In addition, three journal clubs will be held, where one/two publications will be discussed (part I: 1 Journal club, part II: 2 Journal Clubs). For each journal club, students (alone or in groups of up to three students) have to write a summary and discussion of the publication. These written documents will be graded and count as 25% for the final grade.</td>
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</table>
Biological Methods for Engineers (Basic Lab)

Introduction into neuro- and electrophysiology. Functional analysis of peripheral nerves, muscles, sensory organs and the central nervous system.

C. Frei

Scripts of all lectures will be available.

W 2 credits 4P 4G

Abstract
The course during 4 afternoons (13h to 18h) covers basic laboratory skills and safety, cell culture, protein analysis, RNA/DNA isolation and RT-PCR. Each topic will be introduced, followed by practical work at the bench. Presence during the course is mandatory.

Objective
The goal of this laboratory course is to give students practical exposure to basic techniques of cell and molecular biology.

Content
The goal of this laboratory course is to give students practical exposure to basic techniques of cell and molecular biology.

Prerequisites / notice
Enrollment is limited and students from the Master's programme in Biomedical Engineering (BME) have priority.

Biomechanics

Track Core Courses

During the Master program, a minimum of 12 CP must be obtained from track core courses.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>227-0385-10L</td>
<td>Biomedical Imaging</td>
<td>W</td>
<td>6</td>
<td>5G</td>
<td>S. Kozderke, K. P. Prüssmann, M. Rudin</td>
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<tr>
<td>227-0386-00L</td>
<td>Biomedical Engineering</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>J. Vörös, S. J. Ferguson, S. Kozkerke, U. Moser, M. Rudin, M. P. Wolf, M. Zenobi-Wong</td>
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<tr>
<td>227-0447-00L</td>
<td>Image Analysis and Computer Vision</td>
<td>W</td>
<td>6</td>
<td>3V+1U</td>
<td>L. Van Gool, O. Göksel, E. Konukoglu</td>
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<tr>
<td>227-0965-00L</td>
<td>Micro and Nano-Tomography of Biological Tissues</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>M. Stampanoni, P. A. Kaestner</td>
</tr>
</tbody>
</table>

Image Analysis and Computer Vision

Abstract

Objective
Overview of the most important concepts of image formation, perception and analysis, and Computer Vision. Gaining own experience through practical computer and programming exercises.

Content
The first part of the course starts off from an overview of existing and emerging applications that need computer vision. It shows that the realm of image processing is no longer restricted to the factory floor, but is entering several fields of our daily life. First it is investigated how the parameters of the electromagnetic waves are related to our perception. Also the interaction of light with matter is considered. The most important hardware components of technical vision systems, such as cameras, optical devices and illumination sources are discussed. The course then turns to the steps that are necessary to arrive at the discrete images that serve as input to algorithms. The next part describes necessary preprocessing steps of image analysis, that enhance image quality and/or detect specific features. Linear and non-linear filters are introduced for that purpose. The course will continue by analyzing procedures allowing to extract additional types of basic information from multiple images, with motion and depth as two important examples. The estimation of image velocities (optical flow) will get due attention and methods for object tracking will be presented. Several techniques are discussed to extract three-dimensional information about objects and scenes. Finally, approaches for the recognition of specific objects as well as object classes will be discussed and analyzed.

Lecture notes
Introduction to Biomedical Engineering by Enderle, Banchard, and Bronzino

Prerequisites / notice
Limited number of participants.

Webb A, Smith N.B. Introduction to Medical Imaging; Physics, Engineering and Clinical Applications; Cambridge University Press 2011

Analysis, Linear Algebra, Physics, Basics of Signal Theory, Basic skills in Matlab programming

Data: 06.03.2019 12:57  Autumn Semester 2016  Page 298 of 1571
The lecture introduces the physical and technical know-how of X-ray tomographic microscopy. Several X-ray imaging techniques (absorption-, phase- and darkfield contrast) will be discussed and their use in daily research, in particular biology, is presented. The course discusses the aspects of quantitative evaluation of tomographic data sets like segmentation, morphometry and statistics.

Objective
Introduction to the basic concepts of X-ray tomographic imaging, image analysis and data quantification at the micro and nano scale with particular emphasis on biological applications.

Content
Synchrotron-based X-ray micro- and nano-tomography is today a powerful technique for non-destructive, high-resolution investigations of a broad range of materials. The high-brilliance and high-coherence of third generation synchrotron radiation facilities allow quantitative, three-dimensional imaging at the micro and nanometer scale and extend the traditional absorption imaging technique to edge-enhanced and phase-sensitive measurements, which are particularly suited for investigating biological samples.

The lecture includes a general introduction to the principles of tomographic imaging from image formation to image reconstruction. It provides the physical and engineering basics to understand how imaging beamlines at synchrotron facilities work, looks into the recently developed phase contrast methods, and explores the first applications of X-ray nano-tomographic experiments.

The course finally provides the necessary background to understand the quantitative evaluation of tomographic data, from basic image analysis to complex morphometrical computations and 3D visualization, keeping the focus on biomedical applications.

Recommended Elective Courses

These courses are particularly recommended for the Biomechanics track. Please consult your track advisor if you wish to select other subjects.

Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
151-0255-00L | Energy Conversion and Transport in Biosystems | W | 4 credits | 2V+1U | D. Poulikakos, A. Ferrari
151-0524-00L | Continuum Mechanics I | W | 4 credits | 2V+1U | E. Mazza
151-0604-00L | Microrobotics | W | 4 credits | 3G | B. Nelson

Abstract
The lecture deals with constitutive models that are relevant for design and calculation of structures. These include anisotropic linear elasticity, linear viscoelasticity, plasticity, viscoplasticity. Homogenization theories and laminate theory are presented. Theoretical models are complemented by examples of engineering applications and experiments.

Objective
Basic theories for solving continuum mechanics problems of engineering applications, with particular attention to material models.

Content

Lecture notes
yes

Literature
Lecture notes and references therein.

151-0604-00L | Microrobotics | W | 4 credits | 3G | B. Nelson

Abstract
Microrobotics is an interdisciplinary field that combines aspects of robotics, micro and nanotechnology, biomedical engineering, and materials science. The aim of this course is to expose students to the fundamentals of this emerging field. Throughout the course students are expected to submit assignments. The course concludes with an end-of-semester examination.

Objective
The objective of this course is to expose students to the fundamental aspects of the emerging field of microrobotics. This includes a focus on physical laws that predominate at the microscale, technologies for fabricating small devices, bio-inspired design, and applications of the field.

Content
Main topics of the course include:
- Scaling laws at micro/nano scales
- Electrostatics
- Electromagnetism
- Low Reynolds number flows
- Observation tools
- Materials and fabrication methods
- Applications of biomedical microbots

Lecture notes
The powerpoint slides presented in the lectures will be made available in hardcopy and as pdf files. Several readings will also be made available electronically.

Prerequisites / notice
The lecture will be taught in English.
## Content

The course addresses basic science and engineering principles ruling the nano domain. We particularly work out the links between topics that are traditionally taught separately.

Topics are treated in 2 blocks:

(I) From Quantum to Continuum
- From atoms to molecules to condensed matter: characteristic properties of simple nanosystems and how they evolve when moving towards complex ensembles.

(II) Interaction Forces on the Micro and Nano Scale
- Intermolecular forces, their macroscopic manifestations, and ways to control such interactions.
- Self-assembly and directed assembly of 2D and 3D structures.

### Literature


### Objective

Familiarize students with basic science and engineering principles governing the nano domain.

Students will:
- Develop own simple field simulation programs
- Interactively improve the models until sufficiently accurate results are obtained
- Select an appropriate field solver for a given problem
- Perform field simulations
- Evaluate the obtained results
- Choose in particular situations.

### Content

#### Physical Modelling and Simulation

This module consists of (a) an introduction to fundamental equations of electromagnetics, mechanics and heat transfer, (b) a detailed overview of numerical methods for field simulations, and (c) practical examples solved in form of small projects.

#### Objective

Basic knowledge of the fundamental equations and effects of electromagnetics, mechanics, and heat transfer. Knowledge of the main concepts of numerical methods for physical modelling and simulation. Ability (a) to develop own simple field simulation programs, (b) to select an appropriate field solver for a given problem, (c) to perform field simulations, (d) to evaluate the obtained results, and (e) to interactively improve the models until sufficiently accurate results are obtained.

#### Content

The module begins with an introduction to the fundamental equations and effects of electromagnetics, mechanics, and heat transfer. After the introduction follows a detailed overview of the available numerical methods for solving electromagnetic, thermal and mechanical boundary value problems. This part of the course contains a general introduction into numerical methods, differential and integral forms, linear equation systems, Finite Difference Method (FDM), Boundary Element Method (BEM), Method of Moments (MoM), Multiple Multipole Program (MMP) and Finite Element Method (FEM). The theoretical part of the course finishes with a presentation of multiphysics simulations through several practical examples of HF-engineering such as coupled electromagnetic-mechanical and electromagnetic-thermal analysis of MEMS.

In the second part of the course the students will work in small groups on practical simulation problems. For solving practical problems the students can develop and use own simulation programs or chose an appropriate commercial field solver for their specific problem. This practical simulation work of the students is supervised by the lecturer.

#### System Solving

The finite element (FE) method is the method of choice for (approximately) solving partial differential equations on complicated domains. In the first third of the lecture, we give an introduction to the method. The rest of the lecture will be devoted to methods for solving the large sparse linear systems of equation that a typical for the FE method. We will consider direct and iterative methods.

Students will know the most important direct and iterative solvers for sparse linear systems. They will be able to determine which solver to choose in particular situations.
I. THE FINITE ELEMENT METHOD

(1) Introduction, model problems.
(2) 1D problems. Piecewise polynomials in 1D.
(3) 2D problems. Triangulations. Piecewise polynomials in 2D.
(4) Variational formulations. Galerkin finite element method.
(5) Implementation aspects.

II. DIRECT SOLUTION METHODS

(6) LU and Cholesky decomposition.
(7) Sparse matrices.
(8) Fill-reducing orderings.

III. ITERATIVE SOLUTION METHODS

(9) Stationary iterative methods, preconditioning.
(10) Preconditioned conjugate gradient method (PCG).
(11) Incomplete factorization preconditioning.
(12) Multigrid preconditioning.
(13) Nonsymmetric problems (GMRES, BiCGstab).
(14) Indefinite problems (SYMMLQ, MINRES).

Literature


Prerequisites / notice

Prerequisites: Linear Algebra, Analysis, Computational Science.
The exercises are made with Matlab.
Content

Introduction, problem definition, overview
Rehabilitation of visual function
- Anatomy and physiology of the visual sense
- Technical aids (glasses, sensor substitution)
- Retina and cortex implants
Rehabilitation of hearing function
- Anatomy and physiology of the auditory sense
- Hearing aids
- Cochlea Implants
Rehabilitation and use of kinesthetic and tactile function
- Anatomy and physiology of the kinesthetic and tactile sense
- Tactile/haptic displays for motion therapy (incl. electrical stimulation)
- Role of displays in motor learning
Rehabilitation of vestibular function
- Anatomy and physiology of the vestibular sense
- Rehabilitation strategies and devices (e.g. BrainPort)
Rehabilitation of vegetative Functions
- Cardiac Pacemaker
- Phrenic stimulation, artificial breathing aids
- Bladder stimulation, artificial sphincter
- Deep brain stimulation for patients with Parkinson, epilepsy, depression
- Brain-Computer Interfaces

Literature

Introductory Books:


Selected Journal Articles and Web Links:


Prerequisites / notice

Virtual Reality in Medicine W 3 credits 2V R. Riener

Target Group:
- Students of higher semesters and PhD students of
- D-MAVT, D-ITET, D-INFK, D-HEST
- Biomedical Engineering, Robotics, Systems and Control
- Medical Faculty, University of Zurich

Students of other departments, faculties, courses are also welcome

This lecture is independent from Rehabilitation Engineering I. Thus, both lectures can be visited in arbitrary order.
Virtual Reality has the potential to support medical training and therapy. This lecture will derive the technical principles of multi-modal (audiovisual, haptic, tactile etc.) input devices, displays and rendering techniques. Examples are presented in the fields of surgical training, intra-operative augmentation, and rehabilitation. The lecture is accompanied by practical courses and excursions.

Objective
Provide theoretical and practical knowledge of new principles and applications of multi-modal simulation and interface technologies in medical education, therapy, and rehabilitation.

Content
Virtual Reality has the potential to provide descriptive and practical information for medical training and therapy while relieving the patient and/or the physician. Multi-modal interactions between the user and the virtual environment facilitate the generation of high-fidelity sensory impressions, by using not only visual and auditory modalities, but also kinesthetic, tactile, and even olfactory feedback. On the basis of the existing physiological constraints, this lecture will derive the technical requirements and principles of multi-modal input devices, displays, and rendering techniques. Several examples are presented that are currently being developed or already applied for surgical training, intra-operative augmentation, and rehabilitation. The lecture will be accompanied by several practical courses on graphical and haptic display devices as well as excursions to facilities equipped with large-scale VR equipment.

Target Group:
Students of higher semesters and PhD students of - D-HEST, D-MAVT, D-ITET, D-INFK, D-PHY5 - Robotics, Systems and Control Master - Biomedical Engineering/Movement Science and Sport - Medical Faculty, University of Zurich

Students of other departments, faculties, courses are also welcome!

Literature

Prerequisites / notice
The course language is English. Basic experience in Information Technology and Computer Science will be of advantage. More details will be announced in the lecture.

376-1714-00L  Biocompatible Materials  2 credits  4 credits  3G  K. Maniura, J. Möller, M. Zenobi-Wong

Abstract
Introduction to molecules used for biomaterials, molecular interactions between different materials and biological systems (molecules, cells, tissues). The concept of biocompatibility is discussed and important techniques from biomaterials research and development are introduced.

Objective
The class consists of three parts:
1. Introduction into molecular characteristics of molecules involved in the materials-to-biology interface. Molecular design of biomaterials.
2. The concept of biocompatibility.
3. Introduction into methodology used in biomaterials research and application.

Content
Introduction into native and polymeric biomaterials used for medical applications. The concepts of biocompatibility, biodegradation and the consequences of degradation products are discussed on the molecular level. Different classes of materials with respect to potential applications in tissue engineering and drug delivery are introduced. Strong focus lies on the molecular interactions between materials having very different bulk and/or surface chemistry with living cells, tissues and organs. In particular the interface between the materials surfaces and the eukaryotic cell surface and possible reactions of the cells with an implant material are elucidated. Techniques to design, produce and characterize materials in vitro as well as in vivo analysis of implanted and explanted materials are discussed.

In addition, a link between academic research and industrial entrepreneurship is established by external guest speakers.

Lecture notes
Handouts can be accessed online.

Literature
(available online via ETH library)

376-1351-00L  Micro/Nanotechnology and Microfluidics for Biomedical Applications  2 credits  4 credits  2V  E. Delamarche

Abstract
This course is an introduction to techniques in micro/nanotechnology and microfluidics. It reviews how many familiar devices are built.

Objective
The main objective of the course is to introduce micro/nanotechnology and microfluidics to students having a background in the life sciences. The course should familiarize the students with the techniques used in micro/nanotechnology and show them how to link instruments and techniques to specific problems that they might have in their projects/studies. This will also help students getting access to the ETHZ/IBM Nanotech Center infrastructure if needed.

Content
Mostly formal lectures (2 × 45 min), with a 2 hour visit and introduction to cleanroom and micro/nanotechnology instruments, last 3 sessions would be dedicated to the presentation and evaluation of projects by students (3 students per team).

Prerequisites / notice
Nanotech center and lab visit at IBM would be mandatory, as well as attending the student project presentations.

376-1720-00L  Application of MATLAB in the Human Movement Sciences  2 credits  4 credits  2G  R. van de Langenberg

Abstract
Students will learn to import, process and graphically present experimental data using the MATLAB computing environment. Both the data and the methods of analysis will be typical for experiments in Human Movement Science (i.e. kinematics, kinetics and electromyography).

Objective
Students will acquire the ability to independently load, plot, and process kinematic, kinetic and electromyographical data using the MATLAB computing environment.

Content
Drawbacks of Excel; Possibilities in MATLAB; Import of several data formats; Plot of one and more signals; Removing of an offset and filtering of data based on self-written functions; Normalisation and parametrisation of data; Reliability; Interpolation, Differentiation and Integration in MATLAB.

Literature
During the lecture, several electronically available MATLAB introductions are indicated. Course-specific scripts will be provided by the lecturer.

Prerequisites / notice
A Laptop with MATLAB installed (v2009 or higher) and wireless internet access is mandatory. Two students can share a laptop if necessary. A MATLAB student version can be obtained at Stud-IDES for free.

376-1974-00L  Colloquium in Biomechanics  2 credits  4 credits  2K  B. Helgason, S. J. Ferguson, R. Müller, J. G. Snedeker, B. Taylor, K. Würtz-Kozak, M. Zenobi-Wong

Abstract
Current topics in biomechanics presented by speakers from academia and industry.

Data: 06.03.2019 12:57  Autumn Semester 2016  Page 303 of 1571
402-0341-00L

**Biomechanics of Sports Injuries and Rehabilitation**

**Abstract**

This lecture introduces the basic principles of injury mechanics and rehabilitation focussing on sports injuries. Within the scope of this lecture you will learn the basic principles of trauma biomechanics. Based on examples from sports, you will get to know different mechanisms that can possibly result in injury. Investigating the background and cause of injury should allow you to assess the injury risk for sports activities. Furthermore you should be able to develop measures to prevent such injury.

**Objective**

This lecture deals with the basic principles of injury mechanics and rehabilitation. Mechanisms that can result in injury are presented. Furthermore possibilities to prevent injuries are discussed. Thereby the lecture focuses on sports injuries.

**Content**

A course work is required. The mark of this course work contributes to the final credits for this lecture. Details will be given during the first lecture.

**Literature**

Schmitt K-U, Niederer P, M. Muser, Walz F: "Trauma Biomechanics - Accidental Injury in traffic and sports". Springer Verlag

**Prerequisites / notice**

Handouts will be made available.

**Lecture notes**

A script will be provided.

402-0674-00L

**Physics in Medical Research: From Atoms to Cells**

**Abstract**

Scanning probe and diffraction techniques allow studying activated atomic processes during early stages of epitaxial growth. For quantitative description, rate equation analysis, mean-field nucleation and scaling theories are applied on systems ranging from simple metallic to complex organic materials. The knowledge is expanded to optical and electronic properties as well as to proteins and cells.

**Objective**

The lecture series is motivated by an overview covering the skin of the crystals, roughness analysis, contact angle measurements, protein and cell-surface interactions are related to the cell adhesion and the contractile cellular forces. Physical means have been developed to quantify these interactions. Other physical techniques are introduced in cell biology, namely to count and sort cells, to study cell proliferation and metabolism and to determine the relation between cell morphology and function.

3D scaffolds are important for tissue augmentation and engineering. Design, preparation methods, and characterization of these highly porous 3D microstructures are also presented.

Visiting clinical research in a leading university hospital will show the usefulness of the lecture series.

465-0953-00L

**Biostatistics**

The course deals with simple quantitative and graphical as well as more complex methods of biostatistics. Contents: Descriptive statistics, probability theory and design of experiments, testing hypotheses, confidence intervals, correlation, simple and multiple linear regression, classification and prediction, diagnostic tests, measurement of agreement.

551-1295-00L

**Introduction to Bioinformatics: Concepts and Applications**

Storage, handling and analysis of large datasets have become essential in biological research. The course will introduce students to a number of applications of bioinformatics in biology. Freely accessible software tools and databases will be explained and explored in theory and praxis.
Introduction to Bioinformatics I: Concepts and Applications (formerly Bioinformatics I) will provide students with the theoretical background of approaches to store and retrieve information from large databases. Concepts will be developed how DNA sequence information can be used to understand phylogenetic relationships, how RNA sequence relates to structure, and how protein sequence information can be used for genome annotation and to predict protein folding and structure. Students will be introduced to quantitative methods for measuring gene expression and how this information can be used to model gene networks. Methods will be discussed to construct protein interaction maps and how this information can be used to simulate dynamic molecular networks.

In addition to the theoretical background, the students will develop hands-on experiences with the bioinformatics methods through guided exercises. The course provides students from different backgrounds with basic training in bioinformatics approaches that have impact on biological, chemical and physics experimentation. Bioinformatics approaches draw significant expertise from mathematics, statistics and computational science.

Although "Introduction to Bioinformatics I" will focus on theory and praxis of bioinformatics approaches, the course provides an important foundation for the course "Introduction to Bioinformatics II: Fundamentals of computer science, modeling and algorithms" that will be offered in the following semester.

Bioinformatics I will cover the following topics:

- From genes to databases and information
- BLAST searches
- Prediction of gene function and regulation
- RNA structure prediction
- Gene expression analysis using microarrays
- Protein sequence and structure databases
- WWW for bioinformatics
- Protein sequence comparisons
- Proteomics and de novo protein sequencing
- Protein structure prediction
- Cellular and protein interaction networks
- Molecular dynamics simulation

### Biology Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0399-10L</td>
<td>Physiology and Anatomy for Biomedical Engineers I</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>H. Niemann</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course offers an introduction into the structure and function of the human body, and how these are interlinked with one another. Focusing on physiology, the visualization of anatomy is supported by 3D-animation, Computed Tomography and Magnetic Resonance imaging.</td>
<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>To understand basic principles and structure of the human body in consideration of the clinical relevance and the medical terminology used in medical work and research.</td>
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</tr>
</tbody>
</table>
| Content      | - The Human Body: nomenclature, orientations, tissues  
- Musculoskeletal system, Muscle contraction  
- Blood vessels, Heart, Circulation  
- Blood, Immune system  
- Respiratory system  
- Acid-Base-Homeostasis |
| Literature   | Lecture notes and handouts                                 |
| Literature   | Silbernagl S., Despopoulos A. Color Atlas of Physiology; Thieme 2008 |
| Literature   | Faller A., Schuenke M. The Human Body; Thieme 2004 |
| Literature   | Netter F. Atlas of human anatomy; Elsevier 2014 |
| 227-0945-00L | Cell and Molecular Biology for Engineers I                | W    | 3    | 3G    | C. Frei      |
| Abstract     | The course gives an introduction into cellular and molecular biology, specifically for students with a background in engineering. The focus will be on the basic organization of eukaryotic cells, molecular mechanisms and cellular functions. Textbook knowledge will be combined with results from recent research and technological innovations in biology. |
| Objective    | After completing this course, engineering students will be able to apply their previous training in the quantitative and physical sciences to modern biology. Students will also learn the principles how biological models are established, and how these models can be tested. |
| Content      | Lectures will include the following topics: DNA, chromosomes, RNA, protein, genetics, gene expression, membrane structure and function, vesicular traffic, cellular communication, energy conversion, cytokin, cell cycle, cellular growth, apoptosis, autophagy, cancer, development and stem cells. |
| Literature   | Scripts of all lectures will be available.                 |
| 227-0949-00L | Biological Methods for Engineers (Basic Lab)               | W    | 2    | 4P    | C. Frei      |
| Abstract     | This course is part I of a two-semester course.           |
| Objective    | Limited number of participants.                           |
| Content      | The course during 4 afternoons (13th to 18th) covers basic laboratory skills and safety, cell culture, protein analysis, RNA/DNA Isolation and RT-PCR. Each topic will be introduced, followed by practical work at the bench. Presence during the course is mandatory. |
| Prerequisites | The goal of this laboratory course is to give students practical exposure to basic techniques of cell and molecular biology. |
| Literature   | Enrollment is limited and students from the Master's programme in Biomedical Engineering (BME) have priority. |

### Medical Physics

### Track Core Courses

*During the Master program, a minimum of 12 CP must be obtained from track core courses.*

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0385-10L</td>
<td>Biomedical Imaging</td>
<td>W</td>
<td>6</td>
<td>5G</td>
<td>S. Kozerke, K. P. Prüssmann, M. Rudin</td>
</tr>
<tr>
<td>Abstract</td>
<td>Introduction and analysis of medical imaging technology including X-ray procedures, computed tomography, nuclear imaging techniques using single photon and positron emission tomography, magnetic resonance imaging and ultrasound imaging techniques.</td>
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</table>

**Data: 06.03.2019 12:57**

Autumn Semester 2016
Objective: To understand the physical and technical principles underlying X-ray imaging, computed tomography, single photon and positron emission tomography, magnetic resonance imaging, ultrasound and Doppler imaging techniques. The mathematical framework is developed to describe image encoding/decoding, point-spread function/modular transfer function, signal-to-noise ratio, contrast behavior for each of the methods. Matlab exercises are used to implement and study basic concepts.

Content: X-ray imaging
- Computed tomography
- Single photon emission tomography
- Positron emission tomography
- Magnetic resonance imaging
- Ultrasound/Doppler imaging

Lecture notes: Lecture notes and handouts


Prerequisites / notice: Analysis, Linear Algebra, Physics, Basics of Signal Theory, Basic skills in Matlab programming

402-0341-00L Medical Physics I

Abstract: Introduction to the fundamentals of medical radiation physics. Functional chain due to radiation exposure from the primary physical effect to the radiobiologically and medically manifest secondary effects. Dosimetric concepts of radiation protection in medicine. Mode of action of radiation sources used in medicine and its illustration by means of Monte Carlo simulations.

Objective: Understanding the functional chain from primary physical effects of ionizing radiation to clinical radiation effects. Dealing with dose as a quantitative measure of medical exposure. Getting familiar with methods to generate ionizing radiation in medicine and learn how they are applied for medical purposes. Eventually, the lecture aims to show the students that medical physics is a fascinating and evolving discipline where physics can directly be used for the benefit of patients and the society.

Content: The lecture is covering the basic principles of ionizing radiation and its physical and biological effects. The physical interactions of photons as well as of charged particles will be reviewed and their consequences for medical applications will be discussed. The concept of Monte Carlo simulation will be introduced in the exercises and will help the student to understand the characteristics of ionizing radiation in simple and complex situations. Fundamentals of dosimetry will be provided in order to understand the physical and biological effects of ionizing radiation. Deterministic as well as stochastic effects will be discussed and fundamental knowledge about radiation protection will be provided. In the second part of the lecture series, we will cover the generation of ionizing radiation. By this means, the x-ray tube, the clinical linear accelerator, and different radioactive sources in radiology, radiotherapy and nuclear medicine will be addressed. Applications in radiology, nuclear medicine and radiotherapy will be described with a special focus on the physics underlying these applications.

Lecture notes: A script will be provided.

402-0345-00L Introduction to Medical Physics

Abstract: Medical physics is a fascinating and worthwhile scientific discipline, providing many professional opportunities to apply physics to the care of patients, either in the clinic or in industry. It is also an area allowing for exciting, interesting and fulfilling areas of research.

Objective: The aim of this course is to give bachelor and master level students an insight into the wide spectrum of medical applications of physics, and to provide some insight into the work of the medical physicist in clinics, industry and research.

Content: The lecture series will begin with a short historical overview of medical physics and an overview of the lecture series (lecture 1). This will be followed by two lectures on the physics of medical imaging. Medical imaging is one of the most important areas of preventive medicine and diagnostics, and in these two lectures, we will summarise the physics aspects of all the most important medical imaging modalities (X-ray, nuclear medicine, CT, MRI, Ultrasound imaging etc.). With lectures 4 and 5, we will move onto one of the other major areas of physics applied to medicine, radiotherapy. As the name implies, this is a physics 'heavy' discipline, being dependent as it is on both accelerator and particle physics. However, what is less well known is that this is also the second most successful treatment of cancer after surgery and a great success story for the application of physics to medicine. In lectures 6 and 7 we will then move on to a very different area, that of bio-photonics and bio-physics. Here we will look into the applications of lasers in medicine, from therapy to their use in particle acceleration for medical applications, as well as a variety of optical techniques for studying biological tissues, cells and structures.

In the second half of the lecture series (lectures 8-13) the style changes somewhat, and we will concentrate on professional aspects of medical physics and the role of the medical physicist in various professional scenarios. As such, lectures 8-11 will cover the role of the clinical medical physicist in diagnostic radiology, MRI, nuclear medicine and radiotherapy, whilst the last two lectures will concentrate on their role in industry and research. For many of this second set of lectures, external experts in the various areas will be invited in order to give the student the best possible insight into the life of a professional medical physicist.

227-0943-00L Radiobiology

Abstract: The purpose of this course is to impart basic knowledge in radiobiology in order to handle ionizing radiation and to provide a basis for predicting the radiation risk.

Objective: By the end of this course the participants will be able to:
- interpret the 5 Rs of radiation oncology in the context of the hallmarks of cancer
- understand factors which underpin the differing radiosensitivities of different tumors
- understand different treatment responses of the tumor and the normal tissue to differential clinical-related parameters of radiotherapy
- understand differences in the radiation response of normal tissue versus tumor tissue
- understand different treatment responses of the tumor and the normal tissue to differential clinical-related parameters of radiotherapy (dose rate, LET etc.).

Content: Einführung in die Strahlenbiologie ionisierender Strahlen: Allgemeine Grundlagen und Begriffsbestimmungen; Mechanismen der biologischen Strahlenwirkung; Strahlenwirkung auf Zellen, Gewebe und Organe: Modifikation der biologischen Strahlenwirkung; Strahlenzytogenetik: Chromosomenveränderungen, DNA-Defekte, Reparaturprozesse; Molekulare Strahlenbiologie: Bedeutung inter- und intrazellulärer Signalübermittlungsprozesse, Apoptose, Zellzyklus-Checkpoints; Strahlenrisiko: Strahlensyndrome, Krebsinduktion, Mutationsschutz, pränatale Strahlenwirkung; Strahlenbiologische Grundlagen des Strahlenschutzes; Nutzen-Risiko-Abwägungen bei der medizinischen Strahlenanwendung; Prädiktive strahlenbiologische Methoden zur Optimierung der therapeutischen Strahlenanwendung.

Lecture notes: Beilagen mit zusammenfassenden Texten, Tabellen, Bild- und Grafikdarstellungen werden abgegeben


Prerequisites / notice: The former number of this course unit is 465-0951-00L.

Relevant Elective Courses

These courses are particularly recommended for the Medical Physics track. Please consult your track advisor if you wish to select other subjects.

Number | Title | Type | ECTS | Hours | Lecturers
---|---|---|---|---|---
402-0674-00L | Physics in Medical Research: From Atoms to Cells | W | 6 credits | 2V+1U | B. K. R. Müller

Data: 06.03.2019 12:57 Autumn Semester 2016 Page 306 of 1571
Abstract
Scanning probe and diffusion techniques allow studying activated atomic processes during early stages of epitaxial growth. For quantitative description, rate equation analysis, mean-field nucleation and scaling theories are applied on systems ranging from simple metallic to complex organic materials. The knowledge is expanded to optical and electronic properties as well as to proteins and cells.

Objective
The lecture series is motivated by an overview covering the skin of the crystals, roughness analysis, contact angle measurements, protein absorption/activity and monocye behaviour.

As the first step, real structures on clean surfaces including surface reconstructions and surface relaxations, defects in crystals are presented, before the preparation of clean metallic, semiconducting, oxidic and organic surfaces are introduced.

The atomic processes on surfaces are activated by the increase of the substrate temperature. They can be studied using scanning tunneling microscopy (STM) and atomic force microscopy (AFM). The combination with molecular beam epitaxy (MBE) allows determining the sizes of the critical nuclei and the other activated processes in a hierarchical fashion. The evolution of the surface morphology is characterized by the density and size distribution of the nanostructures that could be quantified by means of the rate equation analysis, the mean-field nucleation theory, as well as the scaling theory. The surface morphology is further characterized by defects and nanostructure's shapes, which are based on the strain relieving mechanisms and kinetic growth processes.

High-resolution electron diffraction is complementary to scanning probe techniques and provides exact mean values. Some phenomena are quantitatively described by the kinematic theory and perfectly understood by means of the Ewald construction. Other phenomena need to be described by the more complex dynamical theory. Electron diffraction is not only associated with elastic scattering but also inelastic excitation mechanisms that reflect the electronic structure of the surfaces studied. Low-energy electrons lead to phonon and high-energy electrons to plasmon excitations. Both effects are perfectly described by dipole and impact scattering.

Thin-films of rather complex organic materials are often quantitatively characterized by photons with a broad range of wavelengths from ultra-violet to infra-red light. Asymmetries and preferential orientations of the (anisotropic) molecules are verified using the optical dichroism and second harmonic generation measurements. These characterization techniques are vital for optimizing the preparation of medical implants and the determination of tissue's anisotropies within the human body.

Cell-surface interactions are related to the cell adhesion and the contractile cellular forces. Physical means have been developed to quantify these interactions. Other physical techniques are introduced in cell biology, namely to count and sort cells, to study cell proliferation and metabolism and to determine the relation between cell morphology and function.

3D scaffolds are important for tissue augmentation and engineering. Design, preparation methods, and characterization of these highly porous 3D microstructures are also presented.

Visiting clinical research in a leading university hospital will show the usefulness of the lecture series.

>>> Other Elective Courses

These courses may be suitable for the Medical Physics track. Please consult your track advisor.

Number  Title  Type  ECTS  Hours  Lecturers
227-0447-00L  Image Analysis and Computer Vision  W  6 credits  3V+1U  L. Van Gool, O. Göksel, E. Konukoglu

Abstract

Objective
Overview of the most important concepts of image formation, perception and analysis, and Computer Vision. Gaining own experience through practical computer and programming exercises.

Content
The first part of the course starts off from an overview of existing and emerging applications that need computer vision. It shows that the realm of image processing is no longer restricted to the factory floor, but is entering several fields of our daily life. First it is investigated how the parameters of the electromagnetic waves are related to our perception. Also the interaction of light with matter is considered. The most important hardware components of technical vision systems, such as cameras, optical devices and illumination sources are discussed. The course then turns to the steps that are necessary to arrive at the discrete images that serve as input to algorithms. The next part describes necessary preprocessing steps of image analysis, the enhancement image quality and/or detect specific features. Linear and non-linear filters are introduced for that purpose. The course will continue by analyzing procedures allowing to extract additional types of basic information from multiple images, with motion and depth as two important examples. The estimation of image velocities (optical flow) will get due attention and methods for object tracking will be presented. Several techniques are discussed to extract three-dimensional information about objects and scenes. Finally, approaches for the recognition of specific objects as well as object classes will be discussed and analyzed.

Lecture notes
Course material Script, computer demonstrations, exercises and problem solutions
Prerequisites / notice
Prerequisites:
Basic concepts of mathematical analysis and linear algebra. The computer exercises are based on Linux and C.
The course language is English.

227-0965-00L  Micro and Nano-Tomography of Biological Tissues  W  4 credits  3G  M. Stampanoni, P. A. Kaestner

Abstract
The lecture introduces the physical and technical know-how of X-ray tomographic microscopy. Several X-ray imaging techniques (absorption-, phase- and darkfield contrast) will be discussed and their use in daily research, in particular biology, is presented. The course discusses the aspects of quantitative evaluation of tomographic data sets like segmentation, morphometry and statistics.

Objective
Introduction to the basic concepts of X-ray tomographic imaging, image analysis and data quantification at the micro and nano scale with particular emphasis on biological applications.

Content
Synchrotron-based X-ray micro- and nano-tomography is today a powerful technique for non-destructive, high-resolution investigations of a broad range of materials. The high-brilliance and high-coherence of third generation synchrotron radiation facilities allow quantitative, three-dimensional imaging at the micro and nanometer scale and extend the traditional absorption imaging technique to edge-enhanced and phase-sensitive measurements, which are particularly suited for investigating biological samples.

The lecture includes a general introduction to the principles of tomographic imaging from image formation to image reconstruction. It provides the physical and engineering basics to understand how imaging beamlines at synchrotron facilities work, looks into the recently developed phase contrast methods, and explores the first applications of X-ray nano-tomographic experiments.

The course finally provides the necessary background to understand the quantitative evaluation of tomographic data, from basic image analysis to complex morphometrical computations and 3D visualization, keeping the focus on biomedical applications.

Lecture notes
Available online
Literature
Will be indicated during the lecture.

>>> Biology Courses

Number  Title  Type  ECTS  Hours  Lecturers

227-0399-10L  Physiology and Anatomy for Biomedical Engineers I  W  3 credits  2G  H. Niemann

Abstract
This course offers an introduction into the structure and function of the human body, and how these are interlinked with one another. Focusing on physiology, the visualization of anatomy is supported by 3D-animation, Computed Tomography and Magnetic Resonance Imaging.

Objective
To understand basic principles and structure of the human body in consideration of the clinical relevance and the medical terminology used in medical work and research.

Content
- The Human Body: nomenclature, orientations, tissues
- Musculoskeletal system, Muscle contraction
- Blood vessels, Heart, Circulation
- Blood, Immune system
- Respiratory system
- Acid-Base-Homeostasis

Lecture notes
Lecture notes and handouts

Literature
Silbernagl S., Despopoulos A. Color Atlas of Physiology; Thieme 2008
Faller A., Schuenke M. The Human Body; Thieme 2004
Netter F. Atlas of human anatomy; Elsevier 2014

227-0945-00L  Cell and Molecular Biology for Engineers I  W  3 credits  3G  C. Frei

Abstract
The course gives an introduction into cellular and molecular biology, specifically for students with a background in engineering. The focus will be on the basic organization of eukaryotic cells, molecular mechanisms and cellular functions. Textbook knowledge will be combined with results from recent research and technological innovations in biology.

Objective
After completing this course, engineering students will be able to apply their previous training in the quantitative and physical sciences to modern biology. Students will also learn the principles how biological models are established, and how these models can be tested.

Content
Lectures will include the following topics: DNA, chromosomes, RNA, protein, genetics, gene expression, membrane structure and function, vesicular traffic, cellular communication, energy conversion, cytoskeleton, cell cycle, cellular growth, apoptosis, autophagy, cancer, development and stem cells.

In addition, three journal clubs will be held, where one/two publications will be discussed (part I: 1 Journal club, part II: 2 Journal Clubs). For each journal club, students (alone or in groups of up to three students) have to write a summary and discussion of the publication. These written documents will be graded and count as 25% for the final grade.

Lecture notes
Scripts of all lectures will be available.

Literature

Molecular Bioengineering

Track Core Courses

During the Master program, a minimum of 12 CP must be obtained from track core courses.

Number  Title  Type  ECTS  Hours  Lecturers
376-1103-00L  Frontiers in Nanotechnology  W  4 credits  4V  V. Vogel, further lecturers

Abstract
Many disciplines are meeting at the nanoscale, from physics, chemistry to engineering, from the life sciences to medicine. The course will prepare students to communicate more effectively across disciplinary boundaries, and will provide them with deep insights into the various frontiers.

Objective
Building upon advanced technologies to create, visualize, analyze and manipulate nano-structures, as well as to probe their nano-chemistry, nano-mechanics and other properties within manmade and living systems, many exciting discoveries are currently made. They change the way we do science and result in so many new technologies.

Content
The goal of the course is to give Master and Graduate students from all interested departments an overview of what nanotechnology is all about, from analytical techniques to nanosystems, from physics to biology. Students will start to appreciate the extent to which scientific communities are meeting at the nanoscale. They will learn about the specific challenges and what is currently sizzling in the respective fields, and learn the vocabulary that is necessary to communicate effectively across departmental boundaries.

Each lecturer will first give an overview of the state-of-the-art in his/her field, and then describe the research highlights in his/her own research group. While preparing their Final Projects and discussing them in front of the class, the students will deepen their understanding of how to apply a range of new technologies to solve specific scientific problems and technical challenges. Exposure to the different frontiers will also improve their ability to conduct effective nanoscale research, recognize the broader significance of their work and to start collaborations.

Lecture notes
All the enrolled students will get access to a password protected website where they can find pdf files of the lecture notes, and typically 1-2 journal articles per lecture that cover selected topics.

376-1714-00L  Biocompatible Materials  W  4 credits  3G  K. Maniura, J. Müller, M. Zenobi-Wong

Abstract
Introduction to molecules used for biomaterials, molecular interactions between different materials and biological systems (molecules, cells, tissues). The concept of biocompatibility is discussed and important techniques from biomaterials research and development are introduced.

Objective
The class consists of three parts:
1. Introduction into molecular characteristics of molecules involved in the materials-to-biology interface. Molecular design of biomaterials.
2. The concept of biocompatibility.
3. Introduction into methodology used in biomaterials research and application.

Content
Introduction into native and polymeric biomaterials used for medical applications. The concepts of biocompatibility, biodegradation and the consequences of degradation products are discussed on the molecular level. Different classes of materials with respect to potential applications in tissue engineering and drug delivery are introduced. Strong focus lies on the molecular interactions between materials having very different bulk and/or surface chemistry with living cells, tissues and organs. In particular the interface between the materials surfaces and the eukaryotic cell surface and possible reactions of the cells with an implant material are elucidated. Techniques to design, produce and characterize materials in vitro as well as in vivo analysis of implanted and explanted materials are discussed.

In addition, a link between academic research and industrial entrepreneurship is established by external guest speakers.

Lecture notes
Handouts can be accessed online.
Scanning probe and diffraction techniques allow studying activated atomic processes during early stages of epitaxial growth. For quantitative description, rate equation analysis, mean-field nucleation and scaling theories are applied on systems ranging from simple metallic to complex organic materials. The knowledge is expanded to optical and electronic properties as well as to proteins and cells.

The atomic processes on surfaces are activated by the increase of the substrate temperature. They can be studied using scanning tunneling microscopy (STM) and atomic force microscopy (AFM). The combination with molecular beam epitaxy (MBE) allows determining the sizes of the critical nuclei and the other activated processes in a hierarchical fashion. The evolution of the surface morphology is characterized by the density and size distribution of the nanostructures that could be quantified by means of the rate equation analysis, the mean-field nucleation theory, as well as the scaling theory. The surface morphology is further characterized by defects and nanostructure's shapes, which are based on the strain relieving mechanisms and kinetic growth processes.

High-resolution electron diffraction is complementary to scanning probe techniques and provides exact mean values. Some phenomena are quantitatively described by the kinematic theory and perfectly understood by means of the Ewald construction. Other phenomena need to be described by the more complex dynamical theory. Electron diffraction is not only associated with elastic scattering but also inelastic excitation mechanisms that reflect the electronic structure of the surfaces studied. Low-energy electrons lead to phonon and high-energy electrons to plasmon excitations. Both effects are perfectly described by dipole and impact scattering.

Thin-films of rather complex organic materials are often quantitatively characterized by photons with a broad range of wavelengths from ultra-violet to infra-red light. Asymmetries and preferential orientations of the (anisotropic) molecules are verified using the optical dichroism and second harmonic generation measurements. These characterization techniques are vital for optimizing the preparation of medical implants and the determination of tissue's anisotropies within the human body.

Cell-surface interactions are related to the cell adhesion and the contractile cellular forces. Physical means have been developed to quantify these interactions. Other physical techniques are introduced in cell biology, namely to count and sort cells, to study cell proliferation and metabolism and to determine the relation between cell morphology and function.

3D scaffolds are important for tissue augmentation and engineering. Design, preparation methods, and characterization of these highly porous 3D microstructures are also presented.

Visiting clinical research in a leading university hospital will show the usefulness of the lecture series.

Abstract

The course deals with simple quantitative and graphical as well as more complex methods of biostatistics. Contents: Descriptive statistics, probability theory and design of experiments, testing hypotheses, confidence intervals, correlation, simple and multiple linear regression, classification and prediction, diagnostic tests, measurement of agreement.

Literature


(available online via ETH library)

Handouts provided during the classes and references therein.

402-0674-00L

**Physics in Medical Research: From Atoms to Cells**

**W** 6 credits 2V+1U

**B. K. R. Müller**

Objective

The lecture series is motivated by an overview covering the skin of the crystals, roughness analysis, contact angle measurements, protein absorption/activity and monocyte behaviour.

As the first step, real structures on clean surfaces including surface reconstructions and surface relaxations, defects in crystals are presented, before the preparation of clean metallic, semiconducting, oxidic and organic surfaces are introduced.

The atomic processes on surfaces are activated by the increase of the substrate temperature. They can be studied using scanning tunneling microscopy (STM) and atomic force microscopy (AFM). The combination with molecular beam epitaxy (MBE) allows determining the sizes of the critical nuclei and the other activated processes in a hierarchical fashion. The evolution of the surface morphology is characterized by the density and size distribution of the nanostructures that could be quantified by means of the rate equation analysis, the mean-field nucleation theory, as well as the scaling theory. The surface morphology is further characterized by defects and nanostructure's shapes, which are based on the strain relieving mechanisms and kinetic growth processes.

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Thin-films of rather complex organic materials are often quantitatively characterized by photons with a broad range of wavelengths from ultra-violet to infra-red light. Asymmetries and preferential orientations of the (anisotropic) molecules are verified using the optical dichroism and second harmonic generation measurements. These characterization techniques are vital for optimizing the preparation of medical implants and the determination of tissue's anisotropies within the human body.

Cell-surface interactions are related to the cell adhesion and the contractile cellular forces. Physical means have been developed to quantify these interactions. Other physical techniques are introduced in cell biology, namely to count and sort cells, to study cell proliferation and metabolism and to determine the relation between cell morphology and function.

3D scaffolds are important for tissue augmentation and engineering. Design, preparation methods, and characterization of these highly porous 3D microstructures are also presented.

Visiting clinical research in a leading university hospital will show the usefulness of the lecture series.

465-0953-00L

**Biostatistics**

**W** 4 credits 2V+1U

**B. Sick**

Objective

The goal of this course is to provide students with a wide general understanding cell biology. With this material as a foundation, students have enough of a cell biological basis to begin their specialization not only in cell biology but also in related fields such as biochemistry, microbiology, pharmacological sciences, molecular biology, and others.

Content

The focus is animal cells and the development of multicellular organisms with a clear emphasis on the molecular basis of cellular structures and phenomena. The topics include biological membranes, the cytoskeleton, protein sorting, energy metabolism, cell cycle and division, and phenomena. The topics include biological membranes, the cytoskeleton, protein sorting, energy metabolism, cell cycle and division, and other phenomena.

Lecture notes

The lectures are presented in the Powerpoint format. These are available on the WEB for ETH students over the netzh (Moodle). Some lectures are available on the ETH WEB site in a live format (Livestream) at the above WEB site.

Literature


Prerequisites / notice

Some of the lectures are given in the English language. Certain sections of the text-book must be studied by self-instruction.

551-0103-00L

**Fundamentals of Biology II: Cell Biology**

**W** 5 credits 5V

**E. Hafen, U. Kutay, J. Matos, G. Schertler, U. Suter, S. Werner**

Objective

The goal of this course is to provide students with a wide general understanding cell biology. With this material as a foundation, students have enough of a cell biological basis to begin their specialization not only in cell biology but also in related fields such as biochemistry, microbiology, pharmacological sciences, molecular biology, and others.

Content

The focus is animal cells and the development of multicellular organisms with a clear emphasis on the molecular basis of cellular structures and phenomena. The topics include biological membranes, the cytoskeleton, protein sorting, energy metabolism, cell cycle and division, and other phenomena.

Lecture notes

The lectures are presented in the Powerpoint format. These are available on the WEB for ETH students over the netzh (Moodle). Some lectures are available on the ETH WEB site in a live format (Livestream) at the above WEB site.

Literature


Prerequisites / notice

Some of the lectures are given in the English language. Certain sections of the text-book must be studied by self-instruction.

551-1295-00L

**Introduction to Bioinformatics: Concepts and Applications**

**W** 6 credits 4G

**W. Gruissem, K. Bärenfaller, A. Callisch, G. Capitani, J. Füttner, M. Robinson, A. Wagner**

Objective

Storage, handling and analysis of large datasets have become essential in biological research. The course will introduce students to a number of applications of bioinformatics in biology. Freely accessible software tools and databases will be explained and explored in theory and praxis.
Introduction to Bioinformatics I: Concepts and Applications (formerly Bioinformatics I) will provide students with the theoretical background of approaches to store and retrieve information from large databases. Concepts will be developed how DNA sequence information can be used to understand phylogenetic relationships, how RNA sequence relates to structure, and how protein sequence information can be used for genome annotation and to predict protein folding and structure. Students will be introduced to quantitative methods for measuring gene expression and how this information can be used to model gene networks. Methods will be discussed to construct protein interaction maps and how this information can be used to simulate dynamic molecular networks.

In addition to the theoretical background, the students will develop hands-on experiences with the bioinformatics methods through guided exercises. The course provides students from different backgrounds with basic training in bioinformatics approaches that have impact on biological, chemical and physics experimentation. Bioinformatics approaches draw significant expertise from mathematics, statistics and computational science.

Although "Introduction to Bioinformatics I" will focus on theory and praxis of bioinformatics approaches, the course provides an important foundation for the course "Introduction to Bioinformatics II: Fundamentals of computer science, modeling and algorithms* that will be offered in the following semester.

### Content

Bioinformatics I will cover the following topics:

- From genes to databases and information
- BLAST searches
- Prediction of gene function and regulation
- RNA structure prediction
- Gene expression analysis using microarrays
- Protein sequence and structure databases
- WWW for bioinformatics
- Protein sequence comparisons
- Proteomics and de novo protein sequencing
- Protein structure prediction
- Cellular and protein interaction networks
- Molecular dynamics simulation

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<tr>
<th>Number</th>
<th>Title</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>636-0003-00L</td>
<td>Biological Engineering and Biotechnology</td>
<td>W</td>
<td>6</td>
<td>3V</td>
<td>M. Fussenegger</td>
</tr>
</tbody>
</table>

#### Objective

1. Insight Into The Mammalian Cell Cycle. Cycling, The Balance Between Proliferation and Cancer - Implications For Biopharmaceutical Manufacturing.

#### Lecture Notes

Handsout during the course.

### Recommended Elective Courses

These courses are particularly recommended for the Molecular Bioengineering track. Please consult your track advisor if you wish to select other subjects.

<table>
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<tr>
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<tr>
<td>151-0604-00L</td>
<td>Microrobotics</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>B. Nelson</td>
</tr>
</tbody>
</table>

#### Abstract

Microrobotics is an interdisciplinary field that combines aspects of robotics, micro and nanotechnology, biomedical engineering, and materials science. The aim of this course is to expose students to the fundamentals of this emerging field. Throughout the course students are expected to submit assignments. The course concludes with an end-of-semester examination.

#### Objective

The objective of this course is to expose students to the fundamental aspects of the emerging field of microrobotics. This includes a focus on physical laws that predominate at the microscale, technologies for fabricating small devices, bio-inspired design, and applications of the field.

#### Content

Main topics of the course include:
- Scaling laws at micro/nano scales
- Electrostatics
- Electromagnetism
- Low Reynolds number flows
- Observation tools
- Materials and fabrication methods
- Applications of biomedical microrobots

Lecture notes

The powerpoint slides presented in the lectures will be made available in hardcopy and as pdf files. Several readings will also be made available electronically.

Prerequisites / notice

The lecture will be taught in English.

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<tr>
<td>227-0385-10L</td>
<td>Biomedical Imaging</td>
<td>W</td>
<td>6</td>
<td>5G</td>
<td>S. Kozerke, K. P. Prüssmann, M. Rudin</td>
</tr>
</tbody>
</table>

#### Abstract

Introduction and analysis of medical imaging technology including X-ray procedures, computed tomography, nuclear imaging techniques using single photon and positron emission tomography, magnetic resonance imaging, ultrasound and Doppler imaging techniques. The mathematical framework is developed to describe image encoding/decoding, point-spread function/modular transfer function, signal-to-noise ratio, contrast behavior for each of the methods. Matlab exercises are used to implement and study basic concepts.

#### Objective

To understand the physical and technical principles underlying X-ray imaging, computed tomography, single photon and positron emission tomography, magnetic resonance imaging, ultrasound and Doppler imaging techniques. The mathematical framework is developed to describe image encoding/decoding, point-spread function/modular transfer function, signal-to-noise ratio, contrast behavior for each of the methods.
### Content
- X-ray imaging
- Computed tomography
- Single photon emission tomography
- Positron emission tomography
- Magnetic resonance imaging
- Ultrasound/Doppler imaging

### Lecture notes
Lecture notes and handouts

### Literature
Webb A, Smith N.B. Introduction to Medical Imaging: Physics, Engineering and Clinical Applications; Cambridge University Press 2011
Analysis, Linear Algebra, Physics, Basics of Signal Theory, Basic skills in Matlab programming

### Prerequisites / notice
Analysis, Linear Algebra, Physics, Basics of Signal Theory, Basic skills in Matlab programming
Analysis, Linear Algebra, Physics, Basics of Signal Theory, Basic skills in Matlab programming

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<tr>
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<th>Instructor(s)</th>
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<tr>
<td>227-0386-00L</td>
<td>Biomedical Engineering</td>
<td>W</td>
<td>4 credits</td>
<td>J. Vörös, S. J. Ferguson, S. Kozerke, U. Moser, M. Rudin, M. P. Wolf, M. Zenobi-Wong</td>
</tr>
<tr>
<td>227-0393-10L</td>
<td>Bioelectronics and Biosensors</td>
<td>W</td>
<td>6 credits</td>
<td>J. Vörös, M. F. Yanik, T. Zambelli</td>
</tr>
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</table>

### Abstract
Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The focus is on learning the concepts that govern common medical instruments and the most important organs from an engineering point of view. In addition, the most recent achievements and trends of the field of biomedical engineering are also outlined.

### Objective
Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The course provides an overview of the various topics of the different tracks of the biomedical engineering master course and helps orienting the students in selecting their specialized classes and project locations.

### Content

### Lecture notes
Introduction to Biomedical Engineering by Enderle, Banchard, and Bronzino
AND
https://www1.ethz.ch/lbb/Education/BME

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### Abstract
The course introduces the concepts of bioelectricity and biosensing. The sources and use of electrical fields and currents in the context of biological systems and problems are discussed. The fundamental challenges of measuring biological signals are introduced. The most important biosensing techniques and their physical concepts are introduced in a quantitative fashion.

### Objective
During this course the students will:
- learn the basic concepts in biosensing and bioelectronics
- be able to solve typical problems in biosensing and bioelectronics
- learn about the remaining challenges in this field

### Content

#### L1. Bioelectronics history, its applications and overview of the field
- Volta and Galvani dispute
- BMI, pacemaker, cochlear implant, retinal implant, limb replacement devices
- Fundamentals of biosensing
- Glucometer and ELISA

#### L2. Fundamentals of quantum and classical noise in measuring biological signals

#### L3. Biomeasurement techniques with photons

#### L4. Acoustics sensors
- Differential equation for quartz crystal resonance
- Acoustic sensors and their applications

#### L5. Engineering principles of optical probes for measuring and manipulating molecular and cellular processes

#### L6. Optical biosensors
- Differential equation for optical waveguides
- Optical sensors and their applications
- Plasmonic sensing

#### L7. Basic notions of molecular adsorption and electron transfer
- Quantum mechanics: Schrödinger equation energy levels from H atom to crystals, energy bands
- Electron transfer: Marcus theory, Gerischer theory

#### L8. Potentiometric sensors
- Fundamentals of the electrochemical cell at equilibrium (Nernst equation)
- Principles of operation of ion-selective electrodes

#### L9. Amperometric sensors and bioelectric potentials
- Fundamentals of the electrochemical cell with an applied overpotential to generate a faraday current
- Principles of operation of amperometric sensors
- Ion flow through a membrane (Fick equation, Nernst equation, Donnan equilibrium, Goldman equation)

#### L10. Channels, amplification, signal gating, and patch clamp Y4

#### L11. Action potentials and impulse propagation

#### L12. Functional electric stimulation and recording
- MEA and CMOS based recording
- Applying potential in liquid - simulation of fields and relevance to electric stimulation

#### L13. Neural networks memory and learning

### Literature
Plonsey and Barr, Bioelectricity: A Quantitative Approach (Third edition)
After being introduced to the physical/chemical principles and importance of surfaces and interfaces, the student is introduced to the most

Synchrotron-based X-ray micro- and nano-tomography is today a powerful technique for non-destructive, high-resolution investigations of a

The lecture introduces the physical and technical know-how of X-ray tomographic microscopy. Several X-ray imaging techniques

Micro and Nano-Tomography of Biological Tissues

The course aims to introduce the basic concepts of biomineralization and the underlying principles, such as supersaturation, nucleation and
growth of minerals, the interaction of biomolecules with mineral surfaces, and cell biology of inorganic materials creation. An important part
of this class is the independent study and the presentation of original literature from the field.

Cross-disciplinary collaboration between engineers and medical doctors is indispensable for innovation in health care. This course will
bring together engineering students from ETH Zurich and medical students from the University of Zurich to experience the rewards and
challenges of such interdisciplinary work in a project based learning environment.

The main goal of this course is to demonstrate the differences in communication between the fields of medicine and engineering. Since
different differences become the most evident during actual collaborative work, the course is based on a current project in physiology research
that combines medicine and engineering. For the engineering students, the specific aims of the course are to:

- Acquire a working understanding of the anatomy and physiology of the investigated system;
- Identify the engineering challenges in the project and communicate them to the medical students;
- Develop and implement, together with the medical students, solution strategies for the identified challenges;
- Present the found solutions to a cross-disciplinary audience.

After a general introduction to interdisciplinary communication and detailed background on the collaborative project, the engineering
students will receive tailored lectures on the anatomy and physiology of the relevant system. They will then team up with medical students
who have received a basic introduction to engineering methodology to collaborate on said project. In the process, they will be coached both
by lecturers from ETH Zurich and the University of Zurich, receiving lectures customized to the project. The course will end with each team
presenting their solution to a cross-disciplinary audience.

Surfaces, Interfaces and their Applications I

The course finally provides the necessary background to understand the quantitative evaluation of tomographic data, from basic image
analysis to complex morphometrical computations and 3D visualization, keeping the focus on biomedical applications.

The course provides the physical and engineering basics to understand how imaging beamlines at synchrotron facilities work, looks into the recently
developed phase contrast methods, and explores the first applications of X-ray nano-tomographic experiments.

Cross-disciplinary Research and Development in Medicine and Engineering ■

A maximum of 12 medical degree students and 12
(biomedical) engineering degree students can be
admitted, their number should be equal.

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Surfaces, Interfaces and their Applications I

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Content

Biominingeralization is a multidisciplinary field. Topics dealing with biology, molecular and cell biology, solid state physics, mineralogy, crystallography, organic and physical chemistry, biochemistry, dentistry, oceanography, geology, etc. are addressed. The course covers definition and general concepts of biominingeralization (BM)/ types of biominerals and their function / crystal nucleation and growth / biological induction of BM / control of crystal morphology, habit, shape and orientation by organisms / strategies of compartmentalization / the interface between biomolecules (peptides, polycaccharides) and the mineral phase / modern experimental methods for studying BM phenomena / inter-, intra-, extra- and epicional BM / organic templates and matrices for BM / structure of bone, teeth (vertebrates and invertebrates) and mollusk shells / calcification / silification in diatoms, radiolarians and plants / calcium and iron storage / impact of BM on lithosphere and atmosphere evolution / taxonomy of organisms.

1. Introduction and overview
2. Biominerals and their functions
3. Chemical control of biominingeralization
4. Control of morphology: Organic templates and additives
5. Modern methods of investigation of BM
6. BM in matrices: bone and nacre
7. Vertebrate teeth
8. Invertebrate teeth
9. BM within vesicles: calcite of coccoliths
10. Silica
11. Iron storage and mineralization.

Lecture notes
Script with more than 600 pages with many illustrations will be distributed free of charge.

Literature

3) P. M. Dove, J. J. DeYoreo, S. Weiner (Eds.) Biominingeralization, Reviews in Mineralogy & Geochemistry Vol. 54, 2003

Prerequisites / notice
Each attendee is required to present a publication from the field. The selection of key papers is provided by the lecturer.

No special requirements are needed for attending. Basic knowledge in chemistry and cell biology is expected.

376-1622-00L Practical Methods in Tissue Engineering W 5 credits 4P  K. Würtz-Kozak, M. Zenobi-Wong

Abstract
The goal of this course is to teach MSc students the necessary skills for doing research in the fields of tissue engineering and regenerative medicine.

Objective
Practical exercises and demonstrations on topics including sterile cell culture, light microscopy and histology, protein and gene expression, presentations on advanced synthetic biology topics (e.g., genetic circuit design, adaptation of systems dynamics, analytical concepts, large-scale de novo DNA synthesis), project selection, modeling of selected biological system, its thorough analysis, and the subsequent experimental implementation of the system and the related problems. Results are presented at an international student competition at the MIT (Cambridge).

Further references will be provided in the course.

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Prerequisites

The final presentation of the project is typically at the MIT (Cambridge, US). Other competing schools include regularly Imperial College, Cambridge University, Harvard University, UC Berkeley, Princeton University, CalTech, etc.

This project takes place between end of Spring Semester and beginning of Autumn Semester. Registration in April.

Please note that the number of ECTS credits and the actual work load are disconnected.

### Other Elective Courses

*These courses may be suitable for the Molecular Bioengineering track. Please consult your track advisor.*

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-0313-00L</td>
<td>Microbiology (Part I)</td>
<td>W</td>
<td>3 credits</td>
<td>2V</td>
<td>W.D. Hardt, L. Ebert, H.M. Fischer, J. Piel, M. Pilhofer</td>
</tr>
<tr>
<td>Abstract</td>
<td>Advanced lecture class providing a broad overview on bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.</td>
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<tr>
<td>Objective</td>
<td>This concept class will be based on common concepts and introduce to the enormous diversity among bacteria and archaea. It will cover the current research on bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.</td>
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<tr>
<td>Content</td>
<td>Advanced class covering the state of the research in bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.</td>
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<tr>
<td>Lecture notes</td>
<td>Updated handouts will be provided during the class.</td>
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<tr>
<td>Literature</td>
<td>Current literature references will be provided during the lectures.</td>
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<tr>
<td>Prerequisites</td>
<td>English</td>
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<tr>
<td>notice</td>
<td>The lecture &quot;Grundlagen der Biologie II: Mikrobiologie&quot; is the basis for this advanced lecture.</td>
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<thead>
<tr>
<th>Number</th>
<th>Microbial Biochemistry</th>
<th>W</th>
<th>4 credits</th>
<th>2V</th>
<th>J. Vorholt-Zambelli, J. Piel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>The lecture course aims at providing an advanced understanding of the physiology and metabolism of microorganisms. Emphasis is on processes that are specific to bacteria and archaea and that contribute to the widespread occurrence of prokaryotes. Applied aspects of microbial biochemistry will be pointed out as well as research fields of current scientific interest.</td>
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<tr>
<td>Objective</td>
<td>Important biochemical processes specific to bacteria and archaea will be presented that contribute to the widespread occurrence of prokaryotes. Applied aspects of microbial biochemistry will be pointed out as well as research fields of current scientific interest.</td>
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<tr>
<td>Content</td>
<td>List of topics: Eating sugars and letting them in Challenging: Aromatics, xenobiotics, and oil Complex: (Ligno-)Cellulose and in demand for bioenergy Living on a diet and the anaplerotic provocation Of climate relevance: The microbial C1 cycle What are AMO and Anammox? 20 amino acids: the making of Extending the genetic code The 21st and 22nd amino acid Some exotic biochemistry: nucleotides, cofactors Ancient biochemistry? Iron-sulfur clusters, polymers Secondary metabolites: playground of evolution</td>
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<tr>
<td>Lecture notes</td>
<td>A script will be provided during the course.</td>
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### Biology Courses

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0399-10L</td>
<td>Physiology and Anatomy for Biomedical Engineers I</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>H. Niemann</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course offers an introduction into the structure and function of the human body, and how these are interlinked with one another. Focusing on physiology, the visualization of anatomy is supported by 3D-animation, Computed Tomography and Magnetic Resonance imaging.</td>
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<tr>
<td>Objective</td>
<td>To understand basic principles and structure of the human body in consideration of the clinical relevance and the medical terminology used in medical work and research.</td>
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<tr>
<td>Content</td>
<td>- The Human Body: nomenclature, orientations, tissues - Musculoskeletal system, Muscle contraction - Blood vessels, Heart, Circulation - Blood, Immune system - Respiratory system - Acid-Base-Homeostasis</td>
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<tr>
<td>Lecture notes</td>
<td>Lecture notes and handouts.</td>
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</table>

<table>
<thead>
<tr>
<th>227-0945-00L</th>
<th>Cell and Molecular Biology for Engineers I</th>
<th>W</th>
<th>3 credits</th>
<th>3G</th>
<th>C. Frei</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>The course gives an introduction into cellular and molecular biology, specifically for students with a background in engineering. The focus will be on the basic organization of eukaryotic cells, molecular mechanisms and cellular functions. Textbook knowledge will be combined with results from recent research and technological innovations in biology.</td>
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<tr>
<td>Objective</td>
<td>After completing this course, engineering students will be able to apply their previous training in the quantitative and physical sciences to modern biology. Students will also learn the principles how biological models are established, and how these models can be tested.</td>
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<tr>
<td>Content</td>
<td>Lectures will include the following topics: DNA, chromosomes, RNA, protein, genetics, gene expression, membrane structure and function, vesicular traffic, cellular communication, energy conversion, cytokskeleton, cell cycle, cellular growth, apoptosis, autophagy, cancer, development and stem cells. In addition, three journal clubs will be held, where one/two publications will be discussed (part I: 1 Journal club, part II: 2 Journal Clubs). For each journal club, students (alone or in groups of up to three students) have to write a summary and discussion of the publication. These written documents will be graded and count as 25% for the final grade.</td>
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<tr>
<td>Lecture notes</td>
<td>Scripts of all lectures will be available.</td>
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<table>
<thead>
<tr>
<th>227-0949-00L</th>
<th>Biological Methods for Engineers (Basic Lab)</th>
<th>W</th>
<th>2 credits</th>
<th>4P</th>
<th>C. Frei</th>
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<tbody>
<tr>
<td>Number</td>
<td>Limited number of participants.</td>
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Data: 06.03.2019 12:57 Autumn Semester 2016 Page 314 of 1571
The goal of this laboratory course is to give students practical exposure to basic techniques of cell and molecular biology.

Objective

The goal of this laboratory course is to give students practical exposure to basic techniques of cell and molecular biology.

Content

Enrollment is limited and students from the Master's programme in Biomedical Engineering (BME) have priority.

<table>
<thead>
<tr>
<th>Semester Project</th>
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<tbody>
<tr>
<td>Number</td>
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<tr>
<td>227-1101-00L</td>
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<tr>
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<td>Objective</td>
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<tr>
<td>Literature</td>
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<tr>
<td>Prerequisites / notice</td>
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<table>
<thead>
<tr>
<th>Master's Thesis</th>
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<tbody>
<tr>
<td>Number</td>
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<td>227-1101-00L</td>
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<td>Objective</td>
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<tr>
<td>Literature</td>
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<td>Prerequisites / notice</td>
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<tr>
<th>GESS Science in Perspective</th>
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<tbody>
<tr>
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<td>227-1700-00L</td>
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<tr>
<td>Abstract</td>
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<tr>
<td>Objective</td>
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Data: 06.03.2019 12:57 Autumn Semester 2016 Page 315 of 1571
Generally Accessible Seminars and Colloquia

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>227-0970-00L</td>
<td>Research Topics in Biomedical Engineering</td>
<td>Z</td>
<td>0 credits</td>
<td>2K</td>
<td>M. Rudin, S. Kozerke, K. P. Prüssmann, M. Stampanoni, K. Stephan, J. Vörös</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
<td></td>
<td></td>
<td>Current topics in Biomedical Engineering presented by speakers from academia and industry.</td>
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<tr>
<td></td>
<td>Objective</td>
<td></td>
<td></td>
<td></td>
<td>Getting insight into actual areas and problems of Biomedical Engineering an Health Care.</td>
</tr>
<tr>
<td>227-0980-00L</td>
<td>Seminar on Biomedical Magnetic Resonance</td>
<td>Z</td>
<td>0 credits</td>
<td>2K</td>
<td>K. P. Prüssmann, S. Kozerke, M. Rudin</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
<td></td>
<td></td>
<td>Actual developments and problems of magnetic resonance imaging (MRI)</td>
</tr>
<tr>
<td></td>
<td>Objective</td>
<td></td>
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<td></td>
<td>Getting insight to advanced topics in Magnetic Resonance Imaging</td>
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Biomedical Engineering Master - Key for Type

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

<table>
<thead>
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<th>Key for Hours</th>
<th>Description</th>
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<tbody>
<tr>
<td>V</td>
<td>lecture</td>
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<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
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ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Biotechnology Master

▶ Majors

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>636-0001-00L</td>
<td>Separations in Biotechnology and Bioprocess Economy</td>
<td>W+</td>
<td>6 credits</td>
<td>3G</td>
<td>S. Panke</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td></td>
<td>Separations play an integral part of any biotechnological process. This course aims at enabling students specifically with a chemistry/biology background to select &amp; roughly design suitable separation processes for typical biotechnological products such as monoclonal antibodies, and fine chemicals and at providing a basic set of purification operations &amp; judge on process economy.</td>
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<td></td>
<td><strong>Objective</strong></td>
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<td></td>
<td>Students should be able to select for a given biotechnological product a suitable set of purification operations and judge on process economy.</td>
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<td><strong>Content</strong></td>
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<tr>
<td></td>
<td>Introduction membrane operations adsorption and chromatography crystallization overall process economics</td>
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<td><strong>Lecture notes</strong></td>
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<td>Handouts during course</td>
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<tr>
<td>636-0003-00L</td>
<td>Biological Engineering and Biotechnology</td>
<td>W+</td>
<td>6 credits</td>
<td>3V</td>
<td>M. Fussenegger</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td></td>
<td>Biological Engineering and Biotechnology will cover the latest biotechnological advances as well as their industrial implementation to engineer mammalian cells for use in human therapy. This lecture will provide forefront insights into key scientific aspects and the main points in industrial decision-making to bring a therapeutic from target to market.</td>
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<td><strong>Objective</strong></td>
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<tr>
<td></td>
<td>1. Insight Into The Mammalian Cell Cycle. Cycling, The Balance Between Proliferation and Cancer - Implications For Biopharmaceutical Manufacturing.</td>
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<td>2. The Licence To Kill. Apoptosis Regulatory Networks - Engineering of Survival Pathways To Increase Robustness of Production Cell Lines.</td>
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<td>5. From Target To Market. An Antibody's Journey From Cell Culture to The Clinics.</td>
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<td>6. Biology and Malignant Applications. Do Life Sciences Enable the Development of Biological Weapons?</td>
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<td>7. Functional Food. Enjoy your Meal!</td>
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<td><strong>Lecture notes</strong></td>
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<td>Handouts during the course.</td>
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<tr>
<td>636-0005-00L</td>
<td>Systems Biology</td>
<td>W+</td>
<td>6 credits</td>
<td>3G</td>
<td>R. Paro, N. Beerenwinkel</td>
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<td></td>
<td><strong>Abstract</strong></td>
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<td>This lecture course is an introduction to systems biology. It explores how complex biological networks are experimentally studied and how the resulting models is mathematically evaluated in order to derive predictive models. The biology of selected cellular processes, ranging from protein interaction networks to gene controlling systems and signaling cascades will be discussed in detail.</td>
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<td><strong>Objective</strong></td>
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<td>The goal of this course is to learn how a detailed quantitative description of complex biological processes can be employed for a better understanding of molecular interactions, the power and efficiency of regulatory networks, and the evolution of biological complexity. Students will learn how to identify techniques producing quantitative data and how to develop mathematical models and efficient statistical inference algorithms to recognize patterns, molecular interrelationships and systems behavior.</td>
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<td></td>
<td><strong>Content</strong></td>
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<td>Sessions will alternate between a thorough introduction into the basic biology of defined cellular processes and a corresponding mathematical and statistical analysis of the experimental data. Selected complex biological systems and the respective experimental tools for a quantitative analysis will be presented. Examples include the identification of protein interaction networks required for specific physiological processes in yeast based on graph theoretic methods, including the identification of network motifs and the global statistical analysis of graph properties (power laws); the comparative analysis of gene expressions data from cancer and normal cells involving data normalization techniques, multiple testing procedures, clustering algorithms, Bayesian networks, and linear dynamical systems; the definition of hierarchies of kinase signaling cascades employing Bayesian networks and their causal interpretation and nested effects models for the analysis of perturbed systems; analysis of deep sequencing data derived from studies of chromatin control and gene expression.</td>
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<td><strong>Topics</strong></td>
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<td></td>
<td>- Control of Gene Expression: DNA binding proteins, gene activation in chromatin, postranscriptional control</td>
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<td>- Genetic Switches: combinatorial gene control, transcriptional circuits, transcriptional noise/robustness</td>
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<td></td>
<td>- Analysis of Gene Expression Data: normalization, differential gene expression, multiple testing, PCA, clustering</td>
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<td>- Large-scale Genomic Profiling: mapping genomes/epigenomes, high throughput sequencing technologies</td>
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<td></td>
<td>- Analysis of Deep Sequencing Data: quality control, genome assembly, read mapping, RNA-seq, ChIP-seq</td>
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<td></td>
<td>- Biological Networks: signaling networks and protein-protein interaction networks</td>
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<td>- Network Biology: basic graph theory, motifs, dense subgraphs, power laws</td>
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<td></td>
<td>- Boolean Network Dynamics: Boolean algebra, Boolean networks, random Boolean networks, yeast cell cycle</td>
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<td>- Cellular Communication: signal transduction cascades, regulatory mechanisms.</td>
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<td>- Probabilistic Graphical Models: probabilities, statistical inference, Bayesian networks, nested effects models</td>
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<td></td>
<td>- Evolutionary Mechanisms: RNA world, origin of life, ribozyme selection, genome evolution, SNP mapping, evolution &amp; development</td>
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<td></td>
<td>- Genome-wide association studies</td>
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<tr>
<td></td>
<td><strong>Lecture notes</strong></td>
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<td></td>
<td>The Powerpoint presentations of the lectures as well as other course material relevant for an active participation will be made available online.</td>
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<tr>
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<td><strong>Literature</strong></td>
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</table>

| 636-0011-00L | Introduction to Biological Computers                              | W+  | 6 credits | 3G     | Y. Benenson |
|              | **Prerequisites:** Synthetic Biology I (636-0002-00 L), Basic knowledge of molecular biology is assumed. |      |      |       |           |

Data: 06.03.2019 12:57   Autumn Semester 2016   Page 317 of 1571
Abstract
Biological computers are man-made biological networks that interrogate and control biological hosts-cells and organisms-in which they operate. Their key features, inspired by computer science, are programmability, modularity and versatility. The course will show how to rationally design, implement and test biological computers using molecular engineering, DNA nanothechnology and synthetic biology.

Objective
The course has the following objectives:

* Familiarize students with parallels between theories in computer science and engineering and information-processing in live cells and organisms

* Introduce basic theories of computation

* Introduce approaches to creating novel biological computing systems in non-living environment and in living cells including bacteria, yeast and mammalian/human cells.

The covered approaches will include
- Nucleic acids engineering
- DNA and RNA nanotechnology
- Synthetic biology and gene circuit engineering
- High-throughput genome engineering and gene circuit assembly

* Equip the students with computer-aided design (CAD) tools for biocomputing circuit engineering. A number of tutorials will introduce MATLAB SimBiology toolbox for circuit design and simulations

* Foster creativity, research and communication skills through semester-long "Design challenge" assignment in the broad field of biological computing and biological circuit engineering.
Content

Lecture 1. Introduction: what is molecular computation (part I)?
* What is computing in general?
* What is computing in the biological context (examples from development, chemotaxis and gene regulation)
* The difference between natural computing and engineered biocomputing systems

Lecture 2: What is molecular computation (part II) + State machines

1st hour
* Detailed definition of an engineered biocomputing system
* Basics of characterization
* Design challenge presentation

2nd hour
* Theories of computation: state machines (finite automata and Turing machines)

Lecture 3: Additional models of computation
* Logic circuits
* Analog circuits
* RAM machines

Basic approaches to computer science notions relevant to molecular computation. (i) State machines; (ii) Boolean networks; (iii) analog computing; (iv) distributed computing. Design Challenge presentation.

Lecture 4. Classical DNA computing
* Adleman experiment
* Maximal clique problem
* SAT problem

Lecture 5: Molecular State machines through self-assembly
* Tiling implementation of state machine
* DNA-based tiling system
* DNA/RNA origami as a spin-off of self-assembling state machines

Lecture 6: Molecular State machines that use DNA-encoded tapes
* Early theoretical work
* Tape extension system
* DNA and enzyme-based finite automata for diagnostic applications

Lecture 7: Introduction to cell-based logic and analog circuits
* Computing with (bio)chemical reaction networks
* Turing computation with ultrasensitivity and cooperativity
* Specific examples

Lecture 8: Transcriptional circuits I
* Introducing transcription-based circuits
* General features and considerations
* Guidelines for large circuit construction

Lecture 9: Transcriptional circuits II
* Large-scale distributed logic circuits in bacteria
* Toward large-scale circuits in mammalian cells

Lecture 10: RNA circuits I
* General principles of RNA-centered circuit design
* Riboswitches and sRNA regulation in bacteria
* Riboswitches in yeast and mammalian cells
* General approach to RNAi-based computing

Lecture 11: RNA circuits II
* RNAi logic circuits
* RNAi-based cell type classifiers
* Hybrid transcriptional/posttranscriptional approaches

Lecture 12: In vitro DNA-based logic circuits
* DNAzyme circuits playing tic-tac-toe against human opponents
* DNA brain

Lecture 13: Advanced topics
* Engineered cellular memory
* Counting and sequential logic
* The role of evolution
* Fail-safe design principles
Introduction to semiconductors, microelectronics, microtechnology, and micro electro mechanical systems (MEMS)

As a way of general introduction, the following two review papers could be useful:


Benenson, Y. Biocomputers: from test tubes to live cells. Molecular Biosystems 2009, 5:675:685

Compulsory attendance of (at least) 12 of 14 lectures. In addition, it is recommended that students take 636-0002-00 Synthetic Biology I prior to attending this course. Basic knowledge of molecular biology is assumed.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Type</th>
<th>Prerequisites / notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>636-0013-00L</td>
<td>Stem Cells: Biology and Therapeutic Manipulation</td>
<td>6</td>
<td>W+</td>
<td>3G</td>
</tr>
<tr>
<td>636-0018-00L</td>
<td>Data Mining I</td>
<td>6</td>
<td>W</td>
<td>3G</td>
</tr>
<tr>
<td>636-0020-00L</td>
<td>Microtechnology and Microelectronics</td>
<td>6</td>
<td>W</td>
<td>3G</td>
</tr>
</tbody>
</table>

**636-0013-00L Stem Cells: Biology and Therapeutic Manipulation**

**Abstract**

Stem cells are central in tissue regeneration and repair, and hold great potential for therapy. We will discuss the role of stem cells in health and disease, and possibilities to manipulate their behavior for therapeutic application. Basic molecular and cell biology, engineering and novel technologies relevant for stem cell research and therapy will be discussed.

**Objective**

We will use different diseases to discuss how to potentially model, diagnose or heal them by stem cell based therapies. This will be used as a guiding framework to discuss relevant concepts and technologies in cell and molecular biology, engineering, imaging, bioinformatics, tissue engineering, that are required to manipulate stem cells for therapeutic application.

Topics will include:

- Embryonic and adult stem cells and their niches
- Induced stem cells by directed reprogramming
- Relevant basic cell biology and developmental biology
- Relevant molecular biology
- Cell culture systems
- Cell fates and their molecular control by transcription factors and signalling pathways
- Cell reprogramming
- Disease modelling
- Tissue engineering
- Bioimaging, Bioinformatics
- Single cell technologies

**636-0018-00L Data Mining I**

**Abstract**

Data Mining, the search for statistical dependencies in large databases, is of utmost important in modern society, in particular in biological and medical research. This course provides an introduction to the key problems, concepts, and algorithms in data mining, and the applications of data mining in computational biology.

**Objective**

The goal of this course is that the participants gain an understanding of data mining problems and algorithms to solve these problems, in particular in biological and medical applications.

**Content**

The goal of the field of data mining is to find patterns and statistical dependencies in large databases, to gain an understanding of the underlying system from which the data were obtained. In computational biology, data mining contributes to the analysis of vast experimental data generated by high-throughput technologies, and thereby enables the generation of new hypotheses.

In this course, we will present the algorithmic foundations of data mining and its applications in computational biology. The course will feature an introduction to popular data mining problems and algorithms, reaching from classification via clustering to feature selection. This course is intended for both students who are interested in applying data mining algorithms and students who would like to gain an understanding of the key algorithmic concepts in data mining.

**Tentative list of topics:**

1. Distance functions
2. Classification
3. Clustering
4. Feature Selection

**636-0020-00L Microtechnology and Microelectronics**

**Abstract**

Students are introduced to the basics of semiconductors, microelectronics, microtechnology, and silicon process technology. They will get to know the fabrication of silicon-based microdevices and -systems by a sequence of defined batch processing steps as well as dedicated microfabrication processes.

**Objective**

Students are introduced to the basics of semiconductors, microelectronics, microtechnology, and silicon process technology. They will get to know the different fabrication methods for various microdevices and systems.

**Content**

Introduction to semiconductors, microelectronics, microtechnology, and micro electro mechanical systems (MEMS)

- Fundamentals of semiconductors
- Basics of microelectronics: transistor and diode.
- Silicon processing and fabrication steps
- Silicon crystal structure and manufacturing
- Thermal oxidation
- Doping via diffusion and ion implantation
- Photolithography
- Thin film deposition: dielectrics and metals
- Wet etching & bulk micromachining
- Dry etching & surface micromachining
- Microelectronics processing and fabrication sequence
- Packaging

**Lecture notes**

Handouts in English

**Prerequisites / notice**

Basic understanding of mathematics, as taught in basic mathematics courses at the Bachelor's level.
### Electives

**The MSc Electives will be held in Zürich or Basel**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0927-00L</td>
<td>Rate-Controlled Separations in Fine Chemistry</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>M. Mazzotti</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>The students are supposed to obtain detailed insight into the fundamentals of separation processes that are frequently applied in modern life science processes in particular, fine chemistry and biotechnology.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>The students are supposed to obtain detailed insight into the fundamentals of separation processes that are frequently applied in modern life science processes in particular, fine chemistry and biotechnology.</td>
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<tr>
<td><strong>Content</strong></td>
<td>The class covers separation techniques that are central in the purification and downstream processing of chemicals and bio-pharmaceuticals. Examples from both areas illustrate the utility of the methods: 1) Liquid-liquid extraction; 2) Adsorption and chromatography; 3) Membrane processes; 4) Crystallization and precipitation.</td>
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<tr>
<td><strong>Lecture notes</strong></td>
<td>Handouts during the class</td>
<td></td>
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<tr>
<td><strong>Literature</strong></td>
<td>Recommendations for text books will be covered in the class</td>
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<tr>
<td><strong>Prerequisites / notice</strong></td>
<td>Requirements: Thermal separation Processes I (151-0926-00) and Modelling and mathematical methods in process and chemical engineering (151-0940-00)</td>
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<tr>
<td>363-0389-00L</td>
<td>Technology and Innovation Management</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>S. Brusoni</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>This course focuses on the analysis of innovation as a pervasive process that cut across organizational and functional boundaries. It looks at the sources of innovation, at the tools and techniques that organizations deploy to routinely innovate, and the strategic implications of technical change.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>This course intends to enable all students to:</td>
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<td>- understand the core concepts necessary to analyze how innovation happens</td>
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<td></td>
<td>- master the most common methods and tools organizations deploy to innovate</td>
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<tr>
<td><strong>Content</strong></td>
<td>This course looks at technology and innovation management as a process. Continuously, organizations are faced with a fundamental decision: they have to allocate resources between well-known tasks that reliably generate positive results; or explore new ways of doing things, new technologies, products and services. The latter is a high risk choice. Its rewards can be high, but the chances of success are small. How do firms organize to take these decisions? What kind of management skills are necessary to take them? What kind of tools and methods are deployed to sustain managerial decision-making in highly volatile environments? These are the central questions on which this course focuses, relying on a combination of lectures, case-based discussion, guest speakers, simulations and group work.</td>
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<tr>
<td><strong>Lecture notes</strong></td>
<td>Slides will be available on the TIMGROUP website.</td>
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<tr>
<td><strong>Literature</strong></td>
<td>Readings will be available on the TIMGROUP website.</td>
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<tr>
<td><strong>Prerequisites / notice</strong></td>
<td>No specific background in economics or management is required.</td>
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<tr>
<td>376-1714-00L</td>
<td>Biocompatible Materials</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>K. Maniera, J. Möller, M. Zenobi-Wong</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>Introduction to molecules used for biomaterials, molecular interactions between different materials and biological systems (molecules, cells, tissues). The concept of biocompatibility is discussed and important techniques from biomaterials research and development are introduced.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>The class consists of three parts:</td>
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<tr>
<td></td>
<td>1. Introduction into molecular characteristics of molecules involved in the materials-to-biology interface. Molecular design of biomaterials.</td>
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<td>2. The concept of biocompatibility.</td>
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<td>3. Introduction into methodology used in biomaterials research and application.</td>
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<tr>
<td><strong>Content</strong></td>
<td>Introduction into native and polymeric biomaterials used for medical applications. The concepts of biocompatibility, biodegradation and the consequences of degradation products are discussed on the molecular level. Different classes of materials with respect to potential applications in tissue engineering and drug delivery are introduced. Strong focus lies on the molecular interactions between materials having very different bulk and/or surface chemistry with living cells, tissues and organs. In particular the interface between the materials surfaces and the eukaryotic cell surface and possible reactions of the cells with an implant material are elucidated. Techniques to design, produce and characterize materials in vitro as well as in vivo analysis of implanted and explanted materials are discussed. In addition, a link between academic research and industrial entrepreneurship is established by external guest speakers.</td>
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<tr>
<td><strong>Lecture notes</strong></td>
<td>Handouts can be accessed online.</td>
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<td>(available online via ETH library)</td>
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<tr>
<td><strong>Prerequisites / notice</strong></td>
<td>Handouts provided during the classes and references therein.</td>
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<tr>
<td>529-0723-00L</td>
<td>Enzymes</td>
<td>W</td>
<td>7</td>
<td>3G</td>
<td>D. Hilvert</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>Principles of enzymatic catalysis, enzyme kinetics, mechanisms of enzyme-catalyzed reactions (group transfer reactions, carbon-carbon bond formation, eliminations, isomerisations and rearrangements), cofactor chemistry, enzymes in organic synthesis and the biosynthesis of natural products, catalytic antibodies.</td>
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</tbody>
</table>
The course covers the following topics: drug targeting and delivery principles, radiopharmaceuticals, macromolecular drug carriers, therapeutic proteins, and proteomics.

The course consists of two parts:

1. Therapeutic Proteins
   - Chapters 13-16 of the Immunobiology VIII book (Janeway et al.)
   - EMEA Dossier for Humira
   - Paper References provided in the Scripts

2. Drug Delivery and Drug Targeting
   - Overview of enzymes, enzyme-catalyzed reactions and metabolic processes.
   - Principles of enzymatic catalysis, enzyme kinetics, mechanisms of enzyme catalyzed reactions (group transfer reactions, carbon-carbon bond formation, eliminations, isomerisations and rearrangements), cofactor chemistry, enzymes in organic synthesis and the biosynthesis of natural products, catalytic antibiotics.

Objective
- Overview of enzymes, enzyme-catalyzed reactions and metabolic processes.
- Principles of enzymatic catalysis, enzyme kinetics, mechanisms of enzyme catalyzed reactions (group transfer reactions, carbon-carbon bond formation, eliminations, isomerisations and rearrangements), cofactor chemistry, enzymes in organic synthesis and the biosynthesis of natural products, catalytic antibodies.

Content
- Overview of enzymes, enzyme-catalyzed reactions and metabolic processes.
- Principles of enzymatic catalysis, enzyme kinetics, mechanisms of enzyme catalyzed reactions (group transfer reactions, carbon-carbon bond formation, eliminations, isomerisations and rearrangements), cofactor chemistry, enzymes in organic synthesis and the biosynthesis of natural products, catalytic antibodies.

Lecture notes
- A script will not be handed out.

Literature
- General:

In addition, citations from the original literature relevant to the individual lectures will be assigned weekly.

529-0837-00L  Biomicrofluidic Engineering  W+  7 credits  3G  A. de Mello

Number of participants limited to 30.

Abstract
Microfluidics describes the behaviour, control and manipulation of fluids that are geometrically constrained within sub-microliter environments. The use of microfluidic devices offers an opportunity to control physical and chemical processes with unrivalled precision, and in turn provides a route to performing chemistry and biology in an ultra-fast and high-efficiency manner.

Objective
In the course students will investigate the theoretical concepts behind microfluidic device operation, the methods of microfluidic device manufacture and the application of microfluidic architectures to important problems faced in modern day chemical and biological analysis. A design workshop will allow students to develop new microscale flow processes by appreciating the dominant physics at the microscale. The application of these basic ideas will primarily focus on biological problems and will include a treatment of diagnostic devices for use at the point-of-care, advanced functional material synthesis, DNA analysis, proteomics and cell-based assays. Lectures, assignments and the design workshop will acquaint students with the state-of-the-art in applied microfluidics.

Content
Specific topics in the course include, but not limited to:

1. Theoretical Concepts
   - Features of mass and thermal transport on the microscale
   - Key scaling laws

2. Conventional microfluidic Device Manufacture
   - Conventional lithographic processing of rigid materials
   - Soft lithographic processing of plastics and polymers
   - Mass fabrication of polymeric devices

3. Unit operations and functional components
   - Analytical separations (electrophoresis and chromatography)
   - Chemical and biological synthesis
   - Sample pre-treatment (filtration, SPE, pre-concentration)
   - Molecular detection

4. Design Workshop
   - Design of microfluidic architectures for PCR, distillation & mixing

5. Contemporary Applications in Biological Analysis
   - Microarrays
   - Cellular analyses (single cells, enzymatic assays, cell sorting)

6. System integration
   - Proteomics
   - Applications in radiochemistry, diagnostics and high-throughput experimentation

Lecture notes
Lecture handouts, background literature, problem sheets and notes will be provided electronically.

535-0030-00L  Therapeutic Proteins  W  3 credits  3G  C. Halin Winter, D. Neri

Abstract
In this course, various topics related to the development, GMP production and application of therapeutic proteins will be discussed. Furthermore, students will expand their training in pharmaceutical immunology and will be introduced to the basic concepts of pharmaceutical product quality management.

Objective
Students know and understand:
- basic mechanisms and regulation of the immune response
- the pathogenic mechanisms of the most important immune-mediated disorders
- the most frequently used expression systems for the production of therapeutic proteins
- the use of protein engineering tools for modifying different features of therapeutic proteins
- the mechanism of action of selected therapeutic proteins and their application
- basic concepts in the GMP production of therapeutic proteins

Content
The course consists of two parts:

1. In a first part, students will complete their training of pharmaceutical immunology (Chapter 13 - 16 Immunobiology VIII textbook). This part particularly focuses on the pathogenic mechanisms of immune-mediated diseases. Deepened knowledge of immunology will be relevant for understanding the mechanism of action of many therapeutic proteins, as well as for understanding one major concern related to the use of protein-based drugs, namely, immunogenicity.

2. The second part focuses on topics related to the development and application of therapeutic proteins, such as protein expression, protein engineering, reducing immunogenicity, and GMP production of therapeutic proteins. Furthermore, selected examples of approved therapeutic proteins will be discussed.

Lecture notes
Handouts to the lectures will be available for downloading under http://www.pharma.ethz.ch/scripts/index

Literature
- Chapters 13-16 of the Immunobiology VIII book (Janeway et al.)
- Lecture Handouts
- Paper References provided in the Scripts
- EMEA Dossier for Humira

535-0423-00L  Drug Delivery and Drug Targeting  W  2 credits  2V  J.C. Leroux, D. Brambilla

Abstract
The students gain an overview on current principles, methodologies and systems for controlled delivery and targeting of drugs. This enables the students to understand and evaluate the field in terms of scientific criteria.

Objective
The students dispose of an overview on current principles and systems for the controlled delivery and targeting of drugs. The focus of the course lies on developing a capacity to understand the involved technologies and methods, as well as an appreciation of the chances and constraints of their therapeutic usage, with prime attention on anticancer drugs, therapeutic peptides, proteins, nucleic acids and vaccines.

Content
The course covers the following topics: drug targeting and delivery principles, radiopharmaceuticals, macromolecular drug carriers, liposomes, micelles, micro/nanoparticles, gels and implants, administration of vaccines, delivery of active agents in tissue engineering, targeting at the gastrointestinal level, synthetic carriers for nucleic acid drugs, ophthalmic devices and novel trends in transdermal and nasal drug delivery.

Lecture notes
Selected lecture notes, documents and supporting material will be directly provided or may be downloaded using http://www.galenik.ethz.ch/teaching/drug_del_drug_targ

The website also displays additional information on peroral delivery systems, transdermal systems and systems for alternative routes (nasal, pulmonary) of delivery. These fields are covered in detail in the course Galenische Pharmazie II (Galenical Pharmacy II).
The aim of this course is to introduce certain topics in Probability Theory and Stochastic Processes that have been specifically selected.

Biology is becoming increasingly quantitative and mathematical modeling is now an integral part of biological research. In many biological processes, ranging from gene-expression to randomness, plays an important role that can only be understood using stochastic models. This course will provide the students with a theoretical foundation for developing such stochastic models and analyzing reaction networks.

The course will be in English. It will include the preparation of short essays (marked) about defined topics in Glycobiology.


The course consists of four parts. We first introduce modern genetic sequencing technology, and algorithms to obtain sequence alignments from the output of the sequencers. We then present methods to directly analyze this alignment (such as BLAST algorithm, GWAS approaches). Second, we introduce mechanisms and concepts of molecular evolution, i.e. we discuss how genetic sequences change over time. Third, we employ evolutionary concepts to infer ancestral relationships between organisms based on their genetic sequences, i.e. we discuss methods to infer genealogies and phylogenies. We finally introduce the field of phylodynamics. The aim of that field is to understand and quantify the population dynamic processes (such as transmission in epidemiology or speciation & extinction in macroevolution) based on a phylogeny. Throughout the class, the models and methods are illustrated on different datasets giving insight into the epidemiology and evolution of a range of infectious diseases (e.g. HIV, HCV, influenza, Ebola). Applications of the methods to the field of macroevolution provide insight into the evolution and ecology of different species clades. Students will be trained in the algorithms and their application both on paper and in silico as part of the exercises.

<table>
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<tr>
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<tbody>
<tr>
<td>551-1105-00L</td>
<td>Glycobiology W 4 credits 2V M. Aebi, T. Henriet</td>
</tr>
<tr>
<td>Abstract</td>
<td>Structural principles, nomenclature and different classes of glycosylation. The different pathways of N- and O-linked protein glycosylation and glycolipid biosynthesis in prokaryotes and eukaryotes are discussed. Specific glycan binding proteins and their role in deciphering the glycan code are presented. The role of glycans in infectious diseases, antigen mimicry and autoimmunity are discussed.</td>
</tr>
<tr>
<td>Objective</td>
<td>Detailed knowledge in 1) the different areas of prokaryotic and eukaryotic glycosylation, in particular in the biosynthesis of glycoproteins and glycolipids, 2) the cellular machinery required for these pathways, 3) the principles of carbohydrate/protein interaction, 4) the function of lectins, 5) the role of glycans in infectious disease.</td>
</tr>
<tr>
<td>Content</td>
<td>Structure and linkages; analytical approaches; N-linked protein glycosylation (ER, Golgi); glycan-assisted protein folding and quality control; O-linked protein glycosylation; glucosaminylglycans; glycolipids; prokaryotic glycosylation pathways; lectins; glycans and infectious disease</td>
</tr>
<tr>
<td>Lecture notes</td>
<td>handouts</td>
</tr>
<tr>
<td>Prerequisites / notice</td>
<td>The course will be in English. It will include the preparation of short essays (marked) about defined topics in Glycobiology.</td>
</tr>
<tr>
<td>636-0015-00L</td>
<td>An Introduction to Probability Theory and Stochastic Processes with Applications to Biology W 4 credits 3G</td>
</tr>
<tr>
<td>Abstract</td>
<td>Biology is becoming increasingly quantitative and mathematical modeling is now an integral part of biological research. In many biological processes, ranging from gene-expression to randomness, plays an important role that can only be understood using stochastic models. This course will provide the students with a theoretical foundation for developing such stochastic models and analyzing reaction networks.</td>
</tr>
<tr>
<td>Objective</td>
<td>The aim of this course is to introduce certain topics in Probability Theory and Stochastic Processes that have been specifically selected with an eye on biological applications. This course will teach students the tools and techniques for modeling and analyzing random phenomena. Throughout the course, several biological applications will be discussed and students will be encouraged to do additional reading based on their research interests.</td>
</tr>
<tr>
<td>Content</td>
<td>The first half of the course will cover the basics of Probability Theory while the second half will delve into the theory of Stochastic Processes. Below is the list of topics that will be covered in the course.</td>
</tr>
<tr>
<td>Notice</td>
<td>1. The mathematical representation of random phenomena: The probability space, properties of the probability measure, Independence of events, Conditional probability and Bayes formula, applications to parameter inference.</td>
</tr>
<tr>
<td>Prerequisites / notice</td>
<td>The course will involve a healthy balance between mathematical rigor (theorem proving) and biological applications. Students are expected to have a good grasp of Linear Algebra and Multivariable Calculus. Basic knowledge of set theory will also be needed. Students should be prepared for abstract reasoning.</td>
</tr>
<tr>
<td>636-0017-00L</td>
<td>Computational Biology W 4 credits 3G T. Stadler, C. Magnus</td>
</tr>
<tr>
<td>Abstract</td>
<td>The aim of the course is to provide up-to-date knowledge on how we can study biological processes using genetic sequencing data. Computational algorithms extracting biological information from genetic sequence data are discussed, and statistical tools to understand this information in detail are introduced.</td>
</tr>
<tr>
<td>Objective</td>
<td>Attendees will learn which information is contained in genetic sequencing data and how to extract information from them using computational tools. The main concepts introduced are: stochastic models in molecular evolution, phylogenetic &amp; phylodynamic inference, maximum likelihood and Bayesian statistics. Attendees will apply these concepts to a number of applications yielding biological insight into: epidemiology, pathogen evolution, macroevolution of species.</td>
</tr>
<tr>
<td>Content</td>
<td>The course consists of four parts. We first introduce modern genetic sequencing technology, and algorithms to obtain sequence alignments from the output of the sequencers. We then present methods to directly analyze this alignment (such as BLAST algorithm, GWAS approaches). Second, we introduce mechanisms and concepts of molecular evolution, i.e. we discuss how genetic sequences change over time. Third, we employ evolutionary concepts to infer ancestral relationships between organisms based on their genetic sequences, i.e. we discuss methods to infer genealogies and phylogenies. We finally introduce the field of phylodynamics. The aim of that field is to understand and quantify the population dynamic processes (such as transmission in epidemiology or speciation &amp; extinction in macroevolution) based on a phylogeny. Throughout the class, the models and methods are illustrated on different datasets giving insight into the epidemiology and evolution of a range of infectious diseases (e.g. HIV, HCV, influenza, Ebola). Applications of the methods to the field of macroevolution provide insight into the evolution and ecology of different species clades. Students will be trained in the algorithms and their application both on paper and in silico as part of the exercises.</td>
</tr>
</tbody>
</table>

Data: 06.03.2019 12:57 Autumn Semester 2016 Page 323 of 1571
The students are supposed to acquire a deep understanding of the process of biological design including model representation of a biological system, and then select their own biological system to design. The system is subsequently modeled, analyzed, and experimentally implemented. Results are presented at an international student competition at the MIT (Cambridge).

Objective

The students are required to give presentations on advanced topics in synthetic biology (specifically genetic circuit design) and then select their own biological system to design. The system is subsequently modeled, analyzed, and experimentally implemented. Results are presented at an international student competition at the MIT (Cambridge).

Content

Presentations on advanced synthetic biology topics (eg genetic circuit design, adaptation of systems dynamics, analytical concepts, large scale de novo DNA synthesis), project selection, modeling of selected biological system, design space exploration, sensitivity analysis, conversion into DNA sequence, (DNA synthesis external,) implementation and analysis of design, summary of results in form of scientific presentation and poster, presentation of results at the iGEM international student competition (www.igem.org).

Lecture notes

Handouts during course.

Prerequisites / notice

This course takes place between end of Spring Semester and beginning of Autumn Semester. Registration in April.

Please note that the number of ECTS credits and the actual work load are disconnected.

Literature

* Yang, Z. 2006. Computational Molecular Evolution.
  * Drummond, A. & Bouckaert, R. 2015. Bayesian evolutionary analysis with BEAST

Prerequisites / notice

Basic knowledge in linear algebra, analysis, and statistics will be helpful. Some programming experience will be useful for the exercises, but is not required. Programming skills will not be tested in the examination.

636-0501-00L Advanced Immunology I  W  2 credits  2V  external organisers

636-0503-00L Advanced Molecular Parasitology  W  2 credits  2V  external organisers

636-0507-00L Synthetic Biology II  W+  4 credits  4A  S. Panke, Y. Benenson, J. Stelling

Objective

The students are supposed to acquire a deep understanding of the process of biological design including model representation of a biological system, and then select their own biological system to design. The system is subsequently modeled, analyzed, and experimentally implemented. Results are presented at an international student competition at the MIT (Cambridge).

Content

Presentations on advanced synthetic biology topics (eg genetic circuit design, adaptation of systems dynamics, analytical concepts, large scale de novo DNA synthesis), project selection, modeling of selected biological system, design space exploration, sensitivity analysis, conversion into DNA sequence, (DNA synthesis external,) implementation and analysis of design, summary of results in form of scientific presentation and poster, presentation of results at the iGEM international student competition (www.igem.org).

Lecture notes

Handouts during course.

Prerequisites / notice

This course takes place between end of Spring Semester and beginning of Autumn Semester. Registration in April.

Please note that the number of ECTS credits and the actual work load are disconnected.

636-0508-00L Genomics in Drug Discovery Research  W  2 credits  2V  external organisers

636-0511-00L Developmental Neuroscience (HS)  W  2 credits  2V  external organisers

636-0515-00L Molecular Medicine I  W  2 credits  2V  external organisers

636-0706-00L Spatio-Temporal Modelling in Biology  W  5 credits  3G  D. Iber

Abstract

This course focuses on modeling spatio-temporal problems in biology, in particular on the cell and tissue level. A wide range of mathematical techniques will be presented as part of the course, including concepts from non-linear dynamics (ODE and PDE models), stochastic techniques (SDE, Master equations, Monte Carlo simulations), and thermodynamic descriptions.

Objective

The aim of the course is to introduce students to state-of-the-art mathematical modelling of spatio-temporal problems in biology. Students will learn how to choose from a wide range of modelling techniques and how to apply these to further our understanding of biological mechanisms. The course aims at equipping students with the tools and concepts to conduct successful research in this area; both classical as well as recent research work will be discussed.

Content

1. Introduction to Modelling in Biology
2. Morphogen Gradients
3. Turing Pattern
4. Travelling Waves & Wave Pinning
5. Application Example 1: Dorso-ventral axis formation
6. Chemotaxis, Cell Adhesion & Migration
7. Introduction to Numerical Methods
8. Simulations on Growing Domains
9. Image-Based Modelling
10. Branching Processes
11. Cell-based Simulation Frameworks
12. Application Example 2: Limb Development
13. Summary

Lecture notes

All lecture material will be made available online.

https://www.bsse.ethz.ch/cobi/education/636-0706-00L_Spatial_Modelling_in_Biology.html

Literature

Murray, Mathematical Biology, Springer
Forgacs and Newman, Biological Physics of the Developing Embryo, CUP
Keener and Sneyd, Mathematical Physiology, Springer
Fall et al, Computational Cell Biology, Springer
Szalasi et al, System Modeling in Cellular Biology, MIT Press
Wolkenhauer, Systems Biology
Keaysig, Engineering Mathematics, Wiley

Prerequisites / notice

This course builds on introductory courses in Computational Biology. The course assumes no background in biology but a good foundation regarding mathematical and computational techniques.

752-4005-00L Food Microbiology I  W  3 credits  2V  M. Loessner

Abstract

For students of the study programme Biology BSc the course can only be selected as 4th concept course.

Objective

This lecture offers insights into the basics, practical consequences and applications of Food Microbiology. Contents include basic microbiology of the different bacteria, yeasts and molds present in foods, as well as the occurrence and control of foodborne pathogens and spoilage organisms.

The focus of this first part of the lecture will be on the organisms, but also on the factors which determine spoilage and foodborne disease.
Content

1. History of Food Microbiology
   1.1. Short synopsis of foodborne microorganisms
   1.2. Spoilage of Foods
   1.3. Foodborne Disease
   1.4. Food Preservation
   1.5. VIP's of Food Microbiology

2. Overview of Microorganisms in Foods
   2.1. Origin of foodborne microorganisms
   2.2. Bacteria
   2.3. Yeasts

3. Microbial Spoilage of Foods
   3.1. Intrinsic and Extrinsic Parameters

4. Foodborne Disease
   4.1. Significance and Transmission of Foodborne pathogens
   4.2. Staphylococcus aureus
   4.3. Gram-positive Sporeformers (Bacillus & Clostridium)
   4.4. Listeria monocytogenes
   4.5. Salmonella, Shigella, Escherichia coli
   4.6. Vibrio, Yersinia, Campylobacter
   4.7. Brucella, Mycobacterium
   4.8. Parasites
   4.9. Viruses and Bacteriophages
   4.10. Mycotoxins
   4.11. Bioactive Amines
   4.12. Miscellaneous (Antibiotic-resistant Bacteria, Biofilms)

Lecture notes
Electronic copies of the presentation slides (PDF) and additional material will be made available for download.

Literature
Recommendations will be given in the first lecture

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636-0021-00L Mathematical Modelling in Systems Biology W+ 5 credits 3G D. Iber

Abstract
Basic concepts and mathematical tools to explore biochemical reaction kinetics and biological network dynamics.

Objective
The aim of the course is to provide an introductory overview of mathematical and computational methods to analyse biological network dynamics.

Content
1. Introduction to Mathematical Modeling
2. Introduction to Biochemical Reaction Modeling
3. Model Analysis: Phase Plane
4. Model Analysis: Linear Stability Analysis
5. Model Analysis: Bifurcation Analysis
6. Regulatory Feedback: Switches
7. Regulatory Feedback: Adaptation
8. Regulatory Feedback: Oscillations and Delay Equations
9. Receptor Signaling and Signaling Cascades
10. Network Properties: Sensitivity and Robustness
11. Introduction to Parameter Estimation

Lecture notes

Literature
- Keener and Sneyd, Mathematical Physiology, Springer
- Klipp et al, Systems Biology in Practice, Wiley
- Kreyszig, Engineering Mathematics, Wiley

Prerequisites / notice
Introductory courses in Mathematics (Linear Algebra, Differential Equations, Numerics) and basic concepts of programming.

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636-0801-00L Research Project O 20 credits 46A Lecturers

Abstract
In a research project students extend their knowledge in a particular field, get acquainted with the scientific way of working, and learn to work on an actual research topic. Research projects are carried out in a core or optional subject area as chosen by the student.

Objective
Students get acquainted with scientific working methods and deepen their knowledge in a particular research area

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636-0900-00L Master's Thesis O 40 credits 91D Professors

Abstract
In the Master thesis students prove their ability to independent, structured and scientific working. The Master thesis is carried out under the supervision of a professor in a research group of the D-BSSE, usually at the D-BSSE. Students are free to choose the area.

Objective
In the Master Thesis students prove their ability to independent, structured and scientific working.

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GESS Science in Perspective

Recommended GESS Science in Perspective (Type B) for D-BSSE.

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see GESS Science in Perspective: Type A: Enhancement of Reflection Capability

see GESS Science in Perspective: Language Courses

ETH/UZH
Seminars, Colloquia and Additional Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</table>

Abstract
This seminar will feature invited lectures about recent advances and developments in systems biology, including topics from biology, bioengineering, and computational biology.

Objective
To provide an overview of current systems biology research.

Content
The final list of topics will be available at http://www.bsse.ethz.ch/education/.

Course Units for Additional Admission Requirements

The courses below are only available for MSc students with additional admission requirements.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>626-0002-AAL</td>
<td>Bioinformatics</td>
<td>E-</td>
<td>4 credits</td>
<td>9R</td>
<td>J. Stelling, N. Beerenwinkel</td>
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</tbody>
</table>

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract
The course introduces concepts of bioinformatics starting from first principles: DNA sequence alignment, phylogenetic tree inference, genome annotation, protein structure and function prediction. Key methods and algorithms are covered, including dynamic programming, Markov and Hidden Markov models, and molecular dynamics simulations. Practical applications and limitations are discussed.

Objective
The course aims at introducing the fundamental concepts and methods of bioinformatics. Emphasis is given to a deep understanding of the methods’ foundations and limitations to enable critical evaluations and applications of bioinformatics tools in areas such as biotechnology and systems biology.

Content
From "Understanding Bioinformatics":
Chapter 4: Producing and Analyzing Sequence Alignments
Chapter 5: Pairwise Sequence Alignment and Database Searching
Chapter 6: Patterns, Profiles, and Multiple Alignments
Chapter 7: Recovering Evolutionary History
Chapter 8: Building Phylogenetic Trees
Chapter 9: Revealing Genome Features
Chapter 10: Gene Detection and Genome Annotation
Chapter 11: Obtaining Secondary Structure from Sequence
Chapter 12: Predicting Secondary Structures
Chapter 13: Modeling Protein Structure
Chapter 14: Analyzing Structure-Function Relationships

From "Biological Sequence Analysis":
Sections 3.1, 3.2, 3.3, 4.1, 4.2, 4.4, 5.2, 5.3, 5.4, 6.5 (Markov Chains and Hidden Markov Models)

From "A First Course in Systems Biology":
Chapter 1: Biological Systems

Literature

Prerequisites / notice
There will be two opportunities for tutorials during the semester

http://www.csb.ethz.ch/teaching

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<tr>
<th>Number</th>
<th>Title</th>
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<tr>
<td>626-0003-AAL</td>
<td>Molecular Biology</td>
<td>E-</td>
<td>4 credits</td>
<td>9R</td>
<td>R. Paro</td>
</tr>
</tbody>
</table>

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract
This lecture course gives an in-depth view into molecular mechanisms controlling basic biological processes, ranging from genetic regulatory networks, the internal functional organization of a cell to the signaling events controlling cells in their social context. An additional focus is on methods and techniques used in molecular biology to solve problems in biotechnology and medicine.

Objective
The goal is to achieve a high level knowledge of basic biological processes, to learn the methodology to tackle questions in molecular biology and to interpret experimental molecular data. Emphasis is given to cellular processes amenable to studies in systems and synthetic biology.
Content


Chapter 4 DNA, Chromosomes, and Genomes
p. 173-216

Chapter 5 DNA Replication, Repair, and Recombination
p. 237-286

Chapter 6 How Cells Read the Genome: From DNA to Protein
p. 299-362

Chapter 7 Control of Gene Expression
p. 369-436

Chapter 8 Analyzing Cells, Molecules, and Systems
p. 439-508

Chapter 9 Visualizing Cells
p. 529-562

Chapter 10 Membrane Structure
p. 565-594

Chapter 11 Membrane Transport of Small Molecules and the Electrical Properties of Membranes
p. 597-638

Chapter 12 Intracellular Compartments and Protein Sorting
p. 641-691

Chapter 13 Intracellular Membrane Traffic
p. 695-750

Chapter 15 Cell Signaling
p. 813-880

Chapter 17 The Cell Cycle
p. 963-1018

Chapter 18 Cell Death
p. 1021-1034

Chapter 20 Cancer
p. 1091-1141

Chapter 22 Stem Cells and Tissue Renewal
p. 1217-1260

Lecture notes

Use the respective end-of-chapter problems section ("Which statements are true?") to test your knowledge and prepare for exam.

Literature


http://www.garlandscience.com/product/isbn/9780815344322

Book Summary

As the amount of information in biology expands dramatically, it becomes increasingly important for textbooks to distill the vast amount of scientific knowledge into concise principles and enduring concepts. As with previous editions, Molecular Biology of the Cell, Sixth Edition accomplishes this goal with clear writing and beautiful illustrations. The Sixth Edition has been extensively revised and updated with the latest research in the field of cell biology, and it provides an exceptional framework for teaching and learning.

The entire illustration program has been greatly enhanced. Protein structures better illustrate structure-function relationships, icons are simpler and more consistent within and between chapters, and micrographs have been refreshed and updated with newer, clearer, or better images. As a new feature, each chapter now contains intriguing open-ended questions highlighting "What We Don’t Know" introducing students to challenging areas of future research. Updated end-of-chapter problems reflect new research discussed in the text, and these problems have been expanded to all chapters by adding questions on developmental biology, tissues and stem cells, pathogens, and the immune system.

Prerequisites / notice

During the semester two half days will be offered to discuss the content and allow questions to the lecturer.

626-0007-AAL

Microbial Biotechnology

Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract

Introduction into the field of microbial biotechnology, covering possible products of enzyme and fermentation technology.

Objective

The student should be able to identify opportunities for microbial bioprocesses and to go through basic and advanced design procedures for microbial bioprocesses.

Content

Bioprocess development - An interdisciplinary challenge
Introduction to engineering calculations
Presentation and analysis of data
Material balances
Energy balances
Unsteady-state material and energy balances
Fluid flow
Mixing
Mass transfer
Homogeneous reactions
Heterogeneous reactions
Reactor engineering
Literature
Pauline Doran, Bioprocess Engineering Principles, edition 2013, chapters 1 to 8, 10, 12-14

Other literature:
Nielsen/Villadsen, Bioreaction Engineering Principles (Kluwer)
van’t Riet/Tramper: Basic bioreactor design
Stephanopoulos/Aristidou/Nielsen: Metabolic Engineering

Prerequisites / notice
There will be two opportunities for tutorials during the semester.

<table>
<thead>
<tr>
<th>Biotechnology Master - Key for Type</th>
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<th>W+</th>
<th>W</th>
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<tbody>
<tr>
<td>Compulsory</td>
<td>E-</td>
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<td>Dr</td>
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<tr>
<td>Eligible for credits and recommended</td>
<td>Z</td>
<td>Courses outside the curriculum</td>
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<td>Eligible for credits</td>
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<th>Key for Hours</th>
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<td>lecture</td>
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<td>lecture with exercise</td>
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<td>exercise</td>
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<td>seminar</td>
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<td>colloquium</td>
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<tr>
<th>ECTS</th>
<th>European Credit Transfer and Accumulation System</th>
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<tr>
<td></td>
<td>Special students and auditors need special permission from the lecturers.</td>
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</table>
Certificate of Advanced Studies in Computer Science

Focus Courses and Electives

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>252-0237-00L</td>
<td>Concepts of Object-Oriented Programming</td>
<td>W</td>
<td>6</td>
<td>3V+2U</td>
<td>P. Müller</td>
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<td></td>
<td>Course that focuses on an in-depth understanding of object-oriented programming languages. Topics include different flavors of type systems, inheritance models, encapsulation in the presence of aliasing, object and class initialization, program correctness, reflection.</td>
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<td>After this course, students will:</td>
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<tr>
<td></td>
<td>1. Have a deep understanding of advanced concepts of object-oriented programming and their support through various language features.</td>
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<td>2. Be able to understand language concepts on a semantic level and be able to compare and evaluate language designs.</td>
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<td>3. Be able to learn new languages more rapidly.</td>
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<td>4. Be aware of many subtle problems of object-oriented programming and know how to avoid them.</td>
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<td>The main goal of this course is to convey a deep understanding of the key concepts of sequential object-oriented programming and their support in different programming languages. This is achieved by studying how important challenges are addressed through language features and programming idioms. In particular, the course discusses alternative language designs by contrasting solutions in languages such as C++, C#, Eiffel, Java, Python, and Scala. The course also introduces novel ideas from research languages that may influence the design of future mainstream languages.</td>
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<td>The topics discussed in the course include among others:</td>
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<td>The pros and cons of different flavors of type systems (for instance, static vs. dynamic typing, nominal vs. structural, syntactic vs. behavioral typing)</td>
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<td>The key problems of single and multiple inheritance and how different languages address them</td>
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<td>Generic type systems, in particular, Java generics, C# generics, and C++ templates</td>
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<td>The situations in which object-oriented programming does not provide encapsulation, and how to avoid them</td>
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<td>The pitfalls of object initialization, exemplified by a research type system that prevents null pointer dereferencing</td>
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<td>How to maintain the consistency of data structures</td>
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<tr>
<td>Literature</td>
<td>Will be announced in the lecture.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Prerequisites:</td>
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<td>Mastering at least one object-oriented programming language (this course will NOT provide an introduction to object-oriented programming); programming experience</td>
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<tr>
<td>252-0298-00L</td>
<td>System Construction</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>F. O. Friedrich</td>
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<td></td>
<td>Main goal is teaching knowledge and skills needed for building custom operating systems and runtime environments. Relevant topics are studied at the example of sufficiently simple systems that have been built at our Institute in the past, ranging from purpose-oriented single processor real-time systems up to generic system kernels on multi-core hardware.</td>
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<td>The lecture's main goal is teaching of knowledge and skills needed for building custom operating systems and runtime environments.</td>
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<tr>
<td>Content</td>
<td>Case Study 1: Embedded System</td>
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<td></td>
<td>- Safety-critical and fault-tolerant monitoring system</td>
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<td>- Based on an auto-pilot system for helicopters</td>
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<td>Case Study 2: Multi-Processor Operating System</td>
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<td>- Universal operating system for symmetric multiprocessors</td>
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<td>- Shared memory approach</td>
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<td>- Based on Language-/System Codecs (Active Oberon / A2)</td>
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<td>Case Study 3: Custom designed Single-Processor System</td>
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<td>- RISC Single-processor system designed from scratch</td>
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<td></td>
<td>- Hardware on FPGA</td>
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<td>- Graphical workstation OS and compiler (Project Oberon)</td>
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<td>Case Study 4: Custom-designed Multi-Processor System</td>
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<td>- Special purpose heterogeneous system on a chip</td>
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<td>- Massively parallel hard- and software architecture based on message passing</td>
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<td></td>
<td>- Focus: dataflow based applications</td>
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<tr>
<td>Lecture notes</td>
<td>Printed lecture notes will be delivered during the lecture. Slides will also be available from the lecture homepage.</td>
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<tr>
<td>252-0293-00L</td>
<td>Wireless and Mobile Computing for Entertainment</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>S. Mangold</td>
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<td></td>
<td>Applications</td>
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<td>This course gives a detailed overview about the 802 standards and summarizes the state of the art for WLANs, WPANs, and WMANs, including new concepts such as mesh networks, cognitive radio, and visible light communications. The course combines lectures with a set of assignments in which students are asked to work with a simple JAVA simulation software.</td>
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<tr>
<td>Objective</td>
<td>The objective of the course is to learn about the general principles of wireless communications, including physics, frequency spectrum regulation, and standards. Further, the most up-to-date standards and protocols used for wireless LAN IEEE 802.11, Bluetooth and Wi-Fi, mesh networks, sensor networks, cellular networks, visible light communication, and cognitive radios, are analyzed and evaluated. Students develop their own add-on mobile computing algorithms to improve the behavior of the systems, using a Java-based event-driven simulator. We also hand out embedded systems that can be used for experiments for optical communication.</td>
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<tr>
<td>Lecture notes</td>
<td>The script will be made available from the course webpage.</td>
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<tr>
<td>Literature</td>
<td>The script will be available from the course webpage.</td>
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<tr>
<td></td>
<td>(1) The course webpage at <a href="http://www.lst.inf.ethz.ch/education/wireless.html">http://www.lst.inf.ethz.ch/education/wireless.html</a></td>
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<tr>
<td></td>
<td>(2) The Java 802 protocol emulator &quot;JEmula802&quot;</td>
<td></td>
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<tr>
<td>Prerequisites / notice</td>
<td>Students should have interest in wireless communication, and should be familiar with Java programming.</td>
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</table>

Data: 06.03.2019 12:57  Autumn Semester 2016  Page 329 of 1571
Abstract

Introduction to information retrieval with a focus on text documents and images. Main topics comprise extraction of characteristic features from documents, index structures, retrieval models, search algorithms, benchmarking, and feedback mechanisms. Searching the web, images and XML collections demonstrate recent applications of information retrieval and their implementation.

Objective

In depth understanding of managing, indexing, and retrieving documents with text, image and XML content. Knowledge about basic search algorithms on the web, benchmarking of search algorithms, and relevance feedback methods.

252-0373-00L Mobile and Personal Information Systems W 4 credits 2V+1U M. Norrie

Abstract

The course examines how traditional information system architectures and technologies have been adapted to support various forms of mobile and personal information systems. Topics to be covered include: databases of mobile objects; context-aware services; opportunistic information sharing; ambient information; pervasive display systems.

Objective

Students will be introduced to a variety of novel information services and architectures developed for mobile environments in order to gain insight into the requirements and processes involved in designing and developing such systems and learning to think beyond traditional information systems.

Content

Advances in mobile devices and communication technologies have led to a rapid increase in demands for various forms of mobile information systems where the users, the applications and the databases themselves may be mobile. Based on both lectures and breakout sessions, this course examines the impact of the different forms of mobility and collaboration that systems require nowadays and how these influence the design of systems at the database, the application and the user interface layer. For example, traditional data management techniques have to be adapted to meet the requirements of such systems and cope with new connection, access and synchronisation issues. As mobile devices have increasingly become integrated into the users’ lives and are expected to support a range of activities in different environments, applications should be context-aware, adapting functionality, information delivery and the user interfaces to the current environment and task. Various forms of software and hardware sensors may be used to determine the current context, raising interesting issues for discussion. Finally, user mobility, and the varying and intermittent connectivity that it implies, gives rise to new forms of dynamic collaboration that require lightweight, but flexible, mechanisms for information synchronisation and consistency maintenance. Here, the interplay of mobile, personal and social context will receive special attention.

252-0417-00L Randomized Algorithms and Probabilistic Methods W 7 credits 3V+2U+1A A. Steger, E. Welzl

Abstract

Las Vegas & Monte Carlo algorithms; inequalities of Markov, Chebyshev, Chernoff; negative correlation; Markov chains: convergence, rapidly mixing; generating functions; Examples include: min cut, median, balls and bins, routing in hypercubes, 3SAT, card shuffling, random walks.

Objective

After this course students will know fundamental techniques from probabilistic combinatorics for designing randomized algorithms and will be able to apply them to solve typical problems in these areas.

Content

Randomized Algorithms are algorithms that “flip coins” to take certain decisions. This concept extends the classical model of deterministic algorithms and has become very popular and useful within the last twenty years. In many cases, randomized algorithms are faster, simpler or just more elegant than deterministic ones. In the course, we will discuss basic principles and techniques and derive from them a number of randomized methods for problems in different areas.

Lecture notes

Yes.

Literature


252-0437-00L Distributed Algorithms W 4 credits 3V F. Mattern

Abstract

Models of distributed computations, time space diagrams, virtual time, logical clocks and causality, wave algorithms, parallel and distributed graph traversal, consistent snapshots, mutual exclusion, election and symmetry breaking, distributed termination detection, garbage collection in distributed systems, monitoring distributed systems, global predicates.

Objective

Become acquainted with models and algorithms for distributed systems.

Content

Verteilte Algorithmen sind Verfahren, die dadurch charakterisiert sind, dass mehrere autonome Prozesse gleichzeitig Teile eines gemeinsamen Problems in kooperativer Weise bearbeiten und der dabei erforderliche Informationsaustausch ausschliesslich über Nachrichten erfolgt. Derartige Algorithmen kommen im Rahmen verteilter Systeme zum Einsatz, bei denen kein gemeinsamer Speicher existiert und die Übertragungszeit von Nachrichten i.a. nicht vernachlässigt werden kann. Da dabei kein Prozess eine aktuelle konsistente Sicht des globalen Zustands besitzt, führt dies zu interessanten Problemen. Im einzelnen werden u.a. folgende Themen behandelt:

- Modellene verteilter Berechnungen; Raum-Zeit Diagramme; Virtuelle Zeit; Logische Uhren und Kausalität; Wellenalgorithmen; Verteilte und parallele Graphtraversierung; Berechnung konsistenter Schnappschüsse; Wechselseitiger Ausschluss; Election and Symmetrybreaking; Verteilte Termination; Garbage-Collection in verteilten Systemen; Beobachten verteilter Systeme; Berechnung globaler Prädikate.

Literature

- F. Mattern: Verteilte Basialgorithmen, Springer-Verlag
- G. Tel: Topics in Distributed Algorithms, Cambridge University Press
- G. Tel: Introduction to Distributed Algorithms, Cambridge University Press, 2nd edition
- N. Lynch: Distributed Algorithms, Morgan Kaufmann Publ

252-0463-00L Security Engineering W 5 credits 2V+2U D. Basin

Abstract

Subject of the class are engineering techniques for developing secure systems. We examine concepts, methods and tools, applied within the different activities of the SW development process to improve security of the system. Topics: security requirements & risk analysis, system modeling & model-based development methods, implementation-level security, and evaluation criteria for secure systems.

Objective

Security engineering is an evolving discipline that unifies two important areas: software engineering and security. Software Engineering addresses the development and application of methods for systematically developing, operating, and maintaining, complex, high-quality software.

Security, on the other hand, is concerned with assuring and verifying properties of a system that relate to confidentiality, integrity, and availability of data.

The goal of this class is to survey engineering techniques for developing secure systems. We will examine concepts, methods, and tools that can be applied within the different activities of the software development process, in order to improve the security of the resulting systems.

Topics covered include

- security requirements & risk analysis,
- system modeling and model-based development methods,
- implementation-level security, and
- evaluation criteria for the development of secure systems.
Security engineering is an evolving discipline that unifies two important areas: software engineering and security. Software Engineering addresses the development and application of methods for systematically developing, operating, and maintaining, complex, high-quality software. Security, on the other hand, is concerned with assuring and verifying properties of a system that relate to confidentiality, integrity, and availability of data.

The goal of this class is to survey engineering techniques for developing secure systems. We will examine concepts, methods, and tools that can be applied within the different activities of the software development process, in order to improve the security of the resulting systems.

Topics covered include
* security requirements & risk analysis,  
* system modeling and model-based development methods,  
* implementation-level security, and  
* evaluation criteria for the development of secure systems

Modules taught:

1. Introduction  
   - Introduction of Infsec group and speakers  
   - Security meets SW engineering: an introduction  
   - The activities of SW engineering, and where security fits in  
   - Overview of this class

2. Requirements Engineering: Security Requirements and some Analysis  
   - overview: functional and non-functional requirements  
   - use cases, misuse cases, sequence diagrams  
   - safety and security  
   - FMEA, FTA, attack trees

3. Modeling in the design activities  
   - structure, behavior, and data flow  
   - class diagrams, statecharts

4. Model-driven security for access control (design)  
   - SecureUML as a language for access control  
   - Combining Design Modeling Languages with SecureUML  
   - Semantics, i.e., what does it all mean,  
   - Generation  
   - Examples and experience

5. Model-driven security (Part II)  
   - Continuation of above topics

6. Security patterns (design and implementation)

7. Implementation-level security  
   - Buffer overflows  
   - Input checking  
   - Injection attacks

8. Testing  
   - overview  
   - model-based testing  
   - testing security properties

9. Risk analysis and management 1 (project management)  
   - "risk": assets, threats, vulnerabilities, risk  
   - risk assessment: quantitative and qualitative  
   - safeguards  
   - generic risk analysis procedure  
   - The OCTAVE approach

10. Risk analysis: IT baseline protection  
   - Overview  
   - Example

11. Evaluation criteria  
   - CMM  
   - systems security engineering CMM  
   - common criteria

12. Guest lecture  
   - TBA

Literature
- Further relevant books and journal/conference articles will be announced in the lecture.

Prerequisites / notice
Prerequisite: Class on Information Security

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>W</th>
<th>Credits</th>
<th>V+U+A</th>
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<tr>
<td>252-0535-00L</td>
<td>Machine Learning</td>
<td>8</td>
<td>3V+2U+2A</td>
<td>J. M. Buhmann</td>
<td></td>
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Abstract
Machine learning algorithms provide analytical methods to search data sets for characteristic patterns. Typical tasks include the classification of data, function fitting and clustering, with applications in image and speech analysis, bioinformatics and exploratory data analysis. This course is accompanied by practical machine learning projects.

Objective
Students will be familiarized with the most important concepts and algorithms for supervised and unsupervised learning; reinforce the statistics knowledge which is indispensable to solve modeling problems under uncertainty. Key concepts are the generalization ability of algorithms and systematic approaches to modeling and regularization. A machine learning project will provide an opportunity to test the machine learning algorithms on real world data.
At the end of the course the students will be able to build a rendering system. The students will study the basic principles of rendering and computer graphics. This course covers fundamental concepts of modern computer graphics. Students will learn about 3D object representations and the generation of photorealistic images from digital representations of 3D scenes. The lecture covers topics such as rigid body dynamics, collision detection, and character animation. Furthermore, the lecture will introduce algorithms to real-world data.

### Content

- Bayesian theory of optimal decisions
- Maximum likelihood and Bayesian parameter inference
- Classification with discriminant functions: Perceptrons, Fisher's LDA and support vector machines (SVM)
- Ensemble methods: Bagging and Boosting
- Regression: least squares, ridge and LASSO penalization, non-linear regression and the bias-variance trade-off
- Non parametric density estimation: Parzen windows, nearest neighbour
- Dimension reduction: principal component analysis (PCA) and beyond

### Prerequisites / notice

The course requires solid basic knowledge in analysis, statistics and numerical methods for CSE as well as practical programming experience for solving assignments. Students should at least have followed one previous course offered by the Machine Learning Institute (e.g., CIL or LIS) or an equivalent course offered by another institution.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Winter</th>
<th>Spring</th>
<th>Autumn</th>
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<tbody>
<tr>
<td>252-0546-00L</td>
<td>Physically-Based Simulation in Computer Graphics</td>
<td>W 4 credits</td>
<td>2V+1U</td>
<td>B. Solenthaler, B. Thomaszewski</td>
</tr>
<tr>
<td>252-1407-00L</td>
<td>Algorithmic Game Theory</td>
<td>W 7 credits</td>
<td>3V+2U+1A</td>
<td>P. Widmayer, P. Penna</td>
</tr>
</tbody>
</table>
Abstract

The first part of the lecture covers individual system aspects starting with tamperproof or tamper-resistant hardware in general over operating system related security mechanisms to application software systems, such as host based intrusion detection systems. In the second part, the focus is on system design and methodologies for building secure systems.

Objective

In this lecture, students learn about the security requirements and capabilities that are expected from modern hardware, operating systems, and other software environments. An overview of available technologies, algorithms and standards is given, with which these requirements can be met.

Content

The first part of the lecture covers individual system's aspects starting with tamperproof or tamperresistant hardware in general over operating system related security mechanisms to application software systems such as host based intrusdon detection systems. The main topics covered are: tamper resistant hardware, CPU support for security, protection mechanisms in the kernel, file system security (permissions / ACLs / network filesystem issues), IPC Security, mechanisms in more modern OS, such as Capabilities and Zones, Libraries and Software tools for security assurance, etc.

In the second part, the focus is on system design and methodologies for building secure systems. Topics include: patch management, common software faults (buffer overflows, etc.), writing secure software (design, architecture, QA, testing), compiler-supported security, language-supported security, logging and auditing (BSM audit, dtrace, ...), cryptographic support, and trustworthy computing (TCG, SGX).

Along the lectures, model cases will be elaborated and evaluated in the exercises.

Literature


Prerequisites / notice

Prerequisites: The course assumes basic knowledge of discrete mathematics and algorithms, as supplied in the first semesters of Bachelor Studies at ETH.

Notice: In the following spring semester there is a seminar "Geometry: Combinatorics and Algorithms" that builds on this course. There are ample possibilities for Semester-, Bachelor- and Master Thesis projects in the area.
This combination of requirements, together with the technologies that have emerged in order to address them, is typically referred to as "Big Data." This revolution has led to a completely new way to do business, e.g., develop new products and business models, but also to do science -- which is sometimes referred to as data-driven science or the "fourth paradigm".

Unfortunately, the quantity of data produced and available -- now in the Zettabyte range (that's 21 zeros) per year -- keeps growing faster than our ability to process it. Hence, new architectures and approaches for processing it were and are still needed. Harnessing them must involve a deep understanding of data not only in the large, but also in the small.

The field of databases evolves at a fast pace. In order to be prepared, to the extent possible, to the (re)volutions that will take place in the next few decades, the emphasis of the lecture will be on the paradigms and core design ideas, while today's technologies will serve as supporting illustrations thereof.

After visiting this lecture, you should have gained an overview and understanding of the Big Data landscape, which is the basis on which one can make informed decisions, i.e., pick and orchestrate the relevant technologies together for addressing each business use case efficiently and consistently.

This course gives an overview of database technologies and of the most important database design principles that lay the foundations of the Big Data universe. The material is organized along three axes: data in the large, data in the small, data in the very small. A broad range of aspects is covered with a focus on how they fit together in the big picture of the Big Data ecosystem.

- physical storage (HDFS, S3)
- logical storage (key-value stores, document stores, column stores, key-value stores, data warehouses)
- data formats and syntaxes (XML, JSON, CSV, XBRIL)
- data shapes and models (tables, trees, graphs, cubes)
- an overview of programming languages with a focus on their type systems (SQL, XQuery, MDX)
- the most important query paradigms (selection, projection, joining, grouping, ordering, windowing)
- paradigms for parallel processing (MapReduce) and technologies (Hadoop, Spark)
- optimization techniques (functional and declarative paradigms, query plans, rewrites, indexing)
- applications.

We will also host two guest lectures to get insights from the industry: UBS and Google.

Large scale analytics and machine learning are outside of the scope of this course.

Papers from scientific conferences and journals. References will be given as part of the course material during the semester.

Objective
This course is intended to give students a thorough understanding of design and implementation issues for modern operating systems, with a particular emphasis on the challenges of modern hardware features. We will cover key design issues in implementing an operating system, such as memory management, scheduling, protection, inter-process communication, device drivers, and file systems.

The goals of the course are, firstly, to give students a broader perspective on OS design than that provided by knowledge of Unix or Unix-like systems, such as Linux and OpenBSD. The course will also cover key design issues in implementing an operating system, such as memory management, scheduling, protection, inter-process communication, device drivers, and file systems.

Content
This course is intended to give students a thorough understanding of design and implementation issues for modern operating systems, with a particular emphasis on the challenges of modern hardware features. We will cover key design issues in implementing an operating system, such as memory management, scheduling, protection, inter-process communication, device drivers, and file systems.

Prerequisites / notice
The participation in the course is subject to the following conditions:
1) The number of participants is limited to 120 students (MSc and PhDs),
2) Students must have taken the exam in Machine Learning (252-0535-00) or have acquired equivalent knowledge.

Content
Participants become familiar with the challenges related to sustainable energy usage, understand the principles of a smart grid infrastructure and its applications, know the role of ubiquitous computing technologies, can explain the challenges regarding security and privacy, can reflect the basics cues to induce changes in consumer behavior, develop a general understanding of the effects of a smart grid infrastructure on energy efficiency, and know how to apply the learning to related design projects.

- Background on energy generation and consumption; characteristics, potential, and limitations of renewable energy sources
- Introduction to energy economics
- Smart grid and smart metering infrastructures, virtual power plants, security challenges
- Demand management and home automation using ubiquitous computing technologies
- Changing consumer behavior with smart ICT
- Benefits challenges of a smart energy system

Objective
Participants become familiar with the challenges related to sustainable energy usage, understand the principles of a smart grid infrastructure and its applications, know the role of ubiquitous computing technologies, can explain the challenges regarding security and privacy, can reflect the basics cues to induce changes in consumer behavior, develop a general understanding of the effects of a smart grid infrastructure on energy efficiency, and know how to apply the learning to related design projects.

Objective
The goals of the course are, firstly, to give students a broader perspective on OS design than that provided by knowledge of Unix or Windows, building on the material in a standard undergraduate operating systems class, and secondly, to provide them with practical experience in dealing directly with the concurrency, resource management, and abstraction problems confronting OS designers and implementers.

Prerequisites / notice
The course is based around a milestone-oriented project, where students work in small groups to implement major components of a microkernel-based operating system. The final assessment will be a combination grades awarded for milestones during the course of the project, a final written report on the work, and a set of test cases on the final code.

Abstract
This lecture discusses fundamental concepts and technologies in the area of network security. Several case studies illustrate the details of firewalls, penetration testing, and intrusion detection.

Prerequisites / notice
This course is intended to give students a thorough understanding of design and implementation issues for modern operating systems, with a particular emphasis on the challenges of modern hardware features. We will cover key design issues in implementing an operating system, such as memory management, scheduling, protection, inter-process communication, device drivers, and file systems.
### Objective
Students are aware of current threats that Internet services and networked devices face and can explain appropriate countermeasures. Students can identify and assess known vulnerabilities in a software system that is connected to the Internet. Students know fundamental network security concepts. Students have an in-depth understanding of important security technologies. Students know how to configure a real firewall and know some penetration testing tools from their own experience.

### Content
Risk management and the vulnerability lifecycle of software and networked services are discussed. Threats like denial of service, spam, worms, and viruses are studied in-depth. Fundamental security related concepts like identity, availability, authentication and secure channels are introduced. State of the art technologies like secure shell, network and transport layer security, intrusion detection and prevention systems, cross-site scripting, secure implementation techniques and more for securing the Internet and web applications are presented. Several case studies illustrate the dark side of the Internet and explain how to protect against current threats. A hands-on computer lab that accompanies the lecture gives a deep dive on firewalls, penetration testing and intrusion detection.

This lecture is intended for students with an interest in securing Internet services and networked devices. Students are assumed to have knowledge in networking as taught in the Communication Networks lecture.

### Prerequisites / notice
Due to recent changes in the Swiss law, ETH requires each student of this course to sign a written declaration that he/she will not use the information given in this for illegal purposes. This declaration will have to be signed and submitted no later than at the beginning of the second lesson.

#### 263-4650-00L Specification and Proof of Probabilistic Programs with W

<table>
<thead>
<tr>
<th>Course Code</th>
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<th>Credits</th>
<th>Contact Hours</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>263-4650-00L</td>
<td>Specification and Proof of Probabilistic Programs with W</td>
<td>4</td>
<td>2V+1U</td>
<td>A. McIver, C. C. Morgan</td>
</tr>
</tbody>
</table>

- **Abstract**: The course will introduce participants to semantic models for probabilistic programs. The semantics will provide the fundamental model for deriving generic properties of probabilistic systems, and as a context for proving soundness and completeness of proof techniques.
- **Objective**: Students in this course will learn new ways to specify and reason about quantitative properties of probabilistic programs. Both probabilistic programs' functional behaviour and their information-flow properties are important aspects of modern systems building, complementing existing methods of abstraction, nondeterminism and refinement. This course's objective is to give the students the necessary intellectual skills for rigorous reasoning about building such systems.
- **Content**: The first part of the course will concentrate on program-semantic foundations that support rigorous specification and reasoning about such quantitative programs. The second part of the course will demonstrate how these techniques can be used for analysing both qualitative- and quantitative information flow as they apply to leakage of secure information.
- **Literature**: The course will follow the book “Abstraction, Refinement and Proof for Probabilistic Systems”.
- **Prerequisites / notice**: Knowledge in computer networking and Internet protocols (e.g. course Communication Networks (D-ITET)) or Operating Systems and Networks (D-INFK).

#### 263-4655-00L Lattice Cryptography

<table>
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<tr>
<th>Course Code</th>
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<th>Contact Hours</th>
<th>Authors</th>
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<tr>
<td>263-4655-00L</td>
<td>Lattice Cryptography</td>
<td>4</td>
<td>2V+1U</td>
<td>V. Lyubashevsky</td>
</tr>
</tbody>
</table>

- **Abstract**: The course will introduce lattice-based cryptography, which is one of the main candidates for quantum-resistant cryptography.
- **Objective**: The objective of the course is to bring the students up to a level where they should be able to read academic papers on state-of-the-art designs of lattice-based primitives.
- **Content**: In this course, we will study lattice-based cryptography. We will cover the basic algorithms associated with integer lattices such as Gram-Schmidt orthogonalization, algorithms for finding short and near lattice vectors, as well as the critical algorithm for sampling lattice points according to a discrete Gaussian distribution. We will then proceed to build up a toolbox of lattice-based cryptographic primitives beginning from collision-resistant hash functions, then moving on to digital signatures, encryption, identity-based encryption, and fully-homomorphic encryption. Particular emphasis will be placed on concrete parameters and practical instantiations. For this purpose, we will also study cryptographic constructions based on the hardness of ideal lattices, which are ideals of polynomial rings.
- **Prerequisites / notice**: There are no formal mathematical pre-requisites, but students should have "mathematical maturity", which entails dealing with abstract concepts and being comfortable with doing mathematical proofs. Some previous exposure to linear algebra, abstract algebra, and cryptography would be useful.

#### 263-5001-00L Introduction to Finite Elements and Sparse Linear System Solving

<table>
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<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
<th>Contact Hours</th>
<th>Authors</th>
</tr>
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<tr>
<td>263-5001-00L</td>
<td>Introduction to Finite Elements and Sparse Linear System Solving</td>
<td>4</td>
<td>2V+1U</td>
<td>P. Arbenz</td>
</tr>
</tbody>
</table>

- **Abstract**: The finite element (FE) method is the method of choice for (approximately) solving partial differential equations on complicated domains. In the first third of the lecture, we give an introduction to the method. The rest of the lecture will be devoted to methods for solving the large sparse linear systems of equation that a typical for the FE method. We will consider direct and iterative methods.
- **Objective**: Students will know the most important direct and iterative solvers for sparse linear systems. They will be able to determine which solver to choose in particular situations.
I. THE FINITE ELEMENT METHOD

(1) Introduction, model problems.

(2) 1D problems. Piecewise polynomials in 1D.

(3) 2D problems. Triangulations. Piecewise polynomials in 2D.

(4) Variational formulations. Galerkin finite element method.

(5) Implementation aspects.

II. DIRECT SOLUTION METHODS

(6) LU and Cholesky decomposition.

(7) Sparse matrices.

(8) Fill-reducing orderings.

III. ITERATIVE SOLUTION METHODS

(9) Stationary iterative methods, preconditioning.

(10) Preconditioned conjugate gradient method (PCG).

(11) Incomplete factorization preconditioning.

(12) Multigrid preconditioning.

(13) Nonsymmetric problems (GMRES, BiCGstab).

(14) Indefinite problems (SYMMLQ, MINRES).

Literature


Prerequisites / notice

Prerequisites: Linear Algebra, Analysis, Computational Science. The exercises are made with Matlab.

263-5200-00L Data Mining: Learning from Large Data Sets

- Dealing with large data (Data centers; Map-Reduce/Hadoop; Amazon Mechanical Turk)
- Fast nearest neighbor methods (Shingling, locality sensitive hashing)
- Online learning (Online optimization and regret minimization, online convex programming, applications to large-scale Support Vector Machines)
- Multi-armed bandits (exploration-exploitation tradeoffs, applications to online advertising and relevance feedback)
- Active learning (uncertainty sampling, pool-based methods, label complexity)
- Dimension reduction (random projections, nonlinear methods)
- Data streams (Sketches, coresets, applications to online clustering)
- Recommender systems

Prerequisites: Solid basic knowledge in statistics, algorithms and programming. Background in machine learning is helpful but not required.

263-5210-00L Probabilistic Artificial Intelligence

- Search (BFS, DFS, A”, Constraint satisfaction and optimization
- Tutorial in logic (propositional, first-order)
- Probability
- Bayesian Networks (models, exact and approximative inference, learning) - Temporal models (Hidden Markov Models, Dynamic Bayesian Networks)
- Probabilistic planning (MDPs, POMDPs)
- Reinforcement learning
- Combining logic and probability

Prerequisites / notice

Solid basic knowledge in statistics, algorithms and programming.

263-5902-00L Computer Vision

- How can we build systems that perform well in uncertain environments and unforeseen situations? How can we build systems that exhibit “intelligent” behavior, without prescribing explicit rules? How can we build systems that learn from experience in order to improve their performance? We will study core modeling techniques and algorithms from statistics, optimization, planning, and control and study applications in areas such as sensor networks, robotics, and the Internet.

- Topics covered:
  - Search (BFS, DFS, A”), constraint satisfaction and optimization
  - Tutorial in logic (propositional, first-order)
  - Probability
  - Bayesian Networks (models, exact and approximative inference, learning) - Temporal models (Hidden Markov Models, Dynamic Bayesian Networks)
  - Probabilistic planning (MDPs, POMDPs)
  - Reinforcement learning
  - Combining logic and probability

Prerequisites / notice

Solid basic knowledge in statistics, algorithms and programming.
### Abstract
The goal of this course is to provide students with a good understanding of computer vision and image analysis techniques. The main concepts and techniques will be studied in depth and practical algorithms and approaches will be discussed and explored through the exercises.

### Objective
The objectives of this course are:
1. To introduce the fundamental problems of computer vision.
2. To introduce the main concepts and techniques used to solve those.
3. To enable participants to implement solutions for reasonably complex problems.
4. To enable participants to make sense of the computer vision literature.

### Content
Camera models and calibration, invariant features, Multiple-view geometry, Model fitting, Stereo Matching, Shape from Silhouettes, Optical flow, Structure from motion, Tracking, Object recognition, Object category recognition

### Prerequisites / notice
It is recommended that students have taken the Visual Computing lecture or a similar course introducing basic image processing concepts before taking this course.

<table>
<thead>
<tr>
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<th>Title</th>
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<th>Prerequisites / notice</th>
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<td>Computational Regularity</td>
<td>W</td>
<td>4</td>
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<tr>
<td>Objective</td>
<td>The course forms the key component of this course which links theory and applications. Students will witness effective computational models with concrete applications in robotics, computer vision, computer graphics and medical image analysis. The emphasis is on hands-on computational experience and on producing state of the art, publishable research projects. During the semester, we shall start with intuition, learn the basic mathematical concepts and develop state of the art computer algorithms for real-world problems. Our goal is to build &quot;bridges&quot; connecting, symmetry, symmetry group theory, general and specific regularities and real-world applications.</td>
<td></td>
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</tr>
<tr>
<td>Content</td>
<td>Regularity is an essential and ubiquitous concept in nature, science and art. Numerous biological, natural or man-made structures exhibit regularities, abstracted by symmetries, as a fundamental design principle or as an essential aspect of their function. Whether by evolution or by design, symmetry implies potential structural efficiencies that make it universally appealing. Much of our understanding of the world is based on the perception and recognition of recurring structures, and so is our sense of beauty. With increasing amount and variety of digitized data, seeking for patterns systematically has become increasingly pertinent and necessary. This course concentrates on rigorous theories, keen observations and computational discovery of patterns in various data forms in our daily life and research. We aim to develop effective computational treatments of regularity to capture real world regular or near-regular patterns in spite of uncertainty.</td>
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</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
<th>ECTS</th>
<th>Prerequisites / notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0778-00L</td>
<td>Hardware/Software Codesign</td>
<td>W</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Objective</td>
<td>The course provides advanced knowledge in the design of complex computer systems, in particular embedded systems. Models and methods are discussed that are fundamental for systems that consist of software and hardware components.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Content</td>
<td>The course provides advanced knowledge in the design of complex computer systems, in particular embedded systems. Models and methods are discussed that are fundamental for systems that consist of software and hardware components.</td>
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</table>

### Literature

### 401-0647-00L
Introduction to Mathematical Optimization

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
<th>ECTS</th>
<th>Prerequisites / notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective</td>
<td>The goal of the course is to obtain a good understanding of some of the most fundamental mathematical optimization techniques used to solve linear programs and basic combinatorial optimization problems. The students will also practice applying the learned models to problems in engineering.</td>
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<tr>
<td>Content</td>
<td>Topics covered in this course include:</td>
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<tr>
<td>Literature</td>
<td>- Linear programming (simplex method, duality theory, shadow prices, ...),</td>
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<tr>
<td>Prerequisites / notice</td>
<td>- Basic combinatorial optimization problems (spanning trees, network flows, knapsack problem, ...),</td>
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<td></td>
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<tr>
<td>Literature</td>
<td>- Modelling with mathematical optimization: applications of mathematical programming in engineering.</td>
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</table>

### 636-0007-00L
Computational Systems Biology

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
<th>ECTS</th>
<th>Prerequisites / notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective</td>
<td>The aim of this course is to provide an introductory overview of mathematical and computational methods for the modeling, simulation and analysis of biological networks.</td>
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<tr>
<td>Content</td>
<td>Biology has witnessed an unprecedented increase in experimental data and, correspondingly, an increased need for computational methods to analyze this data. The explosion of sequenced genomes, and subsequently, of bioinformatics methods for the storage, analysis and comparison of genetic sequences provides a prominent example. Recently, however, an additional area of research, captured by the label &quot;Systems Biology&quot;, focuses on how networks, which are more than the mere sum of their parts' properties, establish biological functions. This is essentially a task of reverse engineering. The aim of this course is to provide an introductory overview of corresponding computational methods for the modeling, simulation and analysis of biological networks. We will start with an introduction into the basic units, functions and design principles that are relevant for biology at the level of individual cells. Making extensive use of example systems, the course will then focus on methods and algorithms that allow for the investigation of biological networks with increasing detail. These include (i) graph theoretical approaches for revealing large-scale network organization, (ii) probabilistic (Bayesian) network representations, (iii) structural network analysis based on reaction stoichiometries, (iv) qualitative methods for dynamic modeling and simulation (Boolean and piece-wise linear approaches), (v) mechanistic modeling using ordinary differential equations (ODEs) and finally (vi) stochastic simulation methods.</td>
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</table>


### 636-0017-00L
Computational Biology

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
<th>ECTS</th>
<th>Prerequisites / notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective</td>
<td>The aim of the course is to provide up-to-date knowledge on how we can study biological processes using genetic sequencing data. Computational algorithms extracting biological information from genetic sequence data are discussed, and statistical tools to understand this information in detail are introduced.</td>
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<tr>
<td>Content</td>
<td>The course is meant for students who did not already attend the course &quot;Mathematical Optimization&quot;, which is a more advance lecture covering similar topics and more.</td>
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</table>

Data: 06.03.2019 12:57  Autumn Semester 2016  Page 337 of 1571
Objective
Attendees will learn which information is contained in genetic sequencing data and how to extract information from them using computational tools. The main concepts introduced are:
* stochastic models in molecular evolution
* phylogenetic & phylodynamic inference
* maximum likelihood and Bayesian statistics

Attendees will apply these concepts to a number of applications yielding biological insight into:
* epidemiology
* pathogen evolution
* macroevolution of species

Content
The course consists of four parts. We first introduce modern genetic sequencing technology, and algorithms to obtain sequence alignments from the output of the sequencers. We then present methods to directly analyze this alignment (such as BLAST algorithm, GWAS approaches). Second, we introduce mechanisms and concepts of molecular evolution, i.e. we discuss how genetic sequences change over time. Third, we employ evolutionary concepts to infer ancestral relationships between organisms based on their genetic sequences, i.e. we discuss methods to infer genealogies and phylogenies. Finally, we introduce the field of phylo-dynamics. The aim of that field is to understand and quantify the population dynamic processes (such as transmission in epidemiology or speciation & extinction in macroevolution) based on a phylogeny. Throughout the class, the models and methods are illustrated on different datasets giving insight into the epidemiology and evolution of a range of infectious diseases (e.g. HIV, HCV, influenza, Ebola). Applications of the methods to the field of macroevolution provide insight into the evolution and ecology of different species clades. Students will be trained in the algorithms and their application both on paper and in silico as part of the exercises.

Lecture notes
Slides of the lecture will be available online.
https://www.bsse.ethz.ch/cevo/education/cb-materials.html

Literature
The course is not based on any of the textbooks below, but they are excellent choices as accompanying material:
* Yang, Z. 2006. Computational Molecular Evolution.
* Drummond, A. & Bouckaert, R. 2015. Bayesian evolutionary analysis with BEAST

Prerequisites / notice
Basic knowledge in linear algebra, analysis, and statistics will be helpful. Some programming experience will be useful for the exercises, but is not required. Programming skills will not be tested in the examination.

<table>
<thead>
<tr>
<th>Seminars</th>
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<tbody>
<tr>
<td>Number</td>
</tr>
<tr>
<td>252-4202-00L</td>
</tr>
<tr>
<td>252-4601-00L</td>
</tr>
<tr>
<td>252-5051-00L</td>
</tr>
<tr>
<td>252-5701-00L</td>
</tr>
</tbody>
</table>

The reading list will be published on the course web site.

Number of participants limited to 24.

Abstract
This seminar covers advanced topics in computer graphics, such as modeling, rendering, animation, real-time graphics, physical simulation, and computational photography. Each time the course is offered, a collection of research papers is selected and each student presents one paper to the class and leads a discussion about the paper and related topics.

Objective
The goal is to get an in-depth understanding of actual problems and research topics in the field of computer graphics as well as improve presentations and critical analysis skills.
Research Topics in Software Engineering

Number of participants limited to 22.

This seminar is an opportunity to become familiar with current research in software engineering and more generally with the methods and challenges of scientific research.

Each student will be asked to study some papers from the recent software engineering literature and review them. This is an exercise in critical review and analysis. Active participation is required (a presentation of a paper as well as participation in discussions).

The aim of this seminar is to introduce students to recent research results in the area of programming languages and software engineering. To accomplish that, students will study and present research papers in the area as well as participate in paper discussions. The papers will span topics in both theory and practice, including papers on program verification, program analysis, testing, programming language design, and development tools. A particular focus will be on domain-specific languages.

Organizational note: the seminar will meet only when there is a scheduled presentation. Please consult the seminar’s home page for information.

Machine Learning for Interactive Systems and Advanced Programming Tools

Seminars often suffer from poor attention retention and low student engagement. This is often due to the format of the seminar where only one student reads papers in-depth and then prepares a long presentation about one or sometimes several papers. There is little reason for the other students to really pay attention or engage in the discussion.

To improve this the seminar will use a case-study format where all students read the same paper each week but fulfill different roles and hence prepare with different viewpoints in mind.

Student roles/instructions

The seminar is organized with each student taking one of the following roles on a rotating basis:

- Conference Reviewer (e.g., reviewer of UIST/ICML/PLDI): Complete a full critical review of the paper. Use the original review from and come to a recommendation whether the paper should be accepted or not.
- Historian: Find out how this paper sits in the context of the related work. Use bibliography tools to find the most influential papers cited by this work and at least one paper influenced by the work (and summarize the two papers).
- PhD student: Propose a follow-up project for your own research based on this paper - importantly the project should be directly inspired by the paper or even use/extend the method proposed.
- Hacker: Implement a (simplified) version of the core aspect of the paper. Prepare a demo for the seminar. In case the complexity is too high perform an in-depth analysis of reproducibility of the paper.
- Detective: Find out background information about the authors. Where did they work when the paper was published; what was their role; who else have they published with; which prior work of the authors may have inspired the current paper? Students may contact the authors (but need to adhere to politeness and courteous manners and stay on topic in their conversations).

PhD student: Propose a follow-up project for your own research based on this paper - importantly the project should be directly inspired by the paper or even use/extend the method proposed.

Organizational note: the seminar will meet only when there is a scheduled presentation. Please consult the seminar’s home page for information.

Hardware Acceleration for Data Processing

The seminar will cover topics related to data processing using new hardware in general and hardware accelerators (GPU, FPGA, specialized processors) in particular.

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The general application areas are big data and machine learning. The systems covered will include systems from computer architecture, high performance computing, data appliances, and data centers.

Students taking this seminar should have the necessary background in systems and low level programming.

Communication Networks Seminar

The objectives are (a) to understand the state-of-the-art in the field; (b) to learn to read, present and critique papers; and (c) to identify opportunities for new research.

Students are expected to attend the entire seminar, choose a topic for presentation from a given list, and make a presentation on that topic. Students are evaluated on the knowledge gained, the presentation made, and the report they present at the end of the semester.

Seminar on Molecular Algorithms

Limited number of participants

This seminar covers advanced topics in computer graphics, including both seminal research papers as well as the latest research results. Each time the course is offered, a collection of research papers are selected covering topics such as modeling, rendering, animation, real-time graphics, physical simulation, and computational photography. Each student presents one paper to the class and leads a discussion about the paper and related topics.

All students read the papers and participate in the discussion.

This seminar is an opportunity to become familiar with current research in software engineering and more generally with the methods and challenges of scientific research.

Each student will be asked to study some papers from the recent software engineering literature and review them. This is an exercise in critical review and analysis. Active participation is required (a presentation of a paper as well as participation in discussions).

The aim of this seminar is to introduce students to recent research results in the area of programming languages and software engineering. To accomplish that, students will study and present research papers in the area as well as participate in paper discussions. The papers will span topics in both theory and practice, including papers on program verification, program analysis, testing, programming language design, and development tools. A particular focus will be on domain-specific languages.

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- Historian: Find out how this paper sits in the context of the related work. Use bibliography tools to find the most influential papers cited by this work and at least one paper influenced by the work (and summarize the two papers).
- PhD student: Propose a follow-up project for your own research based on this paper - importantly the project should be directly inspired by the paper or even use/extend the method proposed.
- Hacker: Implement a (simplified) version of the core aspect of the paper. Prepare a demo for the seminar. In case the complexity is too high perform an in-depth analysis of reproducibility of the paper.
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PhD student: Propose a follow-up project for your own research based on this paper - importantly the project should be directly inspired by the paper or even use/extend the method proposed.

Organizational note: the seminar will meet only when there is a scheduled presentation. Please consult the seminar’s home page for information.

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The general application areas are big data and machine learning. The systems covered will include systems from computer architecture, high performance computing, data appliances, and data centers.

Students taking this seminar should have the necessary background in systems and low level programming.

Communication Networks Seminar

The objectives are (a) to understand the state-of-the-art in the field; (b) to learn to read, present and critique papers; and (c) to identify opportunities for new research.

Students are expected to attend the entire seminar, choose a topic for presentation from a given list, and make a presentation on that topic. Students are evaluated on the knowledge gained, the presentation made, and the report they present at the end of the semester.

Seminar on Molecular Algorithms

Limited number of participants
**Abstract**
Develop an understanding of selected topics in the area of molecular algorithms, and the practice of scientific research.

**Objective**
Study and understanding of selected topics of interest in molecular algorithms such as: Computational Power of Molecular Algorithms, Molecular Algorithms for Solving Fundamental Tasks (Majority, Leader Election, Counting), Complexity Lower Bounds, Implementations of Algorithms in DNA.

**Content**
This seminar will familiarize the students with current research on molecular algorithms, with a focus on algorithms executable in DNA. We will have an introductory lecture covering the basics of molecular computational models, and the underlying bio-chemical phenomena. Subsequently, we will read and present selected research papers, focusing on their algorithmic content.

No prior knowledge of biology or chemistry will be required.

**Literature**
Selected research articles.

**Prerequisites / Notice**
The course will require a good understanding of Randomized Algorithms. Hence, you must have passed our “Randomized Algorithms” class (or have acquired equivalent knowledge, in exceptional cases). No prior knowledge of biology or chemistry will be assumed. The basics will be presented in an introductory lecture.

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**227-0559-00L Seminar in Distributed Computing**

**Objective**
In this seminar participating students present and discuss recent research papers in the area of distributed computing. The seminar consists of algorithmic as well as systems papers in distributed computing theory, peer-to-peer computing, ad hoc and sensor networking, or multi-core computing.

**Abstract**
In the last two decades, we have experienced an unprecedented growth in the area of distributed systems and networks; distributed computing now encompasses many of the activities occurring in today's computer and communications world. This course introduces the basics of distributed computing, highlighting common themes and techniques. We study the fundamental issues underlying the design of distributed systems: communication, coordination, synchronization, uncertainty. We explore essential algorithmic ideas and lower bound techniques.

In this seminar, students present the latest work in this domain.

Seminar language: English

**Content**
Different each year. For details see: www.disco.ethz.ch/courses.html

**Lecture notes**
Slides of presentations will be made available.

**Literature**
Papers.

The actual paper selection can be found on www.disco.ethz.ch/courses.html.

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**Certificate of Advanced Studies in Computer Science - Key for Type**

<table>
<thead>
<tr>
<th>O</th>
<th>Compulsory</th>
</tr>
</thead>
<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
</tbody>
</table>

**E-** Recommended, not eligible for credits

**Z** Courses outside the curriculum

**Dr** Suitable for doctorate

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**Key for Hours**

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
</tr>
</thead>
<tbody>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
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<table>
<thead>
<tr>
<th>P</th>
<th>practical/laboratory course</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

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**ECTS** European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
## CAS in Nutrition for Disease Prevention and Health

### Disciplinary Subjects

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>752-6101-00L</td>
<td>Dietary Etiologies of Chronic Disease</td>
<td>W</td>
<td>3 credits</td>
<td>2V</td>
<td>M. B. Zimmermann</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>To have the student gain understanding of the links between the diet and the etiology and progression of chronic diseases, including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>To examine and understand the protective effect of foods and food ingredients in the maintenance of health and the prevention of chronic disease, as well as the progression of complications of the chronic diseases.</td>
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<tr>
<td><strong>Content</strong></td>
<td>The course evaluates food and food ingredients in relation to primary and secondary prevention of chronic diseases including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.</td>
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<tr>
<td><strong>Lecture notes</strong></td>
<td>There is no script. Powerpoint presentations will be made available on-line to students.</td>
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<tr>
<td><strong>Prerequisites / notice</strong></td>
<td>No compulsory prerequisites, but prior completion of Human Nutrition I + II (Humanernährung I+II) is strongly advised.</td>
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<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>752-6403-00L</td>
<td>Nutrition and Performance</td>
<td>W</td>
<td>2 credits</td>
<td>2V</td>
<td>S. Mettler, M. B. Zimmermann</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>The course introduces basic concepts of the interaction between nutrition and exercise and cognitive performance.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>To understand the potential effects of nutrition on exercise performance, with a focus on concepts and principles of nutrition before, during and after exercise.</td>
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<tr>
<td><strong>Content</strong></td>
<td>The course will cover elementary aspects of sports nutrition physiology, including carbohydrate, glycogen, fat, protein and energy metabolism. A main focus will be to understand nutritional aspects before exercise to be prepared for intensive exercise bouts, how exercise performance can be supported by nutrition during exercise and how recovery can be assisted by nutrition after exercise. Although this is a scientific course, it is a goal of the course to translate basic sports nutrition science into practical sports nutrition examples.</td>
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<tr>
<td><strong>Lecture notes</strong></td>
<td>Lecture slides and required handouts will be available on the ETH website.</td>
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<tr>
<td><strong>Literature</strong></td>
<td>Information on further reading will be announced during the lecture. There will be some mandatory as well as voluntary readings.</td>
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<tr>
<td><strong>Prerequisites / notice</strong></td>
<td>General knowledge about nutrition, human biology, physiology and biochemistry is a prerequisite for this course. The course builds on basic nutrition and biochemistry knowledge to address exercise and performance related aspects of nutrition. The course is designed for 3rd year Bachelor students, Master students and postgraduate students (MAS/CAS). Language: English</td>
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It is strongly recommended to attend the lectures. The lecture (including the handouts) is not designed for distance education.

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>752-6301-00L</td>
<td>Selected Topics in Physiology Related to Nutrition</td>
<td>W</td>
<td>3 credits</td>
<td>2V</td>
<td>W. Langhans</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>Gives the students background knowledge necessary for a basic understanding of the complex relationships between food composition and nutrition on one hand and the functioning, as well as the malfunctioning, of major organ systems on the other hand.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>Some basic knowledge in physiology is recommended for this course, which revisits important physiological topics, emphasizing their relation to nutrition. The aim is to give the students background knowledge necessary for a basic understanding of the complex relationships between food composition and nutrition on one hand and the functioning, as well as the malfunctioning, of major organ systems on the other hand. For students with a background in medicine, pharmacy or biology, the course is useful as a review of previously acquired knowledge. Major topics are basic neuroanatomy and neurophysiology; general endocrinology; the physiology of taste and smell; nutrient digestion and absorption; intermediary metabolism and energy homeostasis; and some aspects of cardiovascular physiology and water balance.</td>
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</tr>
<tr>
<td><strong>Lecture notes</strong></td>
<td>Handouts for each lecture will be made available every week: <a href="http://www.fpb.ethz.ch/teaching/handouts.html">http://www.fpb.ethz.ch/teaching/handouts.html</a></td>
<td></td>
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</tbody>
</table>

### CAS in Nutrition for Disease Prevention and Health - Key for Type

| O | Compulsory | E- | Recommended, not eligible for credits |
| W+ | Eligible for credits and recommended | Z | Courses outside the curriculum |
| W | Eligible for credits | Dr | Suitable for doctorate |

### Key for Hours

| V | lecture |
| G | lecture with exercise |
| U | exercise |
| S | seminar |
| K | colloquium |

| P | practical/laboratory course |
| A | independent project |
| D | diploma thesis |
| R | revision course / private study |

### ECTS

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Chemistry (General Courses)

General Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0073-00L</td>
<td>Radiochemistry</td>
<td>E-</td>
<td>2 credits</td>
<td>2V</td>
<td>M. Badertscher</td>
</tr>
<tr>
<td>Abstract</td>
<td>Principles and phenomena around radioactivity.</td>
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</tr>
<tr>
<td>Objective</td>
<td>Knowledge of the most important phenomena in relation with radioactivity. Knowledge of the principles of radiation protection. Ability to judge dangerous situations in handling radioactive materials, geopolitically as well as locally at ones own working place.</td>
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<tr>
<td>Content</td>
<td>Structure and properties of atomic nuclei, mathematical description of the radioactive decay, decay types, interaction of radiation with matter, detectors for ionizing radiation, radiation protection, principles of isotope separation, nuclear power plants, major nuclear accidents. Additional topics may be suggested by the students.</td>
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<tr>
<td>Lecture notes</td>
<td>Stress is on chemical aspects of radioactivity and on radiation protection.</td>
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</tr>
<tr>
<td>Literature</td>
<td>A script is available free of charge.</td>
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</tbody>
</table>

Weitere Literaturangaben werden nach Bedarf in der Vorlesung abgegeben.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>529-0075-00L</td>
<td>Radiochemistry (Practical Training)</td>
<td>E-</td>
<td>4 credits</td>
<td>4P</td>
<td>M. Badertscher</td>
</tr>
<tr>
<td>Objective</td>
<td>Knowledge of the most important phenomena in relation with radioactivity. Knowledge of the principles of radiation protection. Ability to handle radioactive material.</td>
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</tr>
<tr>
<td>Content</td>
<td>Handling open and closed radioactive sources. Getting accustomed to a variety of instruments and detectors for various kinds of ionizing radiation. Acquisition of working techniques under consideration of radiation protection.</td>
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<tr>
<td>Lecture notes</td>
<td>Comprehensive material is available online.</td>
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<thead>
<tr>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>Abstract</td>
<td>Institute-Seminar covering current research Topics in Physical Chemistry</td>
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</tbody>
</table>

529-1100-00L    Fragrance Chemistry       E-   1 credit | 1V    P. Kraft |

Abstract
The lecture provides a journey into the molecular world of scents from the chemical secrets behind Chanel N°5 to structure-odor relationships, industrial processes, and total synthesis of terpenoids. Each subunit is centered on one odorant family and highlights a certain class of chemical reactions, illustrated by prominent perfumery examples.

Objective
After completion of this lecture module the students know all the major perfumery materials of the important odor families with their academic and industrial syntheses, their olfactory properties, their usage, their historic perspective, and today's economic importance. The students can explain the significance of important building blocks and industrial transformations, and can estimate how attractive chemical processes are on large scale. They can retrosynthetically plan academic and industrial syntheses of fragrant compounds and terpenoids, and the acquired knowledge on structure-odor relationships enables them to predict and design new odors. The students can approximate the conformational space of odorants and especially macrocycles on the basis of simple rules, and know how olfactophore models are used. The students understand and can explain the molecular mechanism of smell, the biosynthesis of terpenes, and the basics of perfumery composition. The latter enables them to further their education in perfumery at specialized Universities such as the ISIPCA in Versailles; yet, the student also knows about the links of Fragrance Chemistry with Pharmaceutical Chemistry and the Specialty Chemicals business in general.

Literature

529-0688-00L    Safety Lecture for Assistants | Z | 0 credits | T. Mäder |

Abstract
Safety-Praxis und Riskmanagement in Laboratorien

Objective
Gute Safety-Praxis

Content
Safety-Regeln, Riskmanagement im Labor, Safety-Parcours

Chemistry (General Courses) - Key for Type

<table>
<thead>
<tr>
<th>Dr</th>
<th>Suitable for doctorate</th>
<th>W</th>
<th>Eligible for credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
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</table>

Key for Hours

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
<th>P</th>
<th>practical/laboratory course</th>
</tr>
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<tbody>
<tr>
<td>G</td>
<td>lecture with exercise</td>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>S</td>
<td>seminar</td>
<td>R</td>
<td>revision course / private study</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
<td></td>
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</table>

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Chemistry Bachelor

1. Semester

Compulsory Subjects First Year Examinations

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0011-02L</td>
<td>General Chemistry (Inorganic Chemistry) I</td>
<td>O</td>
<td>3</td>
<td>2V+1U</td>
<td>A. Togni</td>
</tr>
<tr>
<td></td>
<td>Introduction to the chemistry of ionic equilibria: Acids and bases, redox reactions, formation of coordination complexes and precipitation reactions</td>
<td></td>
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<tr>
<td></td>
<td>Understanding and describing ionic equilibria from both a qualitative and a quantitative perspective</td>
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<tr>
<td></td>
<td>Chemical equilibrium and equilibrium constants, mono- and polyprotic acids and bases in aqueous solution, calculation of equilibrium concentrations, acidity functions, Lewis acids, acids in non-aqueous solvents, redox reactions and equilibria, Galvanic cells, electrode potentials, Nernst equation, coordination chemistry, stepwise formation of metal complexes, solubility</td>
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<tr>
<td></td>
<td>Copies of the course slides as well as other documents will be provided as pdf files via the moodle platform.</td>
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<tr>
<td>529-0011-03L</td>
<td>General Chemistry (Organic Chemistry) I</td>
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<td>3</td>
<td>2V+1U</td>
<td>H. Wennemers</td>
</tr>
<tr>
<td></td>
<td>Introduction to Organic Chemistry. Classical structure theory, stereochemistry, chemical bonds and bonding, symmetry, nomenclature, organic thermochemistry, conformational analysis, basics of chemical reactions.</td>
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<tr>
<td></td>
<td>Introduction to the structures of organic compounds as well as the structural and energetic basis of organic chemistry.</td>
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<tr>
<td></td>
<td>Chemical bonding: ionic bonding, covalent bonding, molecular orbitals. Equations of state.</td>
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<td></td>
<td>Introduction to Physical Chemistry</td>
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<tr>
<td></td>
<td>Atomic structure and structure of matter: atomic theory, elementary particles, atomic nuclei, radioactivity, nuclear reactions. Atomic orbitals and energy levels: ionisation energies, atomic spectroscopy, term values and symbols. Quantum mechanical atom model: wave-particle duality, the uncertainty principle, Schrödinger’s equation, the hydrogen atom, construction of the periodic table of the elements.</td>
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<td></td>
<td>Chemical bonding: ionic bonding, covalent bonding, molecular orbitals. Equations of state: ideal gases</td>
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<td>See homepage of the lecture.</td>
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<tr>
<td>529-0011-01L</td>
<td>General Chemistry (Physical Chemistry) I</td>
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<td>F. Merkt</td>
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<td>Atomic structure and structure of matter; Atomic orbitals and energy levels; Quantum mechanical atom model; Chemical bonding; Equations of state.</td>
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<td></td>
<td>Introduction to Physical Chemistry</td>
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<td></td>
<td>Atomic structure and structure of matter: atomic theory, elementary particles, atomic nuclei, radioactivity, nuclear reactions. Atomic orbitals and energy levels: ionisation energies, atomic spectroscopy, term values and symbols. Quantum mechanical atom model: wave-particle duality, the uncertainty principle, Schrödinger’s equation, the hydrogen atom, construction of the periodic table of the elements.</td>
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<td></td>
<td>Chemical bonding: ionic bonding, covalent bonding, molecular orbitals. Equations of state: ideal gases</td>
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<tr>
<td></td>
<td>Voraussetzungen: Maturastoff. Insbesondere Integral- und Differentialrechnung.</td>
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<tr>
<td>551-0015-00L</td>
<td>Biology I</td>
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<td>2</td>
<td>2V</td>
<td>R. Glockshuber, E. Hafen</td>
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<td></td>
<td>The lecture Biology I, together with the lecture Biology II in the following summer semester, is a basic, introductory course into Biology for Students of Materials Sciences and other students with biology as subsidiary subject.</td>
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<tr>
<td></td>
<td>The goal of this course is to give the students a basic understanding of the molecules that build a cell and make it function, and the basic principles of metabolism and molecular genetics.</td>
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<tr>
<td></td>
<td>Die folgenden Kapitelnummern beziehen sich auf das der Vorlesung zugrundeliegende Lehrbuch &quot;Biology&quot; (Campbell &amp; Rees, 10th edition, 2015) Kapitel 1-4 des Lehrbuchs werden als Grundwissen vorausgesetzt</td>
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<tr>
<td></td>
<td>1. Aufbau der Zelle</td>
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<td></td>
<td>Kapitel 5: Struktur und Funktion biologischer Makromoleküle</td>
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<td></td>
<td>Kapitel 6: Eine Tour durch die Zelle</td>
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<td>Kapitel 7: Membranstruktur und-funktion</td>
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<td></td>
<td>Kapitel 8: Einführung in den Stoffwechsel</td>
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<td>Kapitel 9: Zelluläre Atemung und Speicherung chemischer Energie</td>
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<td>Kapitel 10: Photosynthese</td>
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<td>Kapitel 12: Der Zeltyzklus</td>
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<td>Kapitel 17: Vom Gen zum Protein</td>
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<td></td>
<td>2. Allgemeine Genetik</td>
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<td></td>
<td>Kapitel 13: Meiose und Reproduktionszyklen</td>
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<td>Kapitel 14: Mendel'sche Genetik</td>
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<td></td>
<td>Kapitel 15: Die chromosomale Basis der Vererbung</td>
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<td></td>
<td>Kapitel 16: Die molekulare Grundlage der Vererbung</td>
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<td></td>
<td>Kapitel 18: Genetik von Bakterien und Viren</td>
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<td></td>
<td>Kapitel 46: Tierische Reproduktion</td>
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<td></td>
<td>Grundlagen des Stoffwechsels und eines Überblicks über molekulare Genetik</td>
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<tr>
<td></td>
<td>Der Vorlesungsstoff ist sehr nahe am Lehrbuch ge halten, Skripte werden ggf. durch die Dozenten zur Verfügung gestellt.</td>
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<tr>
<td></td>
<td>Das folgende Lehrbuch ist Grundlage für die Vorlesungen Biologie I und II:</td>
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<tr>
<td>401-0271-00L</td>
<td>Mathematical Foundations I: Analysis A</td>
<td>O</td>
<td>5</td>
<td>3V+2U</td>
<td>L. Keller</td>
</tr>
<tr>
<td></td>
<td>Introduction to calculus in one dimension. Building simple models and analysing them mathematically. Functions of one variable: the notion of a function, of the derivative, the idea of a differential equation, complex numbers, Taylor polynomials and Taylor series. The integral of a function of one variable.</td>
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<tr>
<td></td>
<td>Objective: Introduction to calculus in one dimension. Building simple models and analysing them mathematically.</td>
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</table>

Data: 06.03.2019 12:57
Autumn Semester 2016
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Functions of one variable: the notion of a function, of the derivative, the idea of a differential equation, complex numbers, Taylor polynomials and Taylor series. The integral of a function of one variable.

G. B. Thomas, M. D. Weir, J. Hass: Analysis 1, Lehr- und Übungsbuch, Pearson-Verlag
D. W. Jordan, P. Smith: Mathematische Methoden für die Praxis, Spektrum Akademischer Verlag
R. Sperber/M. Alfeld: Analysis I (vdf)
L. Papula: Mathematik für Ingenieure und Naturwissenschaftler (3 Bände), Viewer

Introduction to UNIX, data representation, introduction to C++, programming, errors, algorithms, computer architecture, sorting and searching, databases, numerical algorithms, types of algorithms, simulation, data communication & networks, chemical structures, operating systems, programming languages, software engineering.

For more information: www.csms.ethz.ch/education/linfo

Discuss fundamentals of computer architecture, languages, algorithms and programming with an eye to their application in the area of chemistry, biology and material science.

Minimal introduction to UNIX, Data representation and processing, algorithms and programming in C++, Errors, programming guidelines, efficiency, computer architecture, algorithms for sorting and searching, databases, numerical algorithms, types of algorithms, simulation, data communication & networks, chemical structures, operating systems, programming languages, style, software engineering.

For more information about the lecture: www.csms.ethz.ch/education/linfo

Information about the practical course will be given on the first day.

Qualitative analysis (determination of cations and anions), acid-base-equilibria (pH-values, titrations, buffer), precipitation equilibria (gravimetry, potentiometry, conductivity), redox reactions (syntheses, redox-titrations, galvanic elements), metal complexes (syntheses, complexometric titration) analysis of measured values, states of aggregation (vapour pressure, conductivity, calorimetry)

Qualitative analysis (simple cation and anion separation process, determination of cations and anions), acid-base-equilibria (strengths of acids and bases, pH- and pKa-values, titrations, buffer systems, Kjeldahl determination), precipitation equilibria (gravimetry, potentiometry, conductivity), oxidation state and redox behaviour (syntheses), redox-titrations, galvanic elements), metal complexes (syntheses of complexes, ligand exchange reactions, complexometric titration) analysis of measured values (measuring error, average value, error analysis), states of aggregation (vapour pressure), characteristics of electrolytes (conductivity measurements), thermodynamics (calorimetry)

The general aim for the students of the practical course in general chemistry is an introduction in the scientific work and to get familiar with simple experimental procedures in a chemical laboratory. In general, first experiences with the principal reaction behaviour of a variety of different substances will be made. The chemical characteristics of these will be elucidated by a series of quantitative experiments alongside with the corresponding qualitative analyses. In order to get an overview of classes of substances as well as some general phenomena in chemistry suitable experiments have been chosen. In the second part of the practical course, i.e. physical chemistry, the behaviour of substances in their states of aggregation as well as changes of selected physical values will be recorded and discussed.

http://www.gruetzmacher.ethz.ch/education/labcourses

Compulsory: online enrolment latest one week prior start of the semester

529-0121-00L
529-0221-00L
529-0422-00L

Inorganic Chemistry I
Organic Chemistry I
Physical Chemistry II: Introduction to Chemical

Complexes of the transition metals: structure, bonding, spectroscopic properties, and synthesis. General synthetic strategies.
Chemical reactivity and classes of compounds. Eliminations, fragmentations, chemistry of aldehydes and ketones (hydrates, acetals, imines, enamines, nucleophilic addition of organometallic compounds, reactions with phosphorus and sulfur ylides; reactions of enolates as nucleophiles) and of carboxylic acid derivatives. Aldol reactions.
Full set of the printed lecture notes is provided online. Supplementary material may be provided online.

A. Mezzetti
F. Diederich, C. Schaack
H. J. Wörner

3 credits
3 credits
4 credits
2+1U
2+1U
3+1U

A pdf file of the printed lecture notes is provided online. Supplementary material may be provided online.

A. Mezzetti
F. Diederich, C. Schaack
H. J. Wörner

2016 Autumn Semester

Data: 06.03.2019 12:57

Page 344 of 1571
Reaction Kinetics

Abstract

Objective
Introduction to Chemical Reaction Kinetics

Content
Fundamental concepts: rate laws, elementary reactions and composite reactions, molecularity, reaction order. Experimental methods in reaction kinetics up to new developments in femtosecond kinetics. Simple chemical reaction rate theories: temperature dependence of the rate constant and Arrhenius equation, collision theory, reaction cross-section, transition state theory. Reaction mechanisms and complex kinetic systems, approximation techniques, chain reactions, explosions and detonations. Homogeneous catalysis and enzyme kinetics.

Lecture notes

Literature

Prerequisites / notice
Voraussetzungen:
- Mathematik I und II
- Allgemeine Chemie I und II
- Physikalische Chemie I

402-0043-00L Physics I O 4 credits 3V+1U T. Esslinger

Abstract
Introduction to the concepts and tools in physics with the help of demonstration experiments: mechanics of point-like and ridged bodies, periodic motion and mechanical waves.

Objective
The concepts and tools in physics, as well as the methods of an experimental science are taught. The student should learn to identify, communicate and solve physical problems in his/her own field of science.

Content
Mechanics (motion, Newton's laws, work and energy, conservation of momentum, rotation, gravitation, fluids)
Periodic Motion and Waves (periodic motion, mechanical waves, acoustics).

Lecture notes
The lecture follows the book "Physics" by Paul A. Tipler.

Literature
- Paul A. Tipler and  Gene P. Mosca, Physics (for Scientists and Engineers), W. H. Freeman and Company

Prerequisites / notice
Prerequisites: Mathematics I & II

529-0051-00L Analytical Chemistry I O 3 credits 3G D. Günther, M.O. Ebert, R. Zenobi

Abstract
Knowledge about the necessary theoretical background of spectroscopical methods and their practical applications

Objective
Application oriented basics of organic and inorganic instrumental analysis and of the empirical employment of structure elucidation methods:
- Mass spectrometry: Ionization methods, mass separation, isotope signals, rules of fragmentation, rearrangements.
- NMR spectroscopy: Experimental basics, chemical shift, spin-spin coupling.
- IR spectroscopy: Revisiting topics like harmonic oscillator, normal vibrations, coupled oscillating systems (in accordance to the basics of the related lecture in physical chemistry); sample preparation, acquisition techniques, law of Lambert and Beer, interpretation of IR spectra; Raman spectroscopy.

Lecture notes
Script will be for the production price

Literature
- M. Hesse, H. Meier, B. Zeeh, Spektroskopische Methoden in der organischen Chemie, 5. überarbeitete Auflage, Thieme, Stuttgart, 1995

Prerequisites / notice
Exercises are integrated in the lectures. In addition, attendance in the lecture 529-0289-00 "Instrumental analysis of organic compounts" (4th semester) is recommended.

401-0373-00L Mathematics III: Partial Differential Equations O 4 credits 2V+1U F. Da Lio

Abstract

Objective
The main objective is that the students get a basic knowledge of the classical tools to solve explicitly linear partial differential equations.
Content

## Examples of partial differential equations
- Classification of PDEs
- Superposition principle

## One-dimensional wave equation
- D'Alembert's formula
- Duhamel's principle

## Fourier series
- Representation of piecewise continuous functions via Fourier series
- Examples and applications

## Separation of variables
- Resolution of wave and heat equation
- Homogeneous and inhomogeneous boundary conditions, Dirichlet and Neumann boundary conditions

## Laplace equation
- Resolution of the Laplace equation on rectangle, disk and annulus
- Poisson formula
- Mean value theorem and maximum principle

## Fourier transform
- Derivation and Definition
- Inverse Fourier transformation and inversion formula
- Interpretation and properties of the Fourier transform
- Resolution of the heat equation

## Laplace transform
- Definition, motivation and properties
- Inverse Laplace transform of rational functions
- Application to ordinary differential equations

Lecture notes

There are available some Lecture Notes in English and also in German of the Professor. These can be found following the links provided under the tab 'Lernmaterialien'.

Literature


2) Y. Pinchover and J. Rubinstein, An Introduction to Partial Differential Equations, Cambridge University Press

3) E. Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons (only Chapters 1,2,6,11)


Prerequisites / notice

It is required a minimal background of: 1) multivariable functions (Riemann integrals in two or three variables, change of variables in the integrals through the Jacobian, partial derivatives, differentiability, Jacobian) 2) numerical and functional sequences and series, basic knowledge of ordinary differential equations.

### Laboratory Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>529-0129-00L</td>
<td>Inorganic and Organic Chemistry II</td>
<td>O</td>
<td>11 credits</td>
<td>16P</td>
<td>A. Mezzetti, A. Togni</td>
</tr>
</tbody>
</table>

Abstract

Introduction to the experimental methods of Inorganic Chemistry

Objective

The teaching laboratory offers an insight into different aspects of Inorganic Chemistry, including solid state chemistry, organometallic chemistry, kinetics, etc.. The synthesis, characterization and analysis of inorganic compound are a main topic. Emphasis is given to scientific writing (experiment reports).

Content

Inorganic chemistry part: Synthesis and analysis of elemento-organic compounds, metal complexes, and organometallic compounds. Introduction to Schlenk techniques, solid state synthesis, and kinetics. Introduction in the chemistry library: literature data banks and collections of spectra.

Organic synthesis with organometallic compounds and catalysts: Experiments in the framework of a selected specialised project. Possible projects: Rh catalysed asymmetric hydrogenation of enamides, Mn-catalysed epoxidation of olefins, Cu catalysed Diels-Alder reactions, synthesis of organo-boron compounds and Pd catalysed coupling with halides, Ru catalysed transfer hydrogenation.

Lecture notes

A manual is distributed in the teaching laboratory.

Prerequisites / notice

Prerequisites:
- Practical Course General Chemistry (1. Semester, 529-0011-04)
- Practical Course Inorg. and Org. Chemistry I (2. Sem., 529-0230)
- Attendance of Course Inorg. Chemistry 1 (3. Sem., 529-0121)

If necessary, access priority will be settled according to the results of the first-year examinations.

### Compulsory Subjects Examination Block II

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>529-0132-00L</td>
<td>Inorganic Chemistry III: Organometallic Chemistry and Homogeneous Catalysis</td>
<td>O</td>
<td>4 credits</td>
<td>3G</td>
<td>A. Togni, A. Mezzetti</td>
</tr>
</tbody>
</table>

Abstract

Fundamental aspects of the organometallic chemistry of the transition elements. Mechanistic homogeneous catalysis including oxidative additions, reductive eliminations and insertion reactions. Catalytic hydrogenation, carbylation, C-C bond-forming and related reactions.

Objective

Towards an understanding of the fundamental coordination-chemical and mechanistic aspects of transition-metal chemistry relevant to homogeneous catalysis.

Content

Fundamental aspects of the organometallic chemistry of the transition elements. Mechanistic homogeneous catalysis including oxidative additions, reductive eliminations and insertion reactions. Catalytic hydrogenation, carbylation, C-C bond-forming and related reactions.

<table>
<thead>
<tr>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>529-0231-00L</td>
<td>Organic Chemistry III: Introduction to Asymmetric Synthesis</td>
<td>O</td>
<td>4 credits</td>
<td>3G</td>
<td>E. M. Carreira</td>
</tr>
</tbody>
</table>

Abstract

Methods of Asymmetric Synthesis

Objective

Understanding of the basic principles of diastereoselective synthesis
Conformational analysis: acyclic and cyclic systems; Diastereoselective sigmatropic rearrangements; Diastereoselective Carbonyl addition reactions; Cram- and Felkin-Anh models, carbonyl Lewis acid interactions, chelate controlled reactions; chemistry of enolates, selective formation; asymmetric enolate alkylation; aldol reactions, allyl- and crotyl-metal chemistry; cyclisations, Baldwin rules; Diastereoselective olefin functionalization: hydroboration, dihydroxylation, epoxidation.

Evans’ Problems in Organic Chemistry App

529-0432-00L  
Physical Chemistry IV: Magnetic Resonance  
O  
4 credits  
3G  
B. H. Meier, M. Ernst, G. Jeschke, R. Riek

Abstract  
Theoretical foundations of magnetic resonance (NMR,EPR) and selected applications.

Objective  
Introduction to magnetic resonance in isotropic and anisotropic phase.

Content  
The course gives an introduction to magnetic resonance spectroscopy (NMR and EPR) in liquid, liquid crystalline and solid phase. It starts from a classical description in the framework of the Bloch equations. The implications of chemical exchange are studied and two-dimensional exchange spectroscopy is introduced. An introduction to Fourier spectroscopy in one and two dimensions is given and simple 'pulse trickery' is described. A quantum-mechanical description of magnetic resonance experiments is introduced and the spin Hamiltonian is derived. The chemical shift term as well as the scalar, dipolar and quadrupolar terms are discussed. The product-operator formalism is introduced and various experiments are described, e.g. polarization transfer. Applications in chemistry, biology, physics and medicine, e.g. determination of 3D molecular structure of dissolved molecules, determination of the structure of paramagnetic compounds and imaging (MRI) are presented.

Lecture notes  
Handed out in the lecture (in English)

Literature  
see http://www.ssnmr.ethz.ch/education/PC_IV_Lecture

529-0449-00L  
Spectroscopy  
O  
13 credits  
13P  

Abstract  
Laboratory experiments to acquire a profound knowledge of spectrocopical methods and techniques in chemistry. Evaluation and visualization of measurement data. Writing lab reports.

Objective  
Laboratory experiments to acquire a profound knowledge of spectrocopical methods and techniques in chemistry. Evaluation and visualization of measurement data. Writing lab reports.

Content  
Laboratory experiments: UV/VIS spectroscopy, luminescence spectroscopy, FT infrared spectroscopy, dye laser, light diffraction and refraction, laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS), FT nuclear magnetic resonance spectroscopy (NMR), electron paramagnetic resonance spectroscopy (EPR), atomic force microscopy (AFM), Fourier transform methods.

Prerequisites / notice  
Praktikum Physikalische und Analytische Chemie (529-0054-00) or Praktikum Physikalisiche Chemie (529-0054-01).

529-0141-00L  
Physical Methods for Inorganic Chemistry  
W  
6 credits  
3G  
D. Günther, J. Koch, R. Verel, M. D. Wörle

Abstract  
Introduction into the important methods for structural analysis (solid state NMR), crystal structure analysis and surface analysis techniques and their applications

Objective  
Knowledge in solid state NMR, crystal structure analysis and surface analytical techniques relevant for inorganic materials.

Content  
This lecture course consists of three parts 1) Solid state NMR 2) Surface and direct solid analysis 3) Crystal structure analysis. Most important fundamentals of the individual methods will be presented and details will be explained on most relevant inorganic applications.

Lecture notes  
Will be given during the lectures

529-0441-00L  
Signal Processing  
W  
6 credits  
3G  
G. Jeschke, M. Yulikov

Abstract  
Introduction of the basics of signal processing in spectroscopy. Fourier transformation, linear response theory, stochastic signals, digital data processing, Fourier spectroscopy.

Objective  
Basics of signal processing in spectroscopy

Content  

Lecture notes  
Script available

529-0041-00L  
Modern Mass Spectrometry, Hyphenated Methods, and Chemometrics  
W  
6 credits  
3G  
R. Zenobi, M. Badetscher, B. Hattendorf, P. Martinez-Lozano Sinues

Abstract  
Modern mass spectrometry, hyphenated analytical methods, speciation, methods of surface analysis, chemometrics.

Objective  
Comprehensive knowledge about the analytical methods introduced in this course, and their applications.

Content  
Coupling of separation with identification methods such as GC-MS, LC-MS, GC-IR, LC-IR, LC-NMR etc.; importance of speciation. Modern mass spectrometry: Time of flight and ion cyclotron resonance mass spectrometry, ICP-MS. Soft ionization methods, desorption methods, spray methods. Methods of surface analysis (ESCA, Auger, SIMS, raster microscopy methods). Employment of computer science for processing data in chemical analysis (chemometrics).

Lecture notes  
lecture notes will be available in the lecture at production cost.

Literature  
Information about relevant literature will be available in the lecture & in the lecture notes.
ECTS

Structure, function and chemistry of nucleic acids and carbohydrates. DNA/RNA structure and synthesis; recombinant DNA technology and

Basic crystallographic concepts: Unit cells, Bravais lattices, Laue symmetry, crystal classes (point groups), space groups, crystal growth,

Principles of Crystal Structure Determination

An introduction to the principles of X-ray diffraction and crystal structure determination as it relates to Chemistry

To gain an understanding of the principles of crystal structure determination by X-ray diffraction.

Basic crystallographic concepts: Unit cells, Bravais lattices, Laue symmetry, crystal classes (point groups), space groups, crystal growth, instrumentation, diffraction of X-rays by crystals; physical and geometric basics, powder and single crystal methods, structure solution and modelling, interpretation of crystal structure data; internal coordinates for structure description: atom spacing, co-ordination polyhedra, bond angles, torsion angles; intermolecular interactions, absolute configuration determination. Overview of inorganic, organic and macromolecular databases.

The script and exercises will be distributed weekly in loose form

Additional literature

(2) J.D. Dunitz, "X-ray Analysis and the Structure of Organic Molecules", 1995, Verlag HCA.

Computational Chemistry
### Algorithms and Programming in C++

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>529-0002-00L</td>
<td>Algorithms and Programming in C++</td>
<td>W</td>
<td>6</td>
<td>3G</td>
<td>S. Riniker</td>
</tr>
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</table>

**Abstract**

Introduction to algorithms (special focus on chemistry): Design of algorithms, data structures, search and sort algorithms, graphs, numerical algorithms, algorithms in cheminformatics, machine learning and cheminformatics.

**Objective**

Development of programming skills and craftsmanship in order to be able to deal with the complexity of computer applications in chemistry.

**Content**

Introduction to algorithms (special focus on chemistry): Design of algorithms, data structures, search and sort algorithms, graphs, numerical algorithms, algorithms in cheminformatics, machine learning and cheminformatics.

#### Literature


### Basic Polymer Synthesis

<table>
<thead>
<tr>
<th>Number</th>
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<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>529-0947-00L</td>
<td>Basic Polymer Synthesis</td>
<td>W</td>
<td>6</td>
<td>3G</td>
<td>A. D. Schlüter</td>
</tr>
</tbody>
</table>

**Abstract**

Please note that this course will be offered for the last time in the autumn semester of 2017.

**Objective**

The students should gain an overview of important polymerization procedures, learn how to deal with chemical structures and reactivities, and be able to suggest reasonable synthetic pathways to a given polymer structure. Aspects like achievable molar masses in dependence of the method used and structure perfection play a role throughout.

**Content**

I. Anionic polymerization

1. General
2. Living polymerization
3. Group transfer polymerization (GTP)
4. Some recent developments

II. Cationic polymerization

1. General
2. Some applications (macromonomer and telechelics)

III. Ziegler/Natta- and metallocene polymerization

1. General
2. Mechanism
3. Some applications

IV. Ring-opening metathesis polymerization

1. Comments on history
2. Monomers, catalysts, polymer structures
3. Mechanism, direct NMR monitoring
4. Termination
5. Examples

V. Controlled radical polymerization

1. Nitroxide mediated polymerization (NMP)
2. Atom transfer radical polymerization (ATRP)

**Lecture notes**

A script will not be provided. For all projections shown, however, paper copies will be distributed.

**Literature**

There is no specific literature recommendation. Numerous references will be provided for an easy access to the original literature.

### Introduction to Environmental Chemistry and Ecotoxicology

<table>
<thead>
<tr>
<th>Number</th>
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<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>529-0037-01L</td>
<td>Introduction to Environmental Chemistry and Ecotoxicology</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>K. Fenner, C. Bogdal, J. Hollender</td>
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</tbody>
</table>

**Abstract**

Production and use of chemicals also introduces them into the environment. This course introduces chemistry students to environmental chemistry, ecotoxicology and trace analysis.

**Objective**

The students develop an understanding of the processes that govern the fate and effects of chemicals in the environment.

**Goals**

* The students know a number of methods for estimating the fate and effect of environmental pollutants. They recognize the relevant processes affecting a given compound and know how to use appropriate estimation methods for their quantification.
Content

Part I: Fate of Chemicals in the Environment:
Relevant environmental compartments and how chemicals reach the environment.
Partitioning in the environment:
- Meaning of vapor pressure, water solubility and air-water partition coefficient for environmental behavior
- Octanol-water partition coefficient as surrogate for partitioning into biological systems
- Influence of temperature and pH on partitioning
- Global distribution of semi-volatile chemicals
- Molecular interactions that govern partitioning
- Sorption to natural surfaces, partitioning into natural organic matter
Chemical and photochemical transformation reactions
Microbial transformation processes in the environment

Part II: Effects of chemicals in the environment
Biological test systems for assessing ecotoxicological effects
Endpoints of toxicity assessment:
- Acute and chronic toxicity, effects on reproduction
- Dose-response modeling
Bioavailability and bioaccumulation:
- Bioconcentration, biomagnification, food chain accumulation
- Active and passive uptake mechanisms
Toxicokinetics and toxicodynamics:
- Metabolism and transformation reactions of pollutants in organisms, phase I and II transformations
- Detoxification, active excretion
Molecular mechanisms of toxicity in cells:
- Baseline toxicity
- Specific toxicity (Examples: Inhibition of photosynthesis, neurotoxicity, including AchEsterase, ion channels etc.)
- Oxidative stress
- Genotoxicity

Part III: Specific aspects of trace analysis in the environment (soil, water, air)
Planning of analytical strategy and sampling
Enrichment procedures
Separation and detection
Quantification, screening for unknowns

Lecture notes
Copies of the slides and some articles are distributed

Literature

701-1233-00L Stratospheric Chemistry
W 4 credits 2V+1U T. Peter, A. Stenke

Abstract

Objective
The lecture gives an overview on the manifold reactions which occur in the gas phase, in stratospheric aerosol droplets and in polar cloud particles. The focus is on the chemistry of stratospheric ozone and its influence through natural and anthropogenic effects. Especially the intercontinental air traffic and the ozone depletion caused by FCKW CFC in the mid-latitude and the polar regions as well as coupling with the greenhouse effect.

Content
Short presentation of thermodynamical and kinetic basics of chemical reactions: bi- and thermo rmolecular reactions, photo-dissociation. Introduction to the chemical family concept: active species, their source gases and reservoir gases. Detailed treatment of the pure oxygen family (odd oxygen) according to the Chapman chemistry. Radical reactions of the oxygen species with nitric oxide, active halogens (chlorine and bromine) and odd hydrogen. Ozone depletion cycles. Methane depletion and ozone production in the lower stratosphere (photo-smog reactions). Heterogeneous chemistry on the background aerosol and its significance for heavy air traffic. Chemistry and dynamics of the ozone hole: Formation of polar stratospheric clouds and chloride activation.

Lecture notes
Documents are provided in the contact hours.

Literature

Prerequisites / notice
Prerequisites: Basics in physical chemistry are required and an overview equivalent to the bachelor course in atmospheric chemistry (lecture 701-0471-01) is expected.

701-1233-00 V starts in the first week of the semester. The exercises 701-1233-00 U will start only in the 2nd week of the semester.

► GESS Science in Perspective

see GESS Science in Perspective: Type A: Enhancement of Reflection Capability

see GESS Science in Perspective: Language Courses ETH/UZH

Recommended GESS Science in Perspective (Type B) for D-CHAB.

Chemistry Bachelor - Key for Type

<table>
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<th>Key</th>
<th>Compulsory</th>
<th>Eligible for credits</th>
<th>Eligible for credits and recommended</th>
<th>Recommended, not eligible for credits</th>
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<td>Q</td>
<td>E-</td>
<td>Z</td>
<td>Dr</td>
<td>Suitable for doctorate</td>
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<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td></td>
<td></td>
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<tr>
<td>W</td>
<td>Eligible for credits</td>
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</table>
## Key for Hours

<table>
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<tr>
<td>V</td>
<td>lecture</td>
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<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

**ECTS**

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Multi-Isotopic Compounds: Enrichment and Analysis

This seminar focuses on teaching units in chemistry, physics and mathematics that have been developed at the MINT Learning Center of ETH Zurich. In the first meeting, the mission of the MINT Learning Center will be communicated. Furthermore, in groups of two, the students will intensively work on, refine and optimize a teaching unit following a goal set in advance.

Objective
- Get to know cognitive activating instructions in MINT subjects
- Get information about recent literature on learning and instruction

Prerequisites / notice
Für eine reibungslose Semesterplanung wird um frühe Anmeldung und persönliches Erscheinen zum ersten Lehrveranstaltungstermin ersucht.

ECTS Type Lecturers

851-0242-06L Cognitively Activating Instructions in MINT Subjects W 2 credits 2S R. Schumacher

Abstract
This course unit can only be enrolled after successful participation in, or during enrollment in the course "Human Learning (EW 1)"

Objective
- Get to know cognitively activating instructions in MINT subjects
- Understand research methods used in the empirical human sciences

Prerequisites / notice
Für eine reibungslose Semesterplanung wird um frühe Anmeldung und persönliches Erscheinen zum ersten Lehrveranstaltungstermin ersucht.

ECTS Type Lecturers

851-0242-07L Human Intelligence W 1 credit 1S E. Stern, P. Edelsbrunner, B. Rütsche

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

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

ECTS Type Lecturers

851-0242-08L Research Methods in Educational Science W 1 credit 1S P. Edelsbrunner, B. Rütsche, E. Stern, E. Ziegler

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

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

ECTS Type Lecturers


Abstract
In teams of two, participants in this seminar conduct their own research project. Each team is advised by one of the researchers serving as lecturers in this course. Basic conceptual and methodological issues are the topic of a series of plenary meetings; however, the major part of the work is done in small-group meetings with the advising researcher, and in self-directed research projects.

Objective
The course is targeted at advanced students who have taken an interest in gathering practical research experience in the field of Learning & Instruction. In teams of two, students conduct their own research projects (planning, conducting, analyzing, interpreting, and presenting research); thus, the course requires a high amount of self-directed working. Students are personally advised, and supported in their research project, by one of the researchers serving as lecturers in this course. During the first half the semester, relevant methodological knowledge and skills are practiced during plenary meetings and in students’ independent reading (e.g. generating and testing research questions, designing experiments, and analyzing data in the field of Learning and Instruction)

Learning goals include:
- Participants can illustrate and explain basic methods and concepts for research in the fields of Learning and Instruction, e.g. with the help of practical examples.
- Participants can generate testable research questions for a topic relevant in the fields of Learning and Instruction.
- Participants can design and conduct a study that is relevant for answering their research question.
- Participants can summarize and evaluate the main results from a study in the field of learning and Instruction, with regard to the research question being asked.

see Educational Science Teaching Diploma

Subject Didactics in Chemistry

Important: You can only enrol in the courses of this category if you have not more than 12 CP left for possible additional requirements.

ECTS Type Lecturers

529-0959-00L Mentored Work Subject Didactics Chemistry A O 2 credits 4A R. Ciorciaro
Abstrakt
In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.

Ziel der Arbeit
The objective is for the students:
- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.
- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

Inhalt
Thematic Schwerpunkte

Die Gegenstände der mentorierten Arbeit in Fachdidaktik stammen in der Regel aus dem gymnasialen Unterricht.

Lernformen

Vortrag
Die Arbeit sollte vor Beginn des Praktikums abgeschlossen werden.

Literatur
Die Literatur ist themenspezifisch. Die Studierenden beschaffen sie sich in der Regel selber (siehe Lernziele). In besonderen Fällen wird sie vom Betreuer zur Verfügung gestellt.

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

529-0960-00L  Mentored Work Subject Didactics Chemistry B

Abstract
In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.

Ziel der Arbeit
The objective is for the students:
- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.
- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

Inhalt
Thematic Schwerpunkte

Die Gegenstände der mentorierten Arbeit in Fachdidaktik stammen in der Regel aus dem gymnasialen Unterricht.

Lernformen

Vortrag
Die Arbeit sollte vor Beginn des Praktikums abgeschlossen werden.

Literatur
Die Literatur ist themenspezifisch. Die Studierenden beschaffen sie sich in der Regel selber (siehe Lernziele). In besonderen Fällen wird sie vom Betreuer zur Verfügung gestellt.

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

529-0950-00L  Subject Didactics Chemistry I

Abstract
Implementing findings from research into teaching and learning for chemistry lessons and coverage of subject-specific teaching and learning specialities.

Ziel der Arbeit
The objective is for the students:
- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.
- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.
- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.
- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.

Inhalt
Schwerpunkte

Die Gegenstände der mentorierten Arbeit in Fachdidaktik stammen in der Regel aus dem gymnasialen Unterricht.

Lernformen

Vortrag
Die Arbeit sollte vor Beginn des Praktikums abgeschlossen werden.

Literatur
Die Literatur ist themenspezifisch. Die Studierenden beschaffen sie sich in der Regel selber (siehe Lernziele). In besonderen Fällen wird sie vom Betreuer zur Verfügung gestellt.

Prerequisites / notice
Die Arbeit sollte vor Beginn des Praktikums abgeschlossen werden.
Professional Training in Chemistry

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>529-0966-00L</td>
<td>Introductory Internship Chemistry</td>
<td>O</td>
<td>3</td>
<td>6P</td>
<td>A. Baertsch</td>
</tr>
</tbody>
</table>

**Abstract**
During the introductory teaching practice, the students sit in on five lessons given by the teacher responsible for their teaching practice, and teach five lessons themselves. The students are given observation and reflection assignments by the teacher responsible for their teaching practice.

**Objective**
Right at the start of their training, students acquire initial experience with the observation of teaching, the establishment of concepts for teaching and the implementation of teaching. This early confrontation with the complexity of everything that teaching involves helps students decide whether they wish to and, indeed, ought to, continue with the training. It forms a basis for the subsequent pedagogical and subject-didactics training.

**Content**


**Literature**
Wird von der Praktikumslehrperson bestimmt.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<td>Teaching Internship Chemistry</td>
<td>O</td>
<td>8</td>
<td>17P</td>
<td>A. Baertsch</td>
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</table>

**Abstract**
The teaching practice takes in 50 lessons: 30 are taught by the students, and the students sit in on 20 lessons. The teaching practice lasts 4-6 weeks. It gives students the opportunity to implement the contents of their specialist-subject, educational science and subject-didactics training in the classroom. Students also conduct work assignments in parallel to their teaching practice.

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

**Content**

**Literature**
Wird von der Praktikumslehrperson bestimmt.

<table>
<thead>
<tr>
<th>Number</th>
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<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>529-0955-00L</td>
<td>Professional Exercises: Experiments in Teaching Chemistry</td>
<td>O</td>
<td>2</td>
<td>4V</td>
<td>A. Baertsch</td>
</tr>
</tbody>
</table>

**Abstract**
This course unit introduces students to the technique of conducting experiments in chemistry lessons. It covers didactic, technical, safety-related and presentation aspects.

**Objective**
Amongst other things, students are put in a position to
- appreciate whether experiments would make sense, or are even indispensable
- adapt experiments described in the literature to their own teaching situation
- develop experiments of their own
- plan and implement the incorporation of experiments in their tuition
- perform demonstration experiments in a technically correct and safe manner
- accompany pupils' experiments from the content, educational and safety angles
- evaluate experiments together with the pupils
- observe the safety provisions

**Content**
Schwerpunkte im ersten Studiensemester bilden die folgenden Themen:
- Theoretische Einführung.
- Merkmale für das sichere Experimentieren.
- Erstellen und Überarbeiten von Experimentierschriften.
- Vorführungen von Experimenten.
- Experimentierkurs mit praktischen Übungen für die Studierenden.
- Seminarveranstaltung im experimentellen Unterricht.
- Sensibilisierung für die Wichtigkeit des Experiments im Chemie-Unterricht.
- Führung einer persönlichen Experimente-Bibliothek.
- Befähigung zu eindrücklichem Experimentieren.
- Einhaltung aller einschlägigen Sicherheitsbestimmungen.

**Lecture notes**
In the context of an examination lesson conducted and graded at a high school, the candidates provide evidence of the subject-matter-based and didactic skills they have acquired in the course of their training.

- to develop and conduct teaching that is conducive to learning at high school level, substantiating it in terms of the subject-matter and from the didactic angle.
- to analyze the tuition they have given with regard to its strengths and weaknesses, and outline improvements.
- to develop and conduct teaching that is conducive to learning at high school level, substantiating it in terms of the subject-matter and from the didactic angle.
- to analyze the tuition they have given with regard to its strengths and weaknesses, and outline improvements.

Lecturers

ECTS
Content of the four modules:

1) The language of chemistry: Concepts, formulas, aesthetics, and philosophical aspects
2) Chirality and stereochemistry: Selected aspects, origin of biomolecular chirality, inorganic chemistry
3) Cosmochemistry
4) Chemistry of the atmosphere

Lecture notes
Foli en ausgewählte Literatur werden zur Verfügung gestellt.

Literature
Ausgewählte Artikel aus der Primärliteratur werden vorgestellt, kommentiert und zur Lektüre empfohlen.

Prerequisites / notice
Spezielle Experimental-Veranstaltung zum Lehramt Diplom in Chemie, die als Paket zusammen mit der Veranstaltung "Fachdidaktik Chemie 1" im Herbstsemester besucht werden muss. Die ECTS-Punkte dieser Vorlesung mit praktischen Übungen sind - zusammen mit den ECTS-Punkten für die Veranstaltung "Fachdidaktik Chemie 1" im Herbstsemester - die Voraussetzung für die Zulassung zur Veranstaltung "Fachdidaktik Chemie 2" im Frühlingsemester.

Blockveranstaltung an einem Gymnasium in der Deutschschweiz.

529-0968-01L Examination Lesson I Chemistry O 1 credit 2P A. Baertsch
Simultaneous enrolment in "Examination Lesson II Chemistry" (529-0968-02L) is compulsory.

Will mark the conclusion of the teacher training program in Chemistry.

Abstract
In the context of an examination lesson conducted and graded at a high school, the candidates provide evidence of the subject-matter-based and didactic skills they have acquired in the course of their training.

Objective
- to conduct and develop teaching that is conducive to learning at high school level, substantiating it in terms of the subject-matter and from the didactic angle.
- to analyze the tuition they have given with regard to its strengths and weaknesses, and outline improvements.

Content

Lecture notes
Dokument: Schriftliche Vorbereitung für Prüfungslektionen.https://www.ethz.ch/content/dam/ethz/main/education/didaktische-ausbildung/Files/Diverses/schriftliche%20Unterrichtsvorb%C3%BCr%C3%BCh%C3%BCflekt_04.11.2014..pdf

Prerequisites / notice
Nach Abschluss der übrigen Ausbildung.

529-0968-02L Examination Lesson II Chemistry O 1 credit 2P A. Baertsch
Simultaneous enrolment in "Examination Lesson I Chemistry" (529-0968-01L) is compulsory.

Will mark the conclusion of the teacher training program in Chemistry.

Abstract
In the context of an examination lesson conducted and graded at a high school, the candidates provide evidence of the subject-matter-based and didactic skills they have acquired in the course of their training.

Objective
On the basis of a specified topic, the candidate shows that they are in a position
- to develop and conduct teaching that is conducive to learning at high school level, substantiating it in terms of the subject-matter and from the didactic angle.
- to analyze the tuition they have given with regard to its strengths and weaknesses, and outline improvements.

Content

Lecture notes
Dokument: Schriftliche Vorbereitung für Prüfungslektionen.https://www.ethz.ch/content/dam/ethz/main/education/didaktische-ausbildung/Files/Diverses/schriftliche%20Unterrichtsvorb%C3%BCr%C3%BCh%C3%BCflekt_04.11.2014..pdf

Prerequisites / notice
Nach Abschluss der übrigen Ausbildung.


<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0962-00L</td>
<td>Fundamental Aspects of Chemistry with an Educational Focus B</td>
<td>O</td>
<td>4 credits</td>
<td>2V</td>
<td>A. Togni, R. Alberto</td>
</tr>
<tr>
<td></td>
<td>Mentored Work with an Educational Focus Chemistry for Teaching Diploma.</td>
<td></td>
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</tr>
</tbody>
</table>

Students enrolled at UZH must register for this course and the corresponding exam at ETH.

Abstract
Selected topics in general chemistry:
1) The language of chemistry
2) Chirality and stereochemistry
3) Oxidation of water
4) Chemistry of the atmosphere

Objective
In this course, participants acquire extended and more in-depth knowledge of selected chemistry topics. The selection is based to a large extent on the partial aspects of chemistry that are typically taught at high school. By gaining a broader understanding, teachers are put in a position where they can comprehend the topics that are to be taught. Simultaneously context and critically process these in respect of their teachability and learnability. At the same time, interrelationships between the classical sub-disciplines of chemistry are highlighted, along with the unique features of chemistry as one of the central natural sciences.

Content
Content of the four modules:
1) The language of chemistry: Concepts, formulas, aesthetics, and philosophical aspects
2) Chirality and stereochemistry: Selected aspects, origin of biomolecular chirality, inorganic chemistry
3) Cosmochemistry
4) Chemistry of the atmosphere

Lecture notes
Foli en ausgewählte Literatur werden zur Verfügung gestellt.

Literature
Ausgewählte Artikel aus der Primärliteratur werden vorgestellt, kommentiert und zur Lektüre empfohlen.

Prerequisites / notice
- to analyze the tuition they have given with regard to its strengths and weaknesses, and outline improvements.
- to develop and conduct teaching that is conducive to learning at high school level, substantiating it in terms of the subject-matter and from the didactic angle.
- to analyze the tuition they have given with regard to its strengths and weaknesses, and outline improvements.
- to develop and conduct teaching that is conducive to learning at high school level, substantiating it in terms of the subject-matter and from the didactic angle.
Subject with an Educational Focus Chemistry B

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

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

Content
Thematicsche Schwerpunkte:

Lernformen:

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

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

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

Compulsory Elective Courses

see Compulsory Elective Courses Teaching Diploma

Additional Requirements (ETH-Masterstudents in Chemical + Bioeng.)

Part 1

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>529-0200-00L</td>
<td>Research Project I</td>
<td>O</td>
<td>16 credits</td>
<td>16A</td>
<td>Professors</td>
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<tr>
<td>Abstract</td>
<td>In a research project students extend their knowledge in a particular field, get acquainted with the scientific way of working, and learn to work on an actual research topic. Research projects are carried out in a core or optional subject area as chosen by the student. Students are accustomed to scientific work and they get to know one specific research field.</td>
<td></td>
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<tr>
<td>Objective</td>
<td>Students are accustomed to scientific work and they get to know one specific research field.</td>
<td></td>
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<tr>
<td>529-0132-00L</td>
<td>Inorganic Chemistry III: Organometallic Chemistry and Homogeneous Catalysis</td>
<td>O</td>
<td>4 credits</td>
<td>3G</td>
<td>A. Togni, A. Mezzetti</td>
</tr>
<tr>
<td>Abstract</td>
<td>Fundamental aspects of the organometallic chemistry of the transition elements. Mechanistic homogeneous catalysis including oxidative additions, reductive eliminations and insertion reactions. Catalytic hydrogenation, carbonylation, C-C bond-forming and related reactions.</td>
<td></td>
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<tr>
<td>Objective</td>
<td>Towards an understanding of the fundamental coordination-chemical and mechanistic aspects of transition-metal chemistry relevant to homogeneous catalysis.</td>
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<tr>
<td>Content</td>
<td>Fundamental aspects of the organometallic chemistry of the transition elements. Mechanistic homogeneous catalysis including oxidative additions, reductive eliminations and insertion reactions. Catalytic hydrogenation, carbonylation, C-C bond-forming and related reactions.</td>
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<tr>
<td>Literature</td>
<td>Evans’ Problems in Organic Chemistry App</td>
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<tr>
<td>529-0231-00L</td>
<td>Organic Chemistry III: Introduction to Asymmetric Synthesis</td>
<td>O</td>
<td>4 credits</td>
<td>3G</td>
<td>E. M. Carreira</td>
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<tr>
<td>Abstract</td>
<td>Methods of Asymmetric Synthesis</td>
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<td>Objective</td>
<td>Understanding of the basic principles of diastereoselective synthesis</td>
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<tr>
<td>Content</td>
<td>Conformational analysis: acyclic and cyclic systems; Diastereoselective sigmatropic rearrangements; Diastereoselective Carbonyl addition reactions: Cram- and Felkin-Anh models, carbonyl Lewis acid interactions, chelate controlled reactions; chemistry of enolates, selective formation; asymmetric enolate alkylation; aldol reactions, allyl- and crotyl-metal chemistry; cyclisations, Baldwin rules; Diastereoselective olefin functionalization: hydroboration, dihydroxylation, epoxidation.</td>
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</tr>
<tr>
<td>Literature</td>
<td>Evans’ Problems in Organic Chemistry App</td>
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<tr>
<td>529-0241-00L</td>
<td>Advanced Methods and Strategies in Synthesis</td>
<td>O</td>
<td>7 credits</td>
<td>3G</td>
<td>J. W. Bode</td>
</tr>
<tr>
<td>Abstract</td>
<td>Advanced Modern Methods and Strategies in Synthesis</td>
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<tr>
<td>Objective</td>
<td>Knowledge of modern methods in asymmetric stereocontrol, enantioselective catalysis, and organic reaction mechanisms.</td>
<td></td>
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<tr>
<td>Content</td>
<td>Current trends in methods for and approaches to synthesis of complex natural products, pharmaceuticals, and biological molecules; fragment coupling and group strategies; chemical ligation and biomolecules synthesis; enantioselective catalysis including ligand design and optimization; cross coupling reactions from preactivated precursors; C-H activation and oxidation chemistry; building block synthesis with chiral auxiliaries and reagents; new concepts in asymmetric catalysis. Analysis of key primarily literature including identification of trends, key precendents, and emerging topics will be emphasized.</td>
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<tr>
<td>Lecture notes</td>
<td>will be provided in class and online</td>
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<tr>
<td>Literature</td>
<td>Suggesting Textbooks</td>
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Part 2

see Chemistry Master > Electives

Chemistry Teaching Diploma - Key for Type

<table>
<thead>
<tr>
<th>Type</th>
<th>Compulsory</th>
<th>Eligible for credits and recommended</th>
<th>Eligible for credits</th>
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<tbody>
<tr>
<td>O</td>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
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<tr>
<td>W+</td>
<td>Z</td>
<td>Courses outside the curriculum</td>
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<tr>
<td>W</td>
<td>Dr</td>
<td>Suitable for doctorate</td>
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Data: 06.03.2019 12:57 Autumn Semester 2016 Page 356 of 1571
### Key for Hours

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
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<tr>
<td>V</td>
<td>lecture</td>
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<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

**ECTS**

European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
The aim of the course is to familiarize the students with the basic concepts of magnetic resonance relaxation theory in liquids and solids. Starting from the mathematical description of spin dynamics, the effect of stochastic motional processes on the density operator will be analyzed. In the end students should understand the Redfield formulation of relaxation and be able to understand the effect of dynamics on magnetic resonance experiments.

### Organic Chemistry

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>529-0241-00L</td>
<td>Advanced Methods and Strategies in Synthesis</td>
<td>W*</td>
<td>7 credits</td>
<td>3G</td>
<td>J. W. Bode</td>
</tr>
<tr>
<td>Abstract</td>
<td>Advanced Modern Methods and Strategies in Synthesis</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Objective</td>
<td>Knowledge of modern methods in asymmetric stereocontrol, enantioselective catalysis, and organic reaction mechanisms.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Content</td>
<td>Current trends in methods for and approaches to synthesis of complex natural products, pharmaceuticals, and biological molecules; fragment coupling and protecting group strategies; chemical ligation and biomolecules synthesis; enantioselective catalysis including ligand design and optimization; cross coupling reactions from preactivated precursors; C-H activation and oxidation chemistry; building block synthesis with chiral auxiliaries and reagents; new concepts in asymmetric catalysis. Analysis of key primarily literature including identification of trends, key precendents, and emerging topics will be emphasized.</td>
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</tr>
<tr>
<td>Lecture notes</td>
<td>A manuscript will be distributed to the participants of the course.</td>
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<tr>
<td>Literature</td>
<td>Script and recent original literature indicated in the course.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Basis for the understanding of this lecture are the courses Allgemeine Chemie 1 &amp; 2, Anorganische Chemie 1: Übergangsmetallchemie (Dozent Mezzetti).</td>
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### Physical Chemistry

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>529-0433-00L</td>
<td>Advanced Magnetic Resonance</td>
<td>W</td>
<td>7 credits</td>
<td>3G</td>
<td>B. H. Meier, M. Ernst</td>
</tr>
<tr>
<td>Abstract</td>
<td>The aim of the course is to familiarize the students with the basic concepts of magnetic resonance relaxation theory in liquids and solids. Starting from the mathematical description of spin dynamics, the effect of stochastic motional processes on the density operator will be analyzed. In the end students should understand the Redfield formulation of relaxation and be able to understand the effect of dynamics on magnetic resonance experiments.</td>
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</tr>
<tr>
<td>Objective</td>
<td>The aim of the course is to familiarize the students with the basic concepts of magnetic resonance relaxation theory in liquids and solids. Starting from the mathematical description of spin dynamics, the effect of stochastic motional processes on the density operator will be analyzed. In the end students should understand the Redfield formulation of relaxation and be able to understand the effect of dynamics on magnetic resonance experiments.</td>
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</tr>
<tr>
<td>Content</td>
<td>A script which covers the topics will be distributed in the lecture and will be accessible through the web page <a href="http://www.ssnmr.ethz.ch/education/">http://www.ssnmr.ethz.ch/education/</a></td>
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### Compensatory Courses

### Physical Chemistry

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<th>Night Code</th>
<th>Course Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>529-0443-00L</td>
<td>Advanced Magnetic Resonance</td>
<td>W</td>
<td>7 credits</td>
<td>3G</td>
<td>B. H. Meier, M. Ernst</td>
</tr>
</tbody>
</table>

The course is for advanced students and covers selected topics from magnetic resonance spectroscopy. This year, the lecture will introduce and discuss relaxation theory and its applications in magnetic resonance.
**Electives**

### Inorganic Chemistry

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
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<tr>
<td>529-0143-00L</td>
<td>Inorganic and Organometallic Polymers</td>
<td>O</td>
<td>7</td>
<td>3G</td>
<td>H. Grützmacher, J. Grützmacher</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>This course provides an introduction to the interaction of light with nano- and microparticles followed by an overview of applications of current interest. Examples range from nanoparticles for medical applications and sensing to the role of the interaction of solar radiation with aerosol particles and cloud droplets for the climate.</td>
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</tr>
<tr>
<td><strong>Objective</strong></td>
<td>The students will be introduced to the basic concepts of the interaction of light with nano- and microparticles. The combination of basic concepts with different applications will enable students to apply their knowledge to new problems in various fields where nanoscale objects play a role.</td>
<td></td>
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</tr>
<tr>
<td><strong>Content</strong></td>
<td>Light interacts surprisingly differently with small particles than with bulk or with gas phase materials. The first part of the course provides a basic but rigorous introduction into the interaction of light with nano- and microparticles. The emphasis is on the classical treatment of absorption and scattering of light by small particles. The strengths and limits of this conventional approach will be discussed. The second part of the course is devoted to a broad range of applications. Hierarchical topics include: Plasmon resonances in metallic systems, metallic dielectric nanoparticles for medical applications, the use of lasers for optical trapping and characterization of single particles, vibrational excitons in dielectric nanoparticles, interaction of light with aerosol particles and cloud droplets for remote sensing applications and climate predictions, characterization of ultralime aerosol particles by photomission using velocity mapping imaging.</td>
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<tr>
<td><strong>Lecture notes</strong></td>
<td>will be distributed during the course</td>
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<td></td>
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</tr>
<tr>
<td><strong>Literature</strong></td>
<td>Basics: Absorption and Scattering of Light by Small Particles, C. F. Bohren and D. R. Huffman, John Wiley &amp; Sons, Inc.</td>
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### Organic Chemistry

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<tr>
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<th>Hours</th>
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<tr>
<td>529-0243-00L</td>
<td>Reactive Intermediates</td>
<td>W</td>
<td>7</td>
<td>3G</td>
<td>P. Chen</td>
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<tr>
<td><strong>Abstract</strong></td>
<td>Advanced physical organic chemistry. Methods for the elucidation of reaction mechanisms. Reactive intermediates. Thermochemistry; isotope labeling; cross-over experiments; kinetic isotope effects; thermodynamics-kinetics correlations; solvation and ion pairs; radical reactions; electron transfer; spectroscopic methods.</td>
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</tr>
<tr>
<td><strong>Objective</strong></td>
<td>Methods for the elucidation of organic reaction mechanisms.</td>
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<tr>
<td><strong>Lecture notes</strong></td>
<td>A printed script are handed out in the course. This material is also available for download from the web page of the course (as pdf files).</td>
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<tr>
<td><strong>Literature</strong></td>
<td>Additional reading and original publications are cited in the lectures.</td>
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<tr>
<td><strong>Prerequisites / notice</strong></td>
<td>Required level: Courses in organic and physical chemistry of the first and second year. Each participant is expected to contribute to a 30 min. seminar (prepared by groups of 2-4 students), presented in the last weeks of the semester.</td>
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### Physical Chemistry

<table>
<thead>
<tr>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>529-0241-00L</td>
<td>Advanced Methods and Strategies in Synthesis</td>
<td>W</td>
<td>7</td>
<td>3G</td>
<td>J. W. Bode</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>Advanced Modern Methods and Strategies in Synthesis</td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>Objective</strong></td>
<td>Knowledge of modern methods in asymmetric stereocentrol, enantioselective catalysis, and organic reaction mechanisms.</td>
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</tr>
<tr>
<td><strong>Content</strong></td>
<td>Current trends in methods for and approaches to synthesis of complex natural products, pharmaceuticals, and biological molecules; fragment coupling and protecting group strategies; chemical ligation and biomolecules synthesis; enantioselective catalysis including ligand design and optimization; cross coupling reactions from preactivated precursors; C-H activation and oxidation chemistry; building block synthesis with chiral auxiliaries and reagents; new concepts in asymmetric catalysis. Analysis of key primarily literature including identification of trends, key precendents, and emerging topics will be emphasized.</td>
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<tr>
<td><strong>Lecture notes</strong></td>
<td>will be provided in class and online</td>
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<td></td>
</tr>
<tr>
<td><strong>Literature</strong></td>
<td>Suggesting Textbooks</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Prerequisites / notice</strong></td>
<td>OC I-II</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Literature


### Notice

Applications: References will be provided during the course.
The course is for advanced students and covers selected topics from magnetic resonance spectroscopy. This year, the lecture will introduce and discuss relaxation theory and its applications in magnetic resonance.

Abstract

The aim of the course is to familiarize the students with the basic concepts of magnetic resonance relaxation theory in liquids and solids. Starting from the mathematical description of spin dynamics, the effect of stochastic motional processes on the density operator will be analyzed. In the end students should understand the Redfield formulation of relaxation and be able to understand the effect of dynamics on magnetic resonance experiments.

Objective

The students will be introduced to the basic concepts of the interaction of light with nano- and microparticles. The combination of basic principles with different applications will enable students to apply their knowledge to new problems in various fields where nanoscale objects play a role.

Content

Light interacts surprisingly differently with small particles than with bulk or with gas phase materials. The first part of the course provides a basic but rigorous introduction into the interaction of light with nano- and microparticles. The emphasis is on the classical treatment of absorption and scattering of light by small particles. The strengths and limits of this conventional approach will be discussed. The second part of the course is devoted to a broad range of applications. Here topics include: Plasmon resonances in metallic systems, metallo-dielectric nanoparticles for medical applications, the use of lasers for optical trapping and characterization of single particles, vibrational excitons in dielectric nanoparticles, interaction of light with aerosol particles and cloud droplets for remote sensing applications and climate predictions, characterization of airborne aerosol particles by photoemission using velocity map imaging.

Lecture notes

A script which covers the topics will be distributed in the lecture and will be accessible through the web page http://www.ssnmr.ethz.ch/education/

Literature

Basics: Absorption and Scattering of Light by Small Particles, C. F. Bohren and D. R. Huffman, John Wiley & Sons, Inc.

Applications: References will be provided during the course.

## Analytical Chemistry

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0043-00L</td>
<td>Analytical Strategy</td>
<td>W</td>
<td>7</td>
<td>3G</td>
<td>R. Zenobi, M. Badertscher, P. S. Dittrich, D. Günther</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
<td></td>
<td></td>
<td>Problem-oriented development of analytical strategies and solutions.</td>
</tr>
<tr>
<td></td>
<td>Objective</td>
<td></td>
<td></td>
<td></td>
<td>Ability to create solutions for particular analytical problems.</td>
</tr>
<tr>
<td></td>
<td>Content</td>
<td></td>
<td></td>
<td></td>
<td>Individual development of strategies for the optimal application of chemical, biochemical, and physico-chemical methods in analytical chemistry solving predefined problems. Experts from industry and administration present particular problems in their field of activity.</td>
</tr>
<tr>
<td></td>
<td>Lecture notes</td>
<td></td>
<td></td>
<td></td>
<td>Copies of problem sets and solutions will be distributed free of charge.</td>
</tr>
<tr>
<td></td>
<td>Prerequisites / notice</td>
<td></td>
<td></td>
<td></td>
<td>Prerequisites: 529-0051-00 &quot;Analytical Chemistry I (3. Semester)<em>&quot;, 529-0058-00 &quot;Analytical Chemistry II (4. Semester)</em>&quot; (or equivalent)</td>
</tr>
</tbody>
</table>

| 529-0049-00L | Analytical Methods for Characterization of Nanoparticles and Nanomaterials | W    | 2    | 2G    | C. Latkoczy                      |
|              | Abstract                                        |      |      |       | Introduction to modern analytical methods used to fully characterize and identify nano-engineered materials and systems. |
|              | Objective                                       |      |      |       | Understanding of analytical concepts used in nanotechnology, In-depth knowledge of most important methods used in industry and research, Introduction to selected industrial applications, Basic knowledge of production mechanisms of nano-engineered materials. |
|              | Content                                         |      |      |       | Nanotechnology is the basis of many main technological innovations of the 21st century. After more than twenty years of research, nanotechnologies are now increasingly employed for commercial use: they are used in hundreds of everyday consumer products, such as cosmetics, food, automotive, electronics and medical products. Nanoparticles can contribute to stronger, lighter, cleaner, smarter, better, etc. products. Besides these positive effects, relatively little is still known about potential health and environmental effects and risks of such small nanosized particles. Therefore, a lot of different industry customers are forced nowadays to monitor and regulate the size and concentration of nanoparticles in their nano-enabled products. Above and beyond these regulatory requirements, most industries employing nanoparticles need to be able to online measure nanoparticles to meet their requirements towards quality control and production efficiency. All these requirements demand new precise, accurate, fast and innovative analysis methods to fully characterize nanoparticles in real-time and during the manufacturing process. |
|              | Lecture notes                                   |      |      |       | Lecture notes will be provided |
|              | Prerequisites / notice                          |      |      |       | Prerequisites: 529-0051-00 "Analytical Chemistry I (3. Semester)*", 529-0058-00 "Analytical Chemistry II (4. Semester)*" (or equivalent) |

## Biological Chemistry

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0733-00L</td>
<td>Enzymes</td>
<td>W</td>
<td>7</td>
<td>3G</td>
<td>D. Hilvert</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
<td></td>
<td></td>
<td>Principles of enzymatic catalysis, enzyme kinetics, mechanisms of enzyme-catalyzed reactions (group transfer reactions, carbon-carbon bond formation, eliminations, isomerisations and rearrangements), cofactor chemistry, enzymes in organic synthesis and the biosynthesis of natural products, catalytic antibodies.</td>
</tr>
<tr>
<td></td>
<td>Objective</td>
<td></td>
<td></td>
<td></td>
<td>Overview of enzymes, enzyme-catalyzed reactions and metabolic processes.</td>
</tr>
<tr>
<td></td>
<td>Content</td>
<td></td>
<td></td>
<td></td>
<td>Principles of enzymatic catalysis, enzyme kinetics, mechanisms of enzyme catalyzed reactions (group transfer reactions, carbon-carbon bond formation, eliminations, isomerisations and rearrangements), cofactor chemistry, enzymes in organic synthesis and the biosynthesis of natural products, catalytic antibodies.</td>
</tr>
<tr>
<td></td>
<td>Lecture notes</td>
<td></td>
<td></td>
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<td>A script will not be handed out.</td>
</tr>
</tbody>
</table>
Chemical Aspects of Bioimaging

**W 7 credits  2V+1U**  P. Rivera Fuentes

**Abstract**
This course will introduce basic concepts of fluorescence spectroscopy and microscopy applied to the observation and manipulation of biological systems. The course will focus on the design, preparation and implementation of small-molecule and protein-based probes for biological investigations.

**Objective**
To understand the basic chemical aspects of bioimaging and photoactivation in biology.

**Content**
Principles of fluorescence spectroscopy and microscopy, fluorescent dyes and proteins, chemiluminescence, super-resolution microscopy, fluorescent sensors, photoremovable groups, photoswitchable molecules, and optogenetics.

**Lecture notes**
Handouts, selected original literature, problem sets, and other materials will be provided electronically.

**Literature**


### Chemical Aspects of Energy

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0193-00L</td>
<td>Renewable Energy Technologies I</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>A. Wokaun, A. Steinfeld</td>
</tr>
<tr>
<td></td>
<td>The lectures Renewable Energy Technologies I (529-0193-00L) and Renewable Energy Technologies II (529-0191-00L) can be taken independently from one another.</td>
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<tr>
<td></td>
<td>Abstract</td>
<td></td>
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<td></td>
<td>Scenarios for world energy demand and CO2 emissions, implications for climate. Methods for the assessment of energy chains. Potential and technology of renewable energies: Biomass (heat, electricity, biofuels), solar energy (low temp. heat, solar thermal and photovoltaic electricity, solar chemistry). Wind and ocean energy, heat pumps, geothermal energy, energy from waste. CO2 sequestration.</td>
</tr>
<tr>
<td></td>
<td>Objective</td>
<td></td>
<td></td>
<td></td>
<td>Scenarios for the development of world primary energy consumption are introduced. Students know the potential and limitations of renewable energies for reducing CO2 emissions, and their contribution towards a future sustainable energy system that respects climate protection goals.</td>
</tr>
<tr>
<td></td>
<td>Lecture notes</td>
<td></td>
<td></td>
<td></td>
<td>Lecture notes will be distributed electronically during the course.</td>
</tr>
<tr>
<td></td>
<td>Prerequisites / notice</td>
<td></td>
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<td></td>
<td>Topics are available to carry out a Project Work (Semesterarbeit) on the contents of this course.</td>
</tr>
</tbody>
</table>

### Chemical Crystallography

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0029-00L</td>
<td>Structure Determination</td>
<td>W</td>
<td>7 credits</td>
<td>3G</td>
<td>M. D. Wörle, N. Trapp</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
<td></td>
<td></td>
<td>Advanced X-ray crystal structure analysis</td>
</tr>
<tr>
<td></td>
<td>Objective</td>
<td></td>
<td></td>
<td></td>
<td>To gain a deeper understanding of crystal structure determination principles and practice by X-ray diffraction and the evaluation of results. Review of principles of diffraction and instrumentation, unit cells, lattices, and symmetry. Inorganic structural chemistry: sphere packings, ionic crystals, covalent networks, intermetallic compounds. Overview of powder diffraction and application of crystal chemistry for structure analysis of polycrystalline phases. Working safely with X-rays, crystal growth, selection and mounting, data collection strategies, data reduction, corrections for absorption, extinction and Lp, advanced structure solution theory and techniques: Patterson function, heavy atom technique, Fourier methods, direct methods. Structure modeling and refinement, disorder, twinning, false symmetry, interpretation of anisotropic shift parameters. Determination of absolute configuration, interpretation of results and scope of chemically useful information, validation and publication of results, critical evaluation of published crystal structures.</td>
</tr>
<tr>
<td></td>
<td>Content</td>
<td></td>
<td></td>
<td></td>
<td>Information and exercise sheets will be distributed in loose form.</td>
</tr>
</tbody>
</table>

Data: 06.03.2019 12:57  Autumn Semester 2016  Page 361 of 1571
Additional literature


Prerequisites / notice

Students will conduct the computational exercises and examples of structure solution and refinement on personal computers.

Prerequisite: Principles of Crystal Structure Determination (529-0039-00L).

### Chemical Technology

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>636-0003-00L</td>
<td>Biological Engineering and Biotechnology</td>
<td>W</td>
<td>6 credits</td>
<td>3V</td>
<td>M. Fussenegger</td>
</tr>
</tbody>
</table>

**Abstract**

Biological Engineering and Biotechnology will cover the latest biotechnological advances as well as their industrial implementation to engineer mammalian cells for use in human therapy. This lecture will provide forefront insights into key scientific aspects and the main points in industrial decision-making to bring a therapeutic from target to market.

**Objective**

1. Insight Into The Mammalian Cell Cycle. Cycling, The Balance Between Proliferation and Cancer - Implications For Biopharmaceutical Manufacturing,
2. The Licence To Kill. Apoptosis Regulatory Networks - Engineering of Survival Pathways To Increase Robustness of Production Cell Lines.
5. From Target To Market. An Antibody's Journey From Cell Culture to The Clinics.
6. Biology and Malign Applications. Do Life Sciences Enable the Development of Biological Weapons?
7. Functional Food. Enjoy your Meal!

**Lecture notes**

Handsout during the course.

### Computational Chemistry

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0003-00L</td>
<td>Advanced Quantum Chemistry</td>
<td>W</td>
<td>7 credits</td>
<td>3G</td>
<td>M. Reiher, S. Knecht</td>
</tr>
</tbody>
</table>

**Abstract**

Advanced, but fundamental topics central to the understanding of theory in chemistry and for solving actual chemical problems with a computer. Examples are:

* Operators derived from principles of relativistic quantum mechanics
* Relativistic effects + methods of relativistic quantum chemistry
* Open-shell molecules + spin-density functional theory
* New electron-correlation theories

**Objective**

The aim of the course is to provide an in-depth knowledge of theory and method development in theoretical chemistry. It will be shown that this is necessary in order to be able to solve actual chemical problems on a computer with quantum chemical methods.

The relativistic re-derivation of all concepts known from (nonrelativistic) quantum mechanics and quantum-chemistry lectures will finally explain the form of all operators in the molecular Hamiltonian - usually postulated rather than deduced. From this, we derive operators needed for molecular spectroscopy (like those required by magnetic resonance spectroscopy). Implications of other assumptions in standard non-relativistic quantum chemistry shall be analyzed and understood, too. Examples are the Born-Oppenheimer approximation and the expansion of the electronic wave function in a set of pre-defined many-electron basis functions (Slater determinants). Overcoming these concepts, which are so natural to the theory of chemistry, will provide deeper insights into many-particle quantum mechanics. Also revisiting the workhorse of quantum chemistry, namely density functional theory, with an emphasis on open-shell electronic structures (radicals, transition-metal complexes) will contribute to this endeavor. It will be shown how these insights allow us to make more accurate predictions in chemistry in practice - at the frontier of research in theoretical chemistry.

**Content**

1) Introductory lecture: basics of quantum mechanics and quantum chemistry
2) Einstein’s special theory of relativity and the (classical) electromagnetic interaction of two charged particles
3) Klein-Gordon and Dirac equation; the Dirac hydrogen atom
4) Numerical methods based on the Dirac-Fock-Coulomb Hamiltonian, two-component and scalar relativistic Hamiltonians
5) Response theory and molecular properties, derivation of property operators, Breit-Pauli-Hamiltonian
6) Relativistic effects in chemistry and the emergence of spin
7) Spin in density functional theory
8) New electron-correlation theories: Tensor network and matrix product states, the density matrix renormalization group
9) Quantum chemistry without the Born-Oppenheimer approximation

**Lecture notes**

A set of detailed lecture notes will be provided, which will cover the whole course.
Prerequisites / notice

529-0004-00L Computer Simulation in Chemistry, Biology and Medicine (ECTS: 7, Type: Lecture, Hours: 4G, Lecturers: P. H. Hünenberger, R. Erni)

Abstract
Molecular models, Force fields, Boundary conditions, Electrostatic interactions, Molecular dynamics, Analysis of trajectories, Quantum-mechanical simulation, Structure refinement, Application to real systems. Exercises: Analysis of papers on computer simulation, Molecular simulation in practice, Validation of molecular dynamics simulation.

For more information: www.csms.ethz.ch/education/CSCBP

Objective
Introduction to computer simulation of (bio)molecular systems, development of skills to carry out and interpret computer simulations of biomolecular systems.

Content
Molecular models, Force fields, Spatial boundary conditions, Calculation of Coulomb forces, Molecular dynamics, Analysis of trajectories, Quantum-mechanical simulation, Structure refinement, Application to real systems. Exercises: Analysis of papers on computer simulation, Molecular simulation in practice, Validation of molecular dynamics simulation.

Lecture notes
Available (copies of powerpoint slides distributed before each lecture)

Literature
See: www.csms.ethz.ch/education/CSCBP

Prerequisites / notice
Since the exercises on the computer do convey and test essentially different skills as those being conveyed during the lectures and tested at the oral exam, the results of the exercises are taken into account when evaluating the results of the exam.

For more information about the lecture: www.csms.ethz.ch/education/CSCBP

Materials Science

Course: Introduction to Macromolecular Chemistry (529-0941-00L) will be given in spring semester

Environmental Chemistry


Abstract
Projects on chemical assessment with the focus on the analysis and assessment of basic substance data for selected chemical classes; analysis and modelling of technical processes; characterisation of environmental and health risks. Risk assessment on the basis of quality and protection goals. Estimation of model and parameter uncertainty. Precaution and safety measures.

Note also the standard textbooks:

A) Szabo, N.S., Ostdal, Verlag, Dover Publications
B) Levine, Quantum Chemistry, Pearson
F) McWeeny: Methods of Molecular Quantum Mechanics, Academic Press, 1992
G) Schwabl, Advanced Quantum Mechanics
Concentration: 3.5% of carbon monoxide, 1.6% of nitrogen, 0.05% of ozone, 0.01% of formaldehyde, 0.002% of acrylamide, 0.0001% of benzene.

Environmental Chemistry

Number Title Type ECTS Hours Lecturers

Abstract
Projects on chemical assessment with the focus on the analysis and assessment of basic substance data for selected chemical classes; analysis and modelling of technical processes; characterisation of environmental and health risks. Risk assessment on the basis of quality and protection goals. Estimation of model and parameter uncertainty. Precaution and safety measures.

Note also the standard textbooks:

A) Szabo, N.S., Ostdal, Verlag, Dover Publications
B) Levine, Quantum Chemistry, Pearson

Environmental Chemistry

Number Title Type ECTS Hours Lecturers
529-0745-00L General and Environmental Toxicology (ECTS: 7, Type: Lecture, Hours: 3V, Lecturers: M. Arand, K. Hungerbühler, H. Nägeli, B. B. Stieger, I. Werner)

Abstract
Toxicokinetic and toxicodynamic aspects of xenobiotic interactions with cellular structures and mechanisms. Toxic responses at the level of organs (immune-, neuro-, reproductive and genotoxicity) and organisms. Introduction into developmental toxicology and ecotoxicology.

Objective
Understanding of the impact of chemicals on biological systems; evaluation of the effects from different biomedical perspectives.

Content

Lecture notes
Course material will be handed out as the lectures progress

Literature
Textbooks of pharmacology and toxicology (cf. list in course material)

Educational basis: basic chemistry, biology and biochemistry

Prerequisites / notice

Materials Science

Course: Introduction to Macromolecular Chemistry (529-0941-00L) will be given in spring semester

Number Title Type ECTS Hours Lecturers

Abstract
A comprehensive understanding of the interaction of electrons with condensed matter and details on the instrumentation and methods designed to use these probes in the structural and chemical analysis of various materials.

Objective
A comprehensive understanding of the interaction of electrons with condensed matter and details on the instrumentation and methods designed to use these probes in the structural and chemical analysis of various materials.

Content
This course provides a general introduction into electron microscopy of organic and inorganic materials. In the first part, the basics of transmission- and scanning electron microscopy are presented. The second part includes the most important aspects of specimen preparation, imaging and image processing. In the third part, recent applications in materials science, solid state physics, structural biology, structural geology and structural chemistry will be reported.

Lecture notes
English

Literature


Enri: Aberration-corrected imaging in transmission electron microscopy, Imperial College Press (2010, and 2nd ed. 2015)
Objective and Content

**Objective**

Project thesis (report) on chemicals assessment; time frame totals ca. 80 hours.

Projects on chemical assessment with the focus on the following aspects:

* Analysis and assessment of basic substance data for selected chemical classes: physical chemical properties, environmental behaviour (distribution, persistence), human and eco-toxicity (biochemical metabolism, effect mechanisms), safety.
* Analysis and modelling of technical processes determining chemical release into the environment, e.g., chemicals applications.
* Characterisation of environmental and health risks on the basis of exposure and effect models, QSARs from environmental chemistry, toxicology and methods of risk analysis.
* Risk assessment on the basis of quality and safety goals. Estimation of the model and data uncertainty.
* Demonstration of possibilities and limits of precaution and safety measures (technical, organisational, concerning personnel) including effectiveness and efficiency.

**Lecture notes**

Project teaching; time frame totals ca. 80 hours.

**Literature**

See recommended literature.


**Prerequisites / notice**

Voraussetzung:

529-0580-00L - Risiokoanalyse chemischer Prozesse und Produkte

oder: 701-0998-00L - Environmental and Human Health Risk Assessment of Chemicals

Beschränkt auf 6 Projektarbeiten pro Semester

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**Laboratory Courses and Research Projects**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0200-00L</td>
<td>Research Project I</td>
<td>O</td>
<td>16</td>
<td>16A</td>
<td>Professors</td>
</tr>
<tr>
<td>Abstract</td>
<td>In a research project students extend their knowledge in a particular field, get acquainted with the scientific way of working, and learn to work on an actual research topic. Research projects are carried out in a core or optional subject area as chosen by the student. Students are accustomed to scientific work and they get to know one specific research field.</td>
<td></td>
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</tbody>
</table>

**Objective**

| Objective | Students are accustomed to scientific work and they get to know one specific research field. |

| 529-0201-00L | Research Project II                        | O    | 17   | 17A   | Professors              |
| Abstract     | In a research project students extend their knowledge in a particular field, get acquainted with the scientific way of working, and learn to work on an actual research topic. Research projects are carried out in a core or optional subject area as chosen by the student. Students are accustomed to scientific work and they get to know one specific research field. |

**Objective**

| Objective | Students are accustomed to scientific work and they get to know one specific research field. |

| 529-0739-00L | Biological Chemistry A: Technologies for Directed Evolution of Enzymes | W    | 16   | 16P   | P. A. Kast, D. Hilvert |
| Abstract     | Limited number of participants. Before online enrolment, it is mandatory to sign up directly with P. Kast, no later than 2 weeks prior to start of autumn semester. |

**Objective**

| Objective | All technologies used for the experiments will be explained to the students in practice with the goal that they will be able to independently apply them for the course project and in future research endeavors. After the course, an individual report about the results obtained has to be prepared. |

**Content**

This class conducts and supports experiments for a specifically designed genuine research project. We will carry out biological-chemical enzyme evolution experiments using molecular genetic mutation technologies and in vivo selection in recombinant bacterial strains. The relevant technologies will be taught to the students, such as the preparation of competent cells, production and isolation of DNA fragments, transformation of gene libraries, and DNA sequencing. The course participants will generate a variety of different variants of a chorismate mutase. Individual enzyme catalysts will be purified and subsequently characterized using several different spectroscopic methods. The detailed chemical-physical analyses include determination of the enzymes' kinetic parameters, their molecular mass, and the integrity of the protein structure. The students will present the results obtained from their individual evolution experiments at the end of the semester. We expect that during this lab course we will not only generate novel enzymes, but also gain new mechanistic insights into the investigated catalyst. Further information to registration and work hours: www.protein.ethz.ch/kast/praktikum.html

**Objective**

| Objective | Further information to registration and work hours: www.protein.ethz.ch/kast/praktikum.html |

**Literature**

* Demonstration of possibilities and limits of precaution and safety measures (technical, organisational, concerning personnel) including effectiveness and efficiency.
Master's Thesis

**Number** | **Title** | **Type** | **ECTS** | **Hours** | **Lecturers**
---|---|---|---|---|---
529-0500-00L | Master's Thesis | O | 20 credits | 43D | Professors

**Abstract**
In the Master thesis students prove their ability to independent, structured and scientific working. The Master thesis is usually carried out in a core or optional subject area as chosen by the student.

**Objective**
In the Master Thesis students prove their ability to independent, structured and scientific working.

Course Units for Additional Admission Requirements

The courses below are only available for MSc students with additional admission requirements.

**Number** | **Title** | **Type** | **ECTS** | **Hours** | **Lecturers**
---|---|---|---|---|---
529-0051-AAL | Analytical Chemistry I | E- | 3 credits | 6R | D. Günther, R. Zenobi

**Abstract**
Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

**Objective**
Knowledge about the necessary theoretical background of spectroscopical methods and their practical applications

**Content**
Application oriented basics of organic and inorganic instrumental analysis and of the empirical employment of structure elucidation methods:
- Mass spectrometry: Ionization methods, mass separation, isotope signals, rules of fragmentation, rearrangements.
- NMR spectroscopy: Experimental basics, chemical shift, spin-spin coupling.
- IR spectroscopy: Revisiting topics like harmonic oscillator, normal vibrations, coupled oscillating systems (in accordance to the basics of the related lecture in physical chemistry); sample preparation, acquisition techniques, law of Lambert and Beer, interpretation of IR spectra; Raman spectroscopy.

**Lecture notes**
Script will be for the production price

**Literature**
- M. Hesse, H. Meier, B. Zeeh, Spektroskopische Methoden in der organischen Chemie, 5. überarbeitete Auflage, Thieme, Stuttgart, 1995

**Prerequisites / notice**
Exercises are integrated in the lectures. In addition, attendance in the lecture 529-0289-00 "Instrumental analysis of organic compounds" (4th semester) is recommended.

529-0122-AAL | Inorganic Chemistry II | E- | 3 credits | 6R | M. Kovalenko

**Abstract**
The lecture is based on Inorganic Chemistry I and addresses an enhanced understanding of the symmetry aspects of chemical bonding of molecules and translation polymers, i.e. crystal structures.

**Objective**
The lecture is based on Inorganic Chemistry I and addresses an enhanced understanding of the symmetry aspects of chemical bonding of molecules and translation polymers.

**Content**
Symmetry aspects of chemical bonding, point groups and representations for the deduction of molecular orbitals, energy assessment for molecules and solids, Sanderson formalism, derivation and understanding of bond structures, densities of states, overlap populations, crystal symmetry, basic crystal structures and corresponding properties, visual representations of crystal structures.

**Lecture notes**
Additional information is available on the internet at: http://www.ac.ethz.ch/
user: aach
password: jsenpw

**Literature**

**Prerequisites / notice**
Requirements: Inorganic Chemistry I

529-0132-AAL | Inorganic Chemistry III: Organometallic Chemistry and E-Homogeneous Catalysis | E- | 4 credits | 9R | A. Togni, A. Mezzetti

**Abstract**
Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

**Objective**
Any other students (e.g. incoming exchange students,
Abstract
Fundamental aspects of the organometallic chemistry of the transition elements. Mechanistic homogeneous catalysis including oxidative
additions, reductive eliminations and insertion reactions. Catalytic hydrogenation, carbonylation, C-C bond-forming and related reactions.

Objective
Towards an understanding of the fundamental coordination-chemical and mechanistic aspects of transition-metal chemistry relevant to
homogeneous catalysis.

Content
Fundamental aspects of the organometallic chemistry of the transition elements. Mechanistic homogeneous catalysis including oxidative
additions, reductive eliminations and insertion reactions. Catalytic hydrogenation, carbonylation, C-C bond-forming and related reactions.

Literature
A relatively concise but excellent introduction to organometallic chemistry. Strong textbook character, available as E-book
A more comprehensive standard work on organometallic chemistry. Several chapters written by various authors, partly specialized review-
article style.

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<th>Chemistry Master - Key for Type</th>
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</table>

Special students and auditors need special permission from the lecturers.
### Core Subjects

#### Bioengineering

<table>
<thead>
<tr>
<th>Number</th>
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<tr>
<td>529-0837-00L</td>
<td>Biopolymerization and Colloid Engineering</td>
<td>W+</td>
<td>7 credits</td>
<td>3G</td>
<td>A. de Mello</td>
</tr>
</tbody>
</table>

**Abstract**

Microfluidics describes the behavior, control and manipulation of fluids that are geometrically constrained within sub-microliter environments. The use of microfluidic devices offers an opportunity to control physical and chemical processes with unrivalled precision, and in turn provides a route to performing chemistry and biology in an ultra-fast and high-efficiency manner.

**Objective**

In the course students will investigate the theoretical concepts behind microfluidic device operation, the methods of microfluidic device manufacture and the application of microfluidic architectures to important problems faced in modern day chemical and biological analysis. A design workshop will allow students to develop new microscale flow processes by appreciating the dominant physics at the microscale. The application of these basic ideas will primarily focus on biological problems and will include a treatment of diagnostic devices for use at the point-of-care, advanced functional material synthesis, DNA analysis, proteomics and cell-based assays. Lectures, assignments and the design workshop will acquaint students with the state-of-the-art in applied microfluidics.

**Content**

Specific topics in the course include, but not limited to:

1. Theoretical Concepts
   - Features of mass and thermal transport on the microscale
   - Key scaling laws
2. Microfluidic Device Manufacture
   - Conventional lithographic processing of rigid materials
   - Soft lithographic processing of plastics and polymers
   - Mass fabrication of polymeric devices
3. Unit operations and functional components
   - Analytical separations (electrophoresis and chromatography)
   - Chemical and biological synthesis
   - Sample pre-treatment (filtration, SPE, pre-concentration)
   - Molecular detection
4. Design Workshop
   - Design of microfluidic architectures for PCR, distillation & mixing
5. Contemporary Applications in Biological Analysis
   - Microarrays
   - Cellular analyses (single cells, enzymatic assays, cell sorting)
   - Proteomics
6. System integration
   - Applications in radiochemistry, diagnostics and high-throughput experimentation

**Lecture notes**

Lecture handouts, background literature, problem sheets and notes will be provided electronically.

#### Polymers

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>529-0615-00L</td>
<td>Polymerization Reaction and Colloid Engineering</td>
<td>W+</td>
<td>7 credits</td>
<td>3G</td>
<td>M. Morbidelli, P. Arosio</td>
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</table>

**Abstract**


**Objective**

Introduce the students to the design of polymerization reactors for the production of polymers with molecular characteristics suitably tuned for specific applications. This includes the post-treatment of polymer latexes and the analysis of their colloidal behavior.

**Content**

The aim of the course is to provide the tools needed for the understanding of the fundamental processes and the design of the industrial units involved in the production of polymeric materials and in the post-treatment of polymer colloids. In particular, the following topics are discussed: Physico-chemical characterization of polymers and description of the polymerization processes. Kinetics of free-radical polymerization and use of population balance models. Production of homo- and co-polymers with controlled characteristics in terms of molecular weight distribution and chain composition distribution. Living polymerizations. Design of polymerization reactors and the thermal runaway problem. Surfactants and colloidal stability. Aggregation kinetics and aggregate structure in conditions of diffusion and reaction limited aggregation. The role of shear conditions on aggregation and breakage kinetics and on the aggregate structure. Modeling and design of colloid aggregation processes.

**Lecture notes**

Skripts are available on the "Polymerization Reaction and Colloid Engineering" web page of the Morbidelli-group, vide the given link for details.

**Literature**


<table>
<thead>
<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>529-0619-00L</td>
<td>Chemical Product Design</td>
<td>W+</td>
<td>7 credits</td>
<td>3G</td>
<td>W. J. Stark</td>
</tr>
</tbody>
</table>

**Abstract**

Prerequisites: Basic chemistry and chemical engineering knowledge (Diffusion, Thermodynamics, Kinetics, ...).

The 'Chemical Product Design' course teaches students quantitative concepts to analyze, select and transform theoretical concepts from chemistry and engineering into valuable real-world products. Basic chemistry and chemical engineering knowledge is required (Diffusion, Thermodynamics, Kinetics, ...).

**Objective**

This course starts with analyzing existing chemical needs and unmet technical challenges. We then develop the skills to critically analyze a specific chemical idea for a product, to rapidly test feasibility or chance for success and to eventually realize its manufacturing. The chemical engineering basics are then used to assess performance of products or devices with non-traditional functions based on dynamic properties (e.g. responsive building materials; personal medical diagnostics on paper strips). The course teaches the interface between laboratory and market with a specific focus on evaluating the chemical value of a given process or compound, and the necessary steps to pursue the resulting project within an entrepreneurial environment. We therefore extend the questions of process design ('how do we make something?') to the question of 'what should we make?'

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Data: 06.03.2019 12:57  Autumn Semester 2016  Page 367 of 1571
Part A: The ‘Chemical Product Design’ course starts with discussing questions along, ‘What is a chemical product, and why do people pay for it? How does a given compound in a specific setting provide a service?’ We then learn how to translate new, often ill-defined wishes or ideas into quantifiable specifications.

Part B: Thermodynamic and kinetic data allow sharp selection criteria for successful products. We learn how to deal with insufficient data and development of robust case models to evaluate their technical and financial constraints. How can parameters of a running process in one industry be scaled into another industry? Can dimensionless engineering numbers be applied beyond traditional chemical processes?

Part C: Manufacturing of commodity products, devices and molecular products: Chemical reactors, separation and detection or isolation units as part of a toolbox. Planning of manufacturing and decisions based on hard data. Providing quantitative answers on potential value generated.

Students are expected to actively develop chemical products along the course. Contributions will be made individually, or in small groups, where a larger topic is studied.

Literature


### Process Design

<table>
<thead>
<tr>
<th>Number</th>
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<tr>
<td>529-0613-00L</td>
<td>Process Simulation and Flowsheeting</td>
<td>W+</td>
<td>7</td>
<td>3G</td>
<td>E. Capón García, K. Hungerbühler</td>
</tr>
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</table>

**Abstract**

This course encompasses the theoretical principles of chemical process simulation, as well as its practical application in process analysis and optimization. The techniques for simulating stationary and dynamic processes are presented, and illustrated with case studies. Commercial software packages are presented as a key engineering tool for solving process flowsheeting and simulation problems.

**Objective**

This course aims to develop the competency of chemical engineers in process flowsheeting and simulation. Specifically, students will develop the following skills:
- Deep understanding of chemical engineering fundamentals: the acquisition of new concepts and the application of previous knowledge in the area of chemical process systems and their mechanisms are crucial to intelligently simulate and evaluate processes.
- Modeling of general chemical processes and systems: students have to be able to identify the boundaries of the system to be studied and develop the set of relevant mathematical relations, which describe the process behavior.
- Mathematical reasoning and computational skills: the familiarization with mathematical algorithms and computational tools is essential to be capable of achieving rapid and reliable solutions to simulation and optimization problems. Hence, students will learn the mathematical principles necessary for process simulation and optimization, as well as the structure and application of process simulation software. Thus, they will be able develop criteria to correctly use commercial software packages and critically evaluate their results.

**Content**

- Overview of process simulation and flowsheeting
  - Definition and fundamentals
  - Classification: stationary (steady-state) versus dynamic (transient state) systems
  - Fields of application
  - Case studies
- Process modeling
  - Modeling strategies of process systems
  - Mass conservation
  - Species balance
  - Energy conservation
  - Momentum balance
  - Multiphase-systems: equilibrium & non-equilibrium models
  - Process system model
- Process simulation
  - Process specification
  - Introduction to process specification
  - Classification of mathematical models: AMS, DOE, DAE, PDE
  - Model validation
  - Software tools
  - Solution methods for process flowsheeting
  - Sequential methods
  - Simultaneous methods
- Process optimization and analysis
  - Classification of optimization problems
  - Linear programming
  - Non-linear programming
  - Dynamic programming
  - Optimization methods in process flowsheeting
  - Sequential methods
  - Simultaneous methods
- Commercial software for simulation: Aspen Plus
  - Thermodynamic property methods
  - Reactions and reactors
  - Separation / columns
  - Convergence & debugging

**Prerequisites / notice**

A basic understanding of material and energy balances, thermodynamic property methods and typical unit operations (e.g., reactors, flash separations, distillation/absorption columns etc.) is required.

**Literature**

An exemplary literature list is provided below:
529-0643-00L Process Design and Development W+ 7 credits 3G G. Storti

Abstract
The course is focused on the design of Chemical Processes, with emphasis on the preliminary stage of the design approach, where process creation and quick selection among many alternatives are important. The main concepts behind more detailed process design and process simulation are also examined in the last part of the course.

Objective
The course is focused on the design of Chemical Processes, with emphasis on the preliminary stage of the design approach, where process creation and quick selection among many alternatives are important. The main concepts behind more detailed process design and process simulation are also examined in the last part of the course.

Content

Preliminary process evaluation: simplified material and energy balances (linear balances), degrees of freedom, short-cut models, flowsheet solution algorithm.


Process economic evaluation: equipment sizing and costing, time value of money, cash flow calculations.

Detailed Process Design: unit operation models, flash solution algorithms (different iterative methods, inside-out method), sequencing of nonideal distillation columns, networks of chemical reactors.

Lecture notes
no script

Literature

Prerequisites / notice

Catalysis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<tr>
<td>529-0611-00L</td>
<td>Characterization of Catalysts and Surfaces</td>
<td>W+</td>
<td>7</td>
<td>3G</td>
<td>J. A. van Bokhoven, D. Ferri</td>
</tr>
<tr>
<td>529-0617-00L</td>
<td>Catalysis Engineering</td>
<td>W+</td>
<td>7</td>
<td>3G</td>
<td>J. Pérez-Ramírez</td>
</tr>
</tbody>
</table>

Abstract

Characterization of Catalysts and Surfaces
Basic elements of surface science important for materials and catalysis research. Physical and chemical methods important for research in surface science, material science and catalysis are considered and their application is demonstrated on practical examples.

Catalysis Engineering
The purpose of the "Catalysis Engineering" course is to provide students with tools that enable the optimal design of catalytic materials and reactor engineering concepts favoring more sustainable manufacturing processes within the chemical industry.

Objective
Basic aspects of surface science. Understanding of principles of most important experimental methods used in research concerned with surface science, material science and catalysis.

Content
Methods which are covered embrace: Gas adsorption and surface area analysis, IR-Spectroscopy, X-ray diffraction, X-ray photoelectron spectroscopy, X-ray absorption, solid state NMR, Electron Microscopy and others.

Abstract

Catalysis Engineering
The course aims at illustrating, from conception to implementation, the design of sustainable catalytic processes by integration of the microlevel (catalyst), mesolevel (reactor), and macrolevel (process). The word "sustainable" implies intensified processes with an improved exploitation of raw materials, wider use of renewable feedstocks, reduction of energy consumption, and minimized environmental impact. By the use of modern case studies of industrial relevance, aspects of catalyst preparation and characterization, kinetics, mass and heat transport, and deactivation are discussed. Emphasis is put on understanding the interaction among these basic elements in order to select the optimal catalytic process. Since no textbooks covering this area are available at this time and the intention of this course is unique, the lectures will be based on own texts and journal articles. During the course, there will be specific topics addressed by industrial contributors.

Content
The following general aspects:
- Catalyst preparation and characterization
- Kinetics
- Mass and heat transport
- Selectivity
- Deactivation

will be demonstrated for modern catalytic materials and processes of industrial relevance such as:
- Chlorine recycling
- NO2 abatement
- Chemoselective hydrogenations
- Hierarchical zeolite catalysts
- Syngas conversion
- Biomass to chemicals and fuels

Lecture notes
The course material is based on an own script, journal articles, and slides.

It is assumed that students selecting this course are familiar with general concepts of catalysis, reactor design, and transport phenomena.

Electives

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<th>Number</th>
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<tr>
<td>151-0113-00L</td>
<td>Applied Fluid Dynamics</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>J.P. Kunsch</td>
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Abstract

Applied Fluid Dynamics
The methods of fluid dynamics play an important role in the description of a chain of events, involving the release, spreading and dilution of dangerous fluids in the environment.

Tunnel ventilation systems and strategies are studied, which must meet severe requirements during normal operation and in emergency situations (tunnel fires etc.).

Objective
Generally applicable methods in fluid dynamics and gas dynamics are illustrated and practiced using selected current examples.

Content
Often experts fall back on the methodology of fluid dynamics when involved in the construction of environmentally friendly processing and incineration facilities, as well as when choosing safe transport and storage options for dangerous materials. As a result of accidents, but also in normal operations, dangerous gases and liquids may escape and be transported further by wind or flowing water. There are many possible forms that the resulting damage may take, including fire and explosion when flammable substances are mixed. The topics covered include: Emissions from liquids and gases from containers and pipelines, evaporation from pools and vaporization of gases kept under pressure, the spread and dilution of waste gas plumes in the wind, deflagration and detonation of flammable gases, fireballs in gases held under pressure, pollution and exhaust gases in tunnels (tunnel fires etc.).

Lecture notes
Requirements: successful attendance at lectures "Fluiddynamik I und II", "Thermodynamik I und II"
151-0109-00L Turbulent Flows W 4 credits 2V+1U P. Jenny

Abstract
Contents
- Laminar and turbulent flows, instability and origin of turbulence - Statistical description: averaging, turbulent energy, dissipation, closure problem - Scalings, Homogeneous isotropic turbulence, correlations, Fourier representation, energy spectrum - Free turbulence: wake, jet, mixing layer - Wall turbulence: Channel and boundary layer - Computation and modelling of turbulent flows

Objective
Basic physical phenomena of turbulent flows, quantitative and statistical description, basic and averaged equations, principles of turbulent flow computation and elements of turbulence modelling

Content
- Properties of laminar, transitional and turbulent flows.
- Origin and control of turbulence. Instability and transition.
- Statistical description, averaging, equations for mean and fluctuating quantities, closure problem.
- Scalings, homogeneous isotropic turbulence, energy spectrum.
- Turbulent free shear flows. Jet, wake, mixing layer.
- Wall-bounded turbulent flows.
- Turbulent flow computation and modeling.

Lecture notes
Lecture notes are available

Literature

151-0951-00L Process Design and Safety W 4 credits 2V+1U P. Rudolf von Rohr

Abstract
Process design and safety deals with the fundamentals of process apparatus, plant design and safety.

Objective
The goal of the lecture is to impart the knowledge and characteristics of systems for process engineering applications.

Content
Fundamentals of plant and apparatus design; materials in the process industries, mechanical design and design rules of main components; pumps and fans; piping and armatures, safety in process industry

Lecture notes
Script is available, english slides will be distributed

Literature

151-0927-00L Rate-Controlled Separations in Fine Chemistry W 4 credits 3G M. Mazzotti

Abstract
The students are supposed to obtain detailed insight into the fundamentals of separation processes that are frequently applied in modern life science processes in particular, fine chemistry and biotechnology.

Objective
The students are supposed to obtain detailed insight into the fundamentals of separation processes that are frequently applied in modern life science processes in particular, fine chemistry and biotechnology.

Content
The class covers separation techniques that are central in the purification and downstream processing of chemicals and biopharmaceuticals. Examples from both areas illustrate the utility of the methods: 1) Liquid-liquid extraction; 2) Adsorption and chromatography; 3) Membrane processes; 4) Crystallization and precipitation.

Lecture notes
Handouts during the class

Literature
Recommendations for text books will be covered in the class

Prerequisites / notice
Requirements: Thermal separation Processes I (151-0926-00) and Modelling and mathematical methods in process and chemical engineering (151-0940-00)

529-0611-00L Characterization of Catalysts and Surfaces W 7 credits 3G J. A. van Bokhoven, D. Ferri

Abstract
Basic elements of surface science important for materials and catalysis research. Physical and chemical methods important for research in surface science, material science and catalysis are considered and their application is demonstrated on practical examples.

Objective
Basic aspects of surface science. Understanding of principles of most important experimental methods used in research concerned with surface science, material science and catalysis.

Content
Methods which are covered embrace: Gas adsorption and surface area analysis, IR-Spectroscopy, X-ray diffraction, X-ray photoelectron spectroscopy, X-ray absorption, solid state NMR, Electron Microscopy and others.

Lecture notes
No lecture notes

Literature

529-0615-00L Polymerization Reaction and Colloid Engineering W 7 credits 3G M. Morbidelli, P. Arosio

Abstract

Objective
Introduce the students to the design of polymerization reactors for the production of polymers with molecular characteristics suitably tuned for specific applications. This includes the post-treatment of polymer colloids. The aim is to provide the tools needed for the understanding of the fundamental processes and the design of the industrial units involved in the production of polymeric materials and in the post-treatment of polymer colloids. In particular, the following topics are discussed: Physico-chemical characterization of polymers and description of the polymerization processes. Kinetics of free-radicar polymerization and use of population balance models. Production of homo- and co-polymers with controlled characteristics in terms of molecular weight distribution and chain composition distribution. Living polymerizations. Design of polymerization reactors and the thermal runaway problem. Kinetics and control of emulsion polymerization. The radical segregation problem. Surfaceants and coloidal stability. Aggregation kinetics and aggregate structure in conditions of diffusion and reaction limited aggregation. The role of shear conditions on aggregation and breakage kinetics and on the aggregate structure. Modeling and design of colloid aggregation processes.

Content
The aim of the course is to provide the tools needed for the understanding of the fundamental processes and the design of the industrial units involved in the production of polymeric materials and in the post-treatment of polymer colloids. In particular, the following topics are discussed: Physico-chemical characterization of polymers and description of the polymerization processes. Kinetics of free-radical polymerization and use of population balance models. Production of homo- and co-polymers with controlled characteristics in terms of molecular weight distribution and chain composition distribution. Living polymerizations. Design of polymerization reactors and the thermal runaway problem. Kinetics and control of emulsion polymerization. The radical segregation problem. Surfaceants and coloidal stability. Aggregation kinetics and aggregate structure in conditions of diffusion and reaction limited aggregation. The role of shear conditions on aggregation and breakage kinetics and on the aggregate structure. Modeling and design of colloid aggregation processes.

Lecture notes
No lecture notes

Literature

529-0613-00L Process Simulation and Flowsheeting W 7 credits 3G E. Capón Garcia, K. Hungerbühler

Abstract
This course encompasses the theoretical principles of chemical process simulation, as well as its practical application in process analysis and optimization. The techniques for simulating stationary and dynamic processes are presented, and illustrated with case studies. Commercial software packages are presented as a key engineering tool for solving process flowsheeting and simulation problems.

Objective
This course aims to develop the competency of chemical engineers in process flowsheeting and simulation. Specifically, students will develop the following skills:
- Deep understanding of chemical engineering fundamentals: the acquisition of new concepts and the application of previous knowledge in the area of chemical process systems and their mechanisms are crucial to intelligently simulate and evaluate processes.
- Modeling of general chemical processes and systems: students have to be able to identify the boundaries of the system to be studied and develop the set of relevant mathematical relations, which describe the process behavior.
- Mathematical reasoning and computational skills: the familiarization with mathematical algorithms and computational tools is essential to be capable of achieving rapid and reliable solutions to simulation and optimization problems. Hence, students will learn the mathematical principles necessary for process simulation and optimization, as well as the structure and application of process simulation software. Thus, they will be able develop criteria to correctly use commercial software packages and critically evaluate their results.
Overview of process simulation and flowsheeting
- Definition and fundamentals
- Classification: stationary (steady-state) versus dynamic (transient state) systems
- Fields of application
- Case studies

Process modeling
- Modeling strategies of process systems
- Mass conservation
- Species balance
- Energy conservation
- Momentum balance
- Multiphase-systems: equilibrium & non-equilibrium models
- Process system model

Process simulation
- Process specification
- Introduction to process specification
- Classification of mathematical models: AMS, DOE, DAE, PDE
- Model validation
- Software tools
- Solution methods for process flowsheeting
- Simultaneous methods
- Sequential methods
- Dynamic simulation
- Numerical solution: explicit and implicit methods
- Continuous-discrete simulation: handling of discontinuities

Process optimization and analysis
- Classification of optimization problems
- Linear programming
- Non-linear programming
- Dynamic programming
- Optimization methods in process flowsheeting
- Sequential methods
- Simultaneous methods

Commercial software for simulation: Aspen Plus
- Thermodynamic property methods
- Reaction and reactors
- Separation / columns
- Convergence & debugging

An exemplary literature list is provided below:

A basic understanding of material and energy balances, thermodynamic property methods and typical unit operations (e.g., reactors, flash separations, distillation/absorption columns etc.) is required.

<table>
<thead>
<tr>
<th>Prerequisites / notice</th>
<th>Content</th>
<th>Literature</th>
<th>Abstract</th>
<th>Objective</th>
<th>Content</th>
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<tbody>
<tr>
<td>529-0619-00L</td>
<td>Chemical Product Design</td>
<td>W</td>
<td>7 credits</td>
<td>3G</td>
<td>W. J. Stark</td>
</tr>
<tr>
<td>Prerequisites: Basic chemistry and chemical engineering knowledge (Diffusion, Thermodynamics, Kinetics,...).</td>
<td>The 'Chemical Product Design' course teaches students quantitative concepts to analyze, select and transform theoretical concepts from chemistry and engineering into valuable real-world products. Basic chemistry and chemical engineering knowledge is required (Diffusion, Thermodynamics, Kinetics,...).</td>
<td>This course starts with analyzing existing chemical needs and unmet technical challenges. We then develop the skills to critically analyze a specific chemical idea for a product, to rapidly test feasibility or chance for success and to eventually realize its manufacturing. The chemical engineering basics are then used to assess performance of products or devices with non-traditional functions based on dynamic properties (e.g. responsive building materials; personal medical diagnostics on paper strips). The course teaches the interface between laboratory and market with a specific focus on evaluating the chemical value of a given process or compound, and the necessary steps to pursue the resulting project within an entrepreneurial environment. We therefore extend the questions of process design (&quot;how do we make something?&quot;) to the question of &quot;what should we make?&quot;</td>
<td>Part A: The ‘Chemical Product Design’ course starts with discussing questions along, ‘What is a chemical product, and why do people pay for it? How does a given compound in a specific setting provide a service?’ We then learn how to translate new, often ill-defined wishes or ideas into quantifiable specifications.</td>
<td>Students are expected to actively develop chemical products along the course. Contributions will be made individually, or in small groups, where a larger topic is studied.</td>
<td></td>
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</tbody>
</table>
**Objective**
The course is focused on the design of Chemical Processes, with emphasis on the preliminary stage of the design approach, where process creation and quick selection among many alternatives are important. The main concepts behind more detailed process design and process simulation are also examined in the last part of the course.

**Content**

Preliminary process evaluation: simplified material and energy balances (linear balances), degrees of freedom, short-cut models, flowsheet solution algorithm.


Process economic evaluation: equipment sizing and costing, time value of money, cash flow calculations.

Batch Processes: scheduling, sizing and inventories.

Detailed Process Design: unit operation models, flash solution algorithms (different iterative methods, inside-out method), sequencing of nonideal distillation columns, networks of chemical reactors.

**Lecture notes**
no script

**Literature**


**Prerequisites / notice**
Prerequisite: Thermal Unit Operations

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<tr>
<th>529-0617-00L</th>
<th>Catalysis Engineering</th>
<th>W</th>
<th>7 credits</th>
<th>3G</th>
<th>J. Pérez-Ramírez</th>
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<tr>
<td><strong>Abstract</strong></td>
<td>The purpose of the &quot;Catalysis Engineering&quot; course is to provide students with tools that enable the optimal design of catalytic materials and reactor engineering concepts favoring more sustainable manufacturing processes within the chemical industry.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>The course aims at illustrating, from conception to implementation, the design of sustainable catalytic processes by integration of the microlevel (catalyst), mesolevel (reactor), and macrolevel (process). The word &quot;sustainable&quot; implies intensified processes with an improved exploitation of raw materials, wider use of renewable feedstocks, reduction of energy consumption, and minimized environmental impact. By the use of modern case studies of industrial relevance, aspects of catalyst preparation and characterization, kinetics, mass and heat transport, and deactivation are discussed. Emphasis is put on understanding the interaction among these basic elements in order to select the optimal catalytic process. Since no textbooks covering this area are available at this time and the intention of this course is unique, the lectures will be based on own texts and journal articles. During the course, there will be specific topics addressed by industrial contributors. The following general aspects:</td>
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<tr>
<td><strong>Lecture notes</strong></td>
<td>The course material is based on an own script, journal articles, and slides.</td>
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<tr>
<td><strong>Prerequisites / notice</strong></td>
<td>It is assumed that students selecting this course are familiar with general concepts of catalysis, reactor design, and transport phenomena.</td>
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</table>

<table>
<thead>
<tr>
<th>529-0837-00L</th>
<th>Biomicrofluidic Engineering</th>
<th>W</th>
<th>7 credits</th>
<th>3G</th>
<th>A. de Mello</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Number of participants limited to 30.</strong></td>
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<tr>
<td><strong>Abstract</strong></td>
<td>Microfluidics describes the behaviour, control and manipulation of fluids that are geometrically constrained within sub-microliter environments. The use of microfluidic devices offers an opportunity to control physical and chemical processes with unrivalled precision, and in turn provides a route to performing chemistry and biology in an ultra-fast and high-efficiency manner.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>In the course students will investigate the theoretical concepts behind microfluidic device operation, the methods of microfluidic device manufacture and the application of microfluidic architectures to important problems faced in modern day chemical and biological analysis. A design workshop will allow students to develop new microscale flow processes by appreciating the dominant physics at the microscale. The application of these basic ideas will primarily focus on biological problems and will include a treatment of diagnostic devices for use at the point-of-care, advanced functional material synthesis, DNA analysis, proteomics and cell-based assays. Lectures, assignments and the design workshop will acquaint students with the state-of-the-art in applied microfluidics.</td>
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<tr>
<td><strong>Content</strong></td>
<td>Specific topics in the course include, but not limited to:</td>
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<tr>
<td></td>
<td>1. Theoretical Concepts</td>
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<td></td>
<td>Features of mass and thermal transport on the microscale</td>
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<td></td>
<td>Key scaling laws</td>
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<td></td>
<td>2. Microfluidic Device Manufacture</td>
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<tr>
<td></td>
<td>Conventional lithographic processing of rigid materials</td>
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<td>Soft lithographic processing of plastics and polymers</td>
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<td>Mass fabrication of polymeric devices</td>
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<td>3. Unit operations and functional components</td>
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<tr>
<td></td>
<td>Analytical separations (electrophoresis and chromatography)</td>
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<td></td>
<td>Chemical and biological synthesis</td>
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<td></td>
<td>Sample pre-treatment (filtration, SPE, pre-concentration)</td>
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<td></td>
<td>Molecular detection</td>
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<td>4. Design Workshop</td>
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<td>Design of microfluidic architectures for PCR, distillation &amp; mixing</td>
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<td>5. Contemporary Applications in Biological Analysis</td>
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<td></td>
<td>Microarrays</td>
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<td></td>
<td>Cellular analyses (single cells, enzymatic assays, cell sorting)</td>
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<td></td>
<td>Proteomics</td>
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<td></td>
<td>6. System integration</td>
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<td></td>
<td>Applications in radiochemistry, diagnostics and high-throughput experimentation</td>
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<tr>
<td><strong>Lecture notes</strong></td>
<td>Lecture handouts, background literature, problem sheets and notes will be provided electronically.</td>
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<tr>
<th>529-0047-00L</th>
<th>Risk Assessment of Chemicals</th>
<th>W</th>
<th>7 credits</th>
<th>6A</th>
<th>C. Bogdal, K. Hungerbühler, N. von Götz, Z. Wang</th>
</tr>
</thead>
</table>

Data: 06.03.2019 12:57  Autumn Semester 2016  Page 372 of 1571
Abstract
Projects on chemical assessment with the focus on the analysis and assessment of basic substance data for selected chemical classes; analysis and modelling of technical processes; characterisation of environmental and health risks. Risk assessment on the basis of quality and protection goals. Estimation of model and parameter uncertainty. Precaution and safety measures.

Objective
Project thesis (report) on chemicals assessment; time frame totals ca. 80 hours.

Content
Projects on chemical assessment with the focus on the following aspects:

- Analysis and assessment of basic substance data for selected chemical classes: physical chemical properties, environmental behaviour (distribution, persistence), human and eco-toxicity (biochemical metabolism, effect mechanisms), safety.
- Analysis and modelling of technical processes determining chemical release into the environment, e.g., chemicals applications.
- Characterisation of environmental and health risks on the basis of exposure and effect models, QSARs from environmental chemistry, toxicology and methods of risk analysis.
- Risk assessment on the basis of quality and safety goals. Estimation of the model and data uncertainty.
- Demonstration of possibilities and limits of precaution and safety measures (technical, organisational, concerning personnel) including effectiveness and efficiency.

Project teaching; time frame totals ca. 80 hours.

Lecture notes
See recommended literature.

Literature

Prerequisites / notice
Voraussetzung:
529-0580-00L - Risikoanalyse chemischer Prozesse und Produkte
oder: 701-0998-00L - Environmental and Human Health Risk Assessment of Chemicals

Beschränkt auf 6 Projektarbeiten pro Semester

529-0745-00L General and Environmental Toxicology W 7 credits 3V M. Arand, K. Hungerbühler, H. Nägeli, B. B. Stieger, I. Werner

Abstract
Toxicokinetic and toxicodynamic aspects of xenobiotic interactions with cellular structures and mechanisms. Toxic responses at the level of organs (immune-, neuro-, reproductive and genotoxicity) and organisms. Introduction into developmental toxicology and ecotoxicology.

Objective
Understanding of the impact of chemicals on biological systems; evaluation of the effects from different biomedical perspectives.

Content
Explanation of important interactions between xenobiotic chemicals and cellular structures such as membranes, enzymes, and nucleic acids. Relevance of intake, distribution, excretion, and biochemical transformation. Relevance of mixtures. Explanation of important modes of toxic action such as immunotoxicity, neurotoxicity, reproduction toxicity, genotoxicity based on examples of certain xenobiotics and their effects on important organs.

Lecture notes
Course material will be handed out as the lectures progress.

Literature
Textbooks of pharmacology and toxicology (cf. list in course material).

529-0659-00L Electrochemistry W 6 credits 3G P. Novák

Abstract

Objective
Towards the end of the course the students will understand the basics of electrochemistry and will be able to describe and calculate electrochemistry-related matters in industrial processes and products.

Content

529-0193-00L Renewable Energy Technologies I W 4 credits 3G A. Wokaun, A. Steinfeld

Abstract
The lectures Renewable Energy Technologies I (529-0193-00L) and Renewable Energy Technologies II (529-0191-00L) can be taken independently from one another.

Objective
Scenarios for world energy demand and CO2 emissions, implications for climate. Methods for the assessment of energy chains. Potential and technology of renewable energies: Biomass (heat, electricity, biofuels), solar energy (low temp. heat, solar thermal and photosynthesis, solar chemistry). Wind and ocean energy, heat pumps, geothermal energy, energy from waste, CO2 sequestration.

Content
Scenarios for the development of world primary energy consumption are introduced. Students know the potential and limitations of renewable energies for reducing CO2 emissions, and their contribution towards a future sustainable energy system that respects climate protection goals.

Lecture notes
Lecture notes will be distributed electronically during the course.

Literature
Prerequisites / notice
Fundamentals of chemistry, physics and thermodynamics are a prerequisite for this course.

Topics are available to carry out a Project Work (Semesterarbeit) on the contents of this course.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Type</th>
<th>Instructor</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-1714-00L</td>
<td>Computational Systems Biology</td>
<td>W 6</td>
<td>6 credits</td>
<td>J. Stelling</td>
</tr>
<tr>
<td>636-0007-00L</td>
<td>Biological Engineering and Biotechnology</td>
<td>W 6</td>
<td>6 credits</td>
<td>M. Fussenegger</td>
</tr>
<tr>
<td>151-0104-00L</td>
<td>Uncertainty Quantification for Engineering &amp; Life Sciences</td>
<td>W 4</td>
<td>4 credits</td>
<td>P. Koumoutsakos</td>
</tr>
</tbody>
</table>

Abstract
Introduction to molecular characteristics of molecules involved in the materials-to-biology interface. Molecular design of biomaterials.

Objective
The class consists of three parts:
1. Introduction into native and polymeric biomaterials used for medical applications. The concepts of biocompatibility, biodegradation and the consequences of degradation products are discussed on the molecular level. Different classes of materials with respect to potential applications in tissue engineering and drug delivery are introduced. Strong focus lies on the molecular interactions between materials having very different bulk and/or surface chemistry with living cells, tissues and organs. In particular the interface between the materials surface and the eukaryotic cell surface and possible reactions of the cells with an implant material are elucidated. Techniques to design, produce and characterize materials in vitro as well as in vivo analysis of implanted and explanted materials are discussed. In addition, a link between academic research and industrial entrepreneurship is established by external guest speakers.

Lecture notes
Handsouts can be accessed online.

Literature

Abstract
Study of fundamental concepts, models and computational methods for the analysis of complex biological networks. Topics: Systems approaches in biology, biology and reaction network fundamentals, modeling and simulation approaches (topological, probabilistic, stoichiometric, qualitative, linear / nonlinear ODEs, stochastic), and systems analysis (complexity reduction, stability, identification).

Objective
The aim of this course is to provide an introductory overview of mathematical and computational methods for the modeling, simulation and analysis of biological networks.

Content
- Biology has witnessed an unprecedented increase in experimental data and, correspondingly, an increased need for computational methods to analyze this data. The explosion of sequenced genomes, and subsequently, bioinformatics methods for the storage, analysis and comparison of genetic sequences provides a prominent example. Recently, however, an additional area of research, captured by the label "Systems Biology", focuses on how networks, which are more than the mere sum of their parts' properties, establish biological functions. This is essentially a task of reverse engineering. The aim of this course is to provide an introductory overview of corresponding computational methods for the modeling, simulation and analysis of biological networks.
- We will start with an introduction into the basic units, functions and design principles that are relevant for biology at the level of individual cells. Making extensive use of example systems, the course will focus on methods and algorithms that allow for the investigation of biological networks with increasing detail. These include (i) graph theoretical approaches for revealing large-scale network organization, (ii) probabilistic (Bayesian) network representations, (iii) structural network analysis based on reaction stoichiometries, (iv) qualitative methods for dynamic modeling and simulation (Boolean and piece-wise linear approaches), (v) mechanistic modeling using ordinary differential equations (ODEs) and finally (vi) stochastic simulation methods.

Lecture notes

Literature

Abstract
Biological Engineering and Biotechnology will cover the latest biotechnological advances as well as their industrial implementation to engineer mammalian cells for use in human therapy. This lecture will provide forefront insights into key scientific aspects and the main points in industrial decision-making to bring a therapeutic from target to market.

Objective
1. Insight Into The Mammalian Cell Cycle. Cycling, The Balance Between Proliferation and Cancer - Implications For Biopharmaceutical Manufacturing.
2. The Licence To Kill. Apoptosis Regulatory Networks - Engineering of Survival Pathways To Increase Robustness of Production Cell Lines.
5. From Target To Market. An Antibody's Journey From Cell Culture to the Clinics.

Lecture notes
- Handsouts during the course.

Abstract
Quantification of uncertainties in computational models pertaining to applications in engineering and life sciences. Exploitation of massively available data to develop computational models with quantifiable predictive capabilities. Applications of Uncertainty Quantification and Propagation to problems in mechanics, control, systems and cell biology.

Objective
The course will teach fundamental concept of Uncertainty Quantification and Propagation (UQ+P) for computational models of systems in Engineering and Life Sciences. Emphasis will be placed on practical and computational aspects of UQ+P including the implementation of relevant algorithms in multicore architectures.

Content
- Topics that will be covered include: Uncertainty quantification under parametric and non-parametric modeling uncertainty, Bayesian inference with model class assessment, Markov Chain Monte Carlo simulation, prior and posterior reliability analysis.

Lecture notes
- The class will be largely based on the book: Data Analysis: A Bayesian Tutorial by Devinderjit Sivia as well as on class notes and related literature that will be distributed in class.
Laboratory Course, Research Project, and Case Study

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0300-00L</td>
<td>Research Project</td>
<td>O</td>
<td>8</td>
<td>8A</td>
<td>Professors</td>
</tr>
<tr>
<td>529-0637-00L</td>
<td>Chemical Engineering Laboratory II</td>
<td>O</td>
<td>8</td>
<td>8P</td>
<td>M. Morbidelli, K. Hungerbühler, N. Kobert, F. C. I. Meemken</td>
</tr>
<tr>
<td>529-0459-00L</td>
<td>Case Studies in Process Design</td>
<td>O</td>
<td>7</td>
<td>3A</td>
<td>K. Hungerbühler, E. Capón García</td>
</tr>
</tbody>
</table>

Abstract

- In a research project students extend their knowledge in a particular field, get acquainted with the scientific way of working, and learn to work on an actual research topic. Research projects are carried out in a core or optional subject area as chosen by the student.

Objective

- First contact with experimental techniques of chemical engineering in a research group. Critical evaluation and presentation of the results in a scientific report.

Content

- This laboratory project is organised during the spring vacation before the sixth semester. The participant can choose his topic from the list of projects suggested. Main emphasis during this research work is to get experience in using different engineering tools and evaluation and the interpretation of the results. Those are presented as a scientific report.

- Introduction to the main specific areas in chemical and biochemical engineering. The students sharpen their laboratory skills and learn to plan and perform problem-oriented experiments and to analyse, interpret and present the results.

- Teams of two students will conduct four or five experiments from the following areas: reactor stability, characterization of multiphase reactors, heterogeneous gas phase catalysis, polymer reaction engineering, process control and automation, safety and ecological analysis.

- The learning objective is to design, simulate and optimise a real (bio-)chemical process from a process systems perspective. Specifically, a commercial process simulation software will be used for the process simulation and optimisation. Students have to integrate knowledge combined techniques to plan and perform problem-oriented experiments and to analyse, interpret and present the results.

- Simulate and optimise a chemical production process using a commercial process simulation software.

- The learning objectives (LO) of this course are:

  LO 1: Create a model describing the production process
  - Students will apply a commercial process simulator systematically for process creation and analysis.
  - Students will discriminate the models for the different process units.
  - Students will evaluate the sequencing in which process units associated with recycle loops are solved to obtain converged material and energy balances.

  LO 2: Evaluate the performance of the production process
  - Students will analyse and understand the degrees of freedom in modelling process units and flowsheets.
  - Students will make design specifications and follow the iterations implemented to satisfy them.
  - Students will judge the role of process simulators in equipment sizing and costing and profitability analysis.

  LO 3: Optimise the design and operating conditions of the production process
  - Students will solve sensitivity analyses and optimisations are conducted considering technical and economic criteria.
  - Students will optimise the production process considering economic and environmental criteria.
Prerequisites / notice

Before the case study week, students do exercises in the course of Process Simulation and Flowsheeting in order to get familiar with Aspen Plus simulation software (compulsory). They also receive guidelines for environmental impact assessment and skills on oral presentations.

The problem statement and detailed instructions are provided at the beginning of the case study week.

During the case study week:
- Students work in teams of 3-5 people.
- Students have to pose and solve the different questions presented in the problem statement.
- Students have to coordinate the activities, the preparation of the written report and the oral presentation.
- Students will be assessed in specific questions they may find along the case study development.
- An industry expert, namely a chemical engineer from ETHZ, exchanges with the groups.

One week after the case study week, the groups deliver the written report.

One week later, the students receive the comments on the work done, and implement required corrections.

All the groups prepare a single presentation comparing the results and showing their achievements.

Finally, the students visit the real industrial process at the site. They also present their work to the industrial experts on the day of the industry visit.

➤ GESS Science in Perspective

Recommended GESS Science in Perspective (Type B) for D-CHAB.

see GESS Science in Perspective: Type A: Enhancement of Reflection Capability

see GESS Science in Perspective: Language Courses ETH/UZH

➤ Master’s Thesis

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<tr>
<th>Number</th>
<th>Title</th>
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<th>Hours</th>
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<tbody>
<tr>
<td>529-0600-00L</td>
<td>Master’s Thesis</td>
<td>O</td>
<td>20 credits</td>
<td>43D</td>
<td>Professors</td>
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</table>

Only students who fulfill the following criteria are allowed to begin with their master thesis:

a. successful completion of the bachelor programme;
b. fulfilling of any additional requirements necessary to gain admission to the master programme.

Duration of the Master’s Thesis 16 weeks.

Abstract

In the Master thesis students prove their ability to independent, structured and scientific working. The Master thesis is carried out in a research group of the Department of Chemistry and Applied Biosciences, usually in the Institute of Chemical and Bioengineering, as chosen by the student.

Objective

In the Master Thesis students prove their ability to independent, structured and scientific working.

➤ Course Units for Additional Admission Requirements

The courses below are only available for MSc students with additional admission requirements.

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<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract

The goal of this course is to provide students with a wide general understanding in cell biology. With this material as a foundation, students have enough of a cell biological basis to begin their specialization not only in cell biology but also in related fields such as biochemistry, microbiology, pharmacological sciences, molecular biology, and others.

Objective

The goal of this course is to provide students with a wide general understanding cell biology. With this material as a foundation, students have enough of a cell biological basis to begin their specialization not only in cell biology but also in related fields such as biochemistry, microbiology, pharmacological sciences, molecular biology, and others.

Content

The focus is animal cells and the development of multicellular organisms with a clear emphasis on the molecular basis of cellular structures and phenomena. The topics include biological membranes, the cytoskeleton, protein sorting, energy metabolism, cell cycle and division, viruses, extracellular matrix, cell signaling, embryonic development and cancer research.

Literature


Analyzing cells & molecules / Gebhard Schertler/8/ 439-463;
Membrane structure / Gebhard Schertler/10/ 565-595;
Compartment and Sorting/ Ulrike Kutay/12+14+6/641-694/755-758/782-783/315-320/325 -333/Table 6-2/Figure6-20, 6-21, 6-32, 6-34;
Intracellular Membrane Traffic/ Ulrike Kutay/13/695-752;
The Cytoskeleton/ Ulrike Kutay/16/889 - 948 (only the essentials);
Membrane Transport of Small Molecules and the Electrical Properties of Membranes /Sabine Werner/11/597 - 633;
Mechanisms of Cell Communication / Sabine Werner/15/813-876;
Cancer/ Sabine Werner/20/1091-1141;
Cell Junctions and Extracellular Matrix/Ueli Suter / 1035-1081;
Stem Cells and Tissue Renewal/Ueli Suter /1217-1262;
Development of Multicellular organisms/ Ernst Hafen/ 21/ 1145-1179 /1184-1198/1198-1213;
Cell Migration/Joao Matos/951-960;
Cell Death/Joao Matos/1021-1032;
Cell Cycle/chromosome segregation/Cell division/Melosis/Joao Matos/ 963-1018.
### Biology II

**Enrolment** ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

**Abstract**

The lecture course Biology II is a basic introductory course into biology for students who need to pass this course for admission to their MSc curriculum.

**Objective**

The objective of the lecture course Biology II is the understanding of form, function, and development of animals and of the basic underlying mechanisms.

**Content**

The following numbers of chapters refer to the textbook "Biology" (Campbell & Reece, 7th edition, 2005) on which the course is based. Chapters 1-4 are a basic prerequisite. The sections "Structure of the Cell" (Chapters 5-10, 12, 17) and "General Genetics" (Chapters 13-16, 18, 46) are covered by the lecture Biology I.

1. Genomes, DNA Technology, Genetic Basis of Development

   - Chapter 19: Eukaryotic Genomes: Organization, Regulation, and Evolution
   - Chapter 20: DNA Technology and Genomics
   - Chapter 21: The Genetic Basis of Development

2. Form, Function, and Development of Animals I

   - Chapter 40: Basic Principles of Animal Form and Function
   - Chapter 41: Animal Nutrition
   - Chapter 44: Osmoregulation and Excretion
   - Chapter 47: Animal Development

3. Form, Function, and Development of Animals II

   - Chapter 42: Circulation and Gas Exchange
   - Chapter 43: The Immune System
   - Chapter 45: Hormones and the Endocrine System
   - Chapter 48: Nervous Systems
   - Chapter 49: Sensory and Motor Mechanisms

**Literature**

The following text-book is the basis for the courses Biology I and II:


**Prerequisites / notice**

Prerequisite: Lecture course Biology I of winter semester

### Analytical Chemistry I

**Enrolment** ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

**Abstract**

Introduction into the most important spectroscopical methods and their applications to gain structural information.

**Objective**

Knowledge about the necessary theoretical background of spectroscopical methods and their practical applications

**Content**

Application oriented basics of organic and inorganic instrumental analysis and of the empirical employment of structure elucidation methods:

- Mass spectrometry: Ionization methods, mass separation, isotope signals, rules of fragmentation, rearrangements.
- NMR spectroscopy: Experimental basics, chemical shift, spin-spin coupling.
- IR spectroscopy: Revisiting topics like harmonic oscillator, normal vibrations, coupled oscillating systems (in accordance to the basics of the related lecture in physical chemistry); sample preparation, acquisition techniques, law of Lambert and Beer, interpretation of IR spectra; Raman spectroscopy.
- UV/VIS spectroscopy: Basics, interpretation of electron spectra, Circular dichroism (CD) und optical rotation dispersion (ORD).

**Lecture notes**

Script will be for the production price

**Literature**

- M. Hesse, H. Meier, B. Zeeh, Spektroskopische Methoden in der organischen Chemie, 5. überarbeitete Auflage, Thieme, Stuttgart, 1995

**Prerequisites / notice**

Exercises are integrated in the lectures. In addition, attendance in the lecture 529-0289-00 "Instrumental analysis of organic compounds" (4th semester) is recommended.

### Biochemistry

**Enrolment** ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

**Abstract**

The lecture is a basic introductory course on the molecular principles of biology for students who need to pass this course for admission to their MSc curriculum.

**Objective**

The goal of this course is to give the students a basic understanding of the molecules that build a cell and make it function, and the basic principles of metabolism and molecular genetics
The course content is based on the following chapters of the textbook Biochemistry (Berg, Tymoczko, Stryer, 7th edition, 2012, Freeman & Co, New York)

Chapter 1: The molecular design of life
Chapter 2: Protein composition and structure
Chapter 3: Exploring proteins and proteomes
Chapter 4: DNA, RNA and the flow of information
Chapter 5: Exploring Genes and Genomes
Chapter 7: Hemoglobin
Chapter 8: Enzymes and the basic concepts of catalysis
Chapter 11: Carbohydrates
Chapter 12: Lipids and cell membranes
Chapter 15: Metabolism: Basic concepts and design

Literature

<table>
<thead>
<tr>
<th>Chemical and Bioengineering Master - Key for Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
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<tr>
<td>W+</td>
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<td>W</td>
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<td>E-</td>
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<tr>
<td>Z</td>
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<tr>
<td>Dr</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Key for Hours</th>
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<tbody>
<tr>
<td>V</td>
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<td>G</td>
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<td>S</td>
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<td>K</td>
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<td>P</td>
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<tr>
<td>A</td>
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<tr>
<td>D</td>
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<tr>
<td>R</td>
</tr>
</tbody>
</table>

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.

Chemical equilibrium and equilibrium constants, mono- and polyprotic acids and bases in aqueous solution, calculation of equilibrium constants, Nernst equation, coordination chemistry, stepwise formation of metal complexes, solubility.

Der Vorlesungsstoff ist sehr nahe am Lehrbuch gehalten, Skripte werden ggf. durch die Dozenten zur Verfügung gestellt.

Introduction to Physical Chemistry

Introduction to the chemistry of ionic equilibria: Acids and bases, redox reactions, formation of coordination complexes and precipitation reactions.

The goal of this course is to give the students a basic understanding of the molecules that build a cell and make it function, and the basic principles of metabolism and molecular genetics.

Mathematical Foundations I: Analysis A

Objective

Content

Abstract

Literature

Lecture notes

Prerequisites / notice

The lecture Biology I, together with the lecture Biology II in the following summer semester, is a basic, introductory course into Biology for Students of Materials Sciences and other students with biology as subsidiary subject.

The goal of this course is to give the students a basic understanding of the molecules that build a cell and make it function, and the basic principles of metabolism and molecular genetics.

Grundlagen des Stoffwechsels und eines Überblicks über molekulare Genetik

Das folgende Lehrbuch ist Grundlage für die Vorlesungen Biologie I und II:


Introduction to calculus in one dimension. Building simple models and analysing them mathematically.

Objective

Content

Abstract

Literature

Lecture notes

Prerequisites / notice

Introduction to calculus in one dimension. Building simple models and analysing them mathematically.

Voraussetzungen: Maturastoff. Insbesondere Integral- und Differenzialrechnung.

Students of Materials Sciences and other students with biology as subsidiary subject.

**Laboratory Courses**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0011-04L</td>
<td>Practical Course General Chemistry</td>
<td>O</td>
<td>8</td>
<td>12P</td>
<td>H. V. Schönberg, E. C. Meister</td>
</tr>
</tbody>
</table>

**Abstract**
Information about the practical course will be given on the first day.

**Objective**
Qualitative analysis (determination of cations and anions), acid-base-equilibria (pH-values, titrations, buffer), precipitation equilibria (gravimetry, potentiometry, conductivity), redoxreactions (syntheses, redox-titrations, galvanic elements), metal complexes (syntheses, complexometric titration) analysis of measured values, states of aggregation (vapour pressure, conductivity, calorimetry)

**Content**
The general aim for the students of the practical course in general chemistry is an introduction in the scientific work and to get familiar with simple experimental procedures in a chemical laboratory. In general, first experiences with the principal reaction behaviour of a variety of different substances will be made. The chemical characteristics of these will be elucidated by a series of quantitative experiments alongside with the corresponding qualitative analyses. In order to get an overview of classes of substances as well as some general phenomena in chemistry suitable experiments have been chosen. In the second part of the practical course, i.e. physical chemistry, the behaviour of substances in their states of aggregation as well as changes of selected physical values will be recorded and discussed.

**Lecture notes**
http://www.gruetzmacher.ethz.ch/education/labcourses

**Prerequisites / notice**
Compulsory: online enrolment latest one week prior start of the semester

---

**3. Semester**

**Compulsory Subjects Examination Block I**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0121-00L</td>
<td>Inorganic Chemistry I</td>
<td>O</td>
<td>3</td>
<td>2+1U</td>
<td>A. Mezzetti</td>
</tr>
</tbody>
</table>

**Abstract**
Introduction to the binding theory in complexes of the transition metals. Interpretation of structure, bonding, and spectroscopic properties. General synthetic strategies.

**Objective**

**Content**
Can be bought at the HCI-shop

**Lecture notes**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0221-00L</td>
<td>Organic Chemistry I</td>
<td>O</td>
<td>3</td>
<td>2+1U</td>
<td>F. Diederich, C. Schäck</td>
</tr>
</tbody>
</table>

**Abstract**
Chemical reactivity and classes of compounds. Eliminations, fragmentations, chemistry of aldehydes and ketones (hydrates, acetals, imines, enamines, nucleophilic addition of organometallic compounds, reactions with phosphorus and sulfur ylides; reactions of enolates as nucleophiles) and of carboxylic acid derivatives. Aldol reactions.

**Objective**
Acquisition of a basic repertoire of synthetic methods including important reactions of aldehydes, ketones, carboxylic acids and carboxylic acid derivatives, as well as eliminations and fragmentations. Particular emphasis is placed on the understanding of reaction mechanisms and the correlation between structure and reactivity. A deeper understanding of the concepts presented during the lecture is reached by solving the problems handed out each time and discussed one week later in the exercise class.

**Content**
A pdf file of the printed lecture notes is provided online. Supplementary material may be provided online.

**Lecture notes**
- A. Thomas, M. D. Weir, J. Hass: Analysis 1, Lehr- und Übungsbuch, Pearson-Verlag
- D. W. Jordan, P. Smith: Mathematische Methoden für die Praxis, Spektrum Akademischer Verlag
- H. J. Wörner: Mathematik für Ingenieure und Naturwissenschaftler (3 Bände), Viewer further reading suggestions will be indicated during the lecture

**Literature**
- C. Schaack: Physical Chemistry II: Introduction to Chemical Engineering, Pearson-Verlag

**Prerequisites**
None

**Notice**
No set textbooks. Optional lecture notes will be provided at the beginning of the class and in the lecture notes.
Reaction Kinetics

Abstract

Objective
Introduction to Chemical Reaction Kinetics

Content
Fundamental concepts: rate laws, elementary reactions and composite reactions, molecularity, reaction order. Experimental methods in reaction kinetics up to new developments in femtosecond kinetics. Simple chemical reaction rate theories: temperature dependence of the rate constant and Arrhenius equation, collision theory, reaction cross-section, transition state theory. Reaction mechanisms and complex kinetic systems, approximation techniques, chain reactions, explosions and detonations. Homogeneous catalysis and enzyme kinetics.

Lecture notes

Literature

Prerequisites / notice
Voraussetzungen:
- Mathematik I und II
- Allgemeine Chemie I und II
- Physikalische Chemie I

402-0043-00L Physics I O 4 credits 3V+1U T. Esslinger

Abstract
Introduction to the concepts and tools in physics with the help of demonstration experiments: mechanics of point-like and ridged bodies, periodic motion and mechanical waves.

Objective
The concepts and tools in physics, as well as the methods of an experimental science are taught. The student should learn to identify, communicate and solve physical problems in his/her own field of science.

Content
Mechanics (motion, Newton's laws, work and energy, conservation of momentum, rotation, gravitation, fluids)
Periodic Motion and Waves (periodic motion, mechanical waves, acoustics).

Lecture notes
The lecture follows the book "Physics" by Paul A. Tipler.

Literature
Paul A. Tipler and Gene P. Mosca, Physics (for Scientists and Engineers), W. H. Freeman and Company

Prerequisites / notice
Prerequisites: Mathematics I & II

529-0051-00L Analytical Chemistry I O 3 credits 3G D. Günther, M.O. Ebert, R. Zenobi

Abstract
Introduction into the most important spectroscopical methods and their applications to gain structural information.

Objective
Knowledge about the necessary theoretical background of spectroscopical methods and their practical applications

Content
Application oriented basics of organic and inorganic instrumental analysis and of the empirical employment of structure elucidation methods:
Mass spectrometry: Ionization methods, mass separation, isotope signals, rules of fragmentation, rearrangements.
NMR spectroscopy: Experimental basics, chemical shift, spin-spin coupling.
IR spectroscopy: Revisiting topics like harmonic oscillator, normal vibrations, coupled oscillating systems (in accordance to the basics of the related lecture in physical chemistry); sample preparation, acquisition techniques, law of Lambert and Beer, interpretation of IR spectra; Raman spectroscopy.
UV/VIS spectroscopy: Basics, interpretation of electron spectra. Circular dichroism (CD) und optical rotation dispersion (ORD).

Lecture notes
Script will be for the production price

Literature
- M. Hesse, H. Meier, B. Zeeh, Spektroskopische Methoden in der organischen Chemie, 5. überarbeitete Auflage, Thieme, Stuttgart, 1995

Prerequisites / notice
Excercises are integrated in the lectures. In addition, attendance in the lecture 529-0289-00 "Instrumental analysis of organic compounds" (4th semester) is recommended.

401-0373-00L Mathematics III: Partial Differential Equations O 4 credits 2V+1U F. Da Lio

Abstract

Objective
The main objective is that the students get a basic knowledge of the classical tools to solve explicitly linear partial differential equations.
## Examples of partial differential equations
- Classification of PDEs
- Superposition principle

## One-dimensional wave equation
- D'Alembert's formula
- Duhamel's principle

## Separation of variables
- Resolution of wave and heat equation
- Homogeneous and inhomogeneous boundary conditions, Dirichlet and Neumann boundary conditions

## Laplace equation
- Resolution of the Laplace equation on rectangle, disk and annulus
- Poisson formula
- Mean value theorem and maximum principle

## Fourier series
- Representation of piecewise continuous functions via Fourier series
- Examples and applications

## Separation of variables
- Resolution of the wave and heat equation
- Homogeneous and inhomogeneous boundary conditions, Dirichlet and Neumann boundary conditions

## Laplace equation
- Resolution of the Laplace equation on rectangle, disk and annulus
- Poisson formula
- Mean value theorem and maximum principle

## Fourier transform
- Derivation and Definition
- Inverse Fourier transformation and inversion formula
- Interpretation and properties of the Fourier transform
- Resolution of the heat equation

## Laplace transform
- Definition, motivation and properties
- Inverse Laplace transform of rational functions
- Application to ordinary differential equations

### Laboratory Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0129-00L</td>
<td>Inorganic and Organic Chemistry II</td>
<td>O</td>
<td>11 credits</td>
<td>16P</td>
<td>A. Mezzetti, A. Togni</td>
</tr>
</tbody>
</table>

**Abstract**
Yearly enrolment is one week before the beginning of the semester.

**Objective**
The teaching laboratory offers an insight into different aspects of Inorganic Chemistry, including solid state chemistry, organometallic chemistry, kinetics, etc. The synthesis, characterization and analysis of inorganic compounds are a main topic. Emphasis is given to scientific writing (experiment reports).

**Content**
Inorganic chemistry part: Synthesis and analysis of elemento-organic compounds, metal complexes, and organometallic compounds. Introduction to Schlenk techniques, solid state synthesis, and kinetics. Introduction in the chemistry library: literature data banks and collections of spectra.

Organic synthesis with organometallic compounds and catalysts: Experiments in the framework of a selected specialised project. Possible projects: Rh catalysed asymmetric hydrogenation of enamides, Mn-catalysed epoxidation of olefins, Cu catalysed Diels-Alder reactions, synthesis of organo-boron compounds and Pd catalysed coupling with halides, Ru catalysed transfer hydrogenation.

A manual is distributed in the teaching laboratory.

**Prerequisites / notice**
Prerequisites:
- Practical Course General Chemistry (1. Semester, 529-0011-04)
- Practical Course Inorg. and Org. Chemistry I (2. Sem., 529-0230)
- Attendance of Course Inorg. Chemistry 1 (3. Sem., 529-0121)
If necessary, access priority will be settled according to the results of the first-year examinations.

#### 5. Semester

#### Compulsory Subjects

#### Examination Block Thermodynamics and Transport Phenomena

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0557-00L</td>
<td>Chemical Engineering Thermodynamics</td>
<td>O</td>
<td>4 credits</td>
<td>3G</td>
<td>A. Butté</td>
</tr>
</tbody>
</table>

**Abstract**
This course teaches the fundamentals of thermodynamics applied to the description of real mixtures in the presence of physicochemical equilibria, including methods to quantitatively estimate them. While giving insights into the meaning and properties of main thermodynamic quantities, the course keeps primary focus on application to real chemical engineering problems.

**Objective**
The objective of the course is twofold. First, to teach the methods to calculate the volumetric and thermodynamic properties of mixtures in the presence of physicochemical equilibria. In particular, students are supposed to acquire the knowledge on which thermodynamic properties have to be estimated to carry out such calculation, on which data which need to be gathered and estimated, on the methods, the relative assumption and approximations. Second, the course is intended to give the students a sufficient theoretical insight on the thermodynamic properties, which will be used for future applications and studies.
The first part of the course is focusing on pure fluids (ideal and real). First, some fundamentals of thermodynamics are reviewed, including thermodynamic quantities and balances (of mass, energy and entropy). Then, equations of state and their use to estimate the volumetric properties of pure fluids are introduced. Finally, it is discussed how to use previous results for the estimation of the main thermodynamic properties (internal energy, enthalpy, entropy, free Gibbs energy, fugacity, etc.).

The second part of the course is focusing on mixtures, starting from binary mixture to mixtures of N components. Again, real mixtures are discussed, with emphasis on when such mixtures can be approximated as ideal ones and on the corrections which are needed to switch from ideal to real mixtures. As for pure fluids, first the use of the equations of state is discussed to estimate volumetric properties, then the estimation of the thermodynamic properties of mixtures is introduced. In this part, a particular focus is given to phase equilibria in the absence of chemical reactions. The most common equilibria (liquid-vapor, solid-liquid, liquid-liquid, etc) are discussed.

In the last part of the course, the chemical equilibria are discussed, with particular focus on the calculation of mass and energy balances for multicomponent systems (mixtures), also in the presence of physical equilibria.

During the lectures, theoretical aspects will be discussed and will be linked to application by the discussion of a comprehensive study case, including the methods for its solution. Detailed exercises will be given (and discussed later) to the students, to let them familiarize with the main methods discussed during the lecture.

No script will be available. Support material consists of PowerPoint presentations, which will be available in PDF format online.

Books on this subject can be mostly found under the title: 'Chemical Engineering Thermodynamics', 'Thermodynamics for Chemical Engineers', or 'Chemical Process Principles'. A selection:


Acquisition of material properties and data:

11] "TRC Thermodynamic Tables", Thermodynamic Research Center, College Station USA
**Objective**: Provide to the students a complete methodology for the analysis and design of homogeneous reactors


**Lecture notes**: Scripts are available on line on the web page of the Morbidelli group.

**Literature**:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
<th>Sub-Credits</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>752-4001-00L</td>
<td>Microbiology</td>
<td>2</td>
<td></td>
<td>M. Schuppler, S. Schiegel, J. Vorhoft-Zambelli</td>
</tr>
<tr>
<td>401-0675-00L</td>
<td>Statistical and Numerical Methods for Chemical Engineers</td>
<td>3</td>
<td>2+2U</td>
<td>R. Käppeli, P. Müller, M. Sokolov</td>
</tr>
</tbody>
</table>

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

**Content**: Der Schwerpunkt liegt auf den Themen: Bakterielle Zellbiologie, Molekulare Genetik, Wachstumsphysiologie, Biochemische Diversität, Phylogenie und Taxonomie, Prokaryotische Vielfalt, Interaktion zwischen Menschen und Mikroorganismen sowie Biotechnologie.

**Lecture notes**: Vorträge von den jeweiligen Dozenten ausgegeben.

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

**Objective**: This course covers common numerical algorithms and statistical methods used by chemical engineers to solve typical problems arising in industrial and research practice.

**Content**: This course covers common numerical algorithms and statistical methods used by chemical engineers to solve typical problems arising in industrial and research practice. The focus is on application of these algorithms to real world problems, while the underlying mathematical principles are also explained. The MATLAB environment is adopted to integrate computation, visualization and programming.

**Lecture notes**: For the numerics part, see http://www.sam.math.ethz.ch/~karoger/numci/2016/

**Literature**: Scripts are available on line on the web page of the Morbidelli group.

**Objective**: Teaching of basic knowledge in microbiology.

**Content**: Teaching of basic knowledge in microbiology.

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

**Objective**: Discovering Management aims to broaden the students' understanding of the principles of business management, emphasizing the importance of identifying entrepreneurial opportunities, analyse the future business environment and successfully respond to it by taking systematic decisions, e.g. critical assessment of technological possibilities.

**Content**: This business case is as relevant to someone exploring innovation within an organisation as it is if you are planning to start your own business. The purpose of the course is to advance students' understanding of factors driving innovation, entrepreneurship, and company success. Doing so, this exercise will provide an insight into the context of managerial problem-solving and corporate innovation, and enhance the students' appreciation for the complex tasks companies and managers deal with. The business game presents a realistic model of a company and provides a valuable learning platform to integrate the increasingly important development of the skills and competences required to identify entrepreneurial opportunities, analyse the future business environment and successfully respond to it by taking systematic decisions, e.g. critical assessment of technological possibilities.

**Objective**: Discovering Management involves ‘learning by doing’. The objective is to introduce the students to the relevant topics of the management literature and give them a good introduction in entrepreneurship topics too. The course is a series of lectures on the topics of strategy, innovation, corporate finance, leadership, design thinking and corporate social responsibility. While the 14 different lectures provide the theoretical and conceptual foundations, the experiential learning outcome is from the interactive business game. The purpose of the business game is to analyse the innovative needs of a large multinational company and develop a business case for the company to grow. This business case is as relevant to someone exploring innovation within an organisation as it is if you are planning to start your own business. By discovering the key aspects of entrepreneurial management, the purpose of the course is to advance students' understanding of factors driving innovation, entrepreneurship, and company success.

**Content**: Discovering Management combines an innovative format of lectures and an advanced business game. The learning model for Discovering Management involves 'learning by doing'. The objective is to introduce the students to the relevant topics of the management literature and give them a good introduction in entrepreneurship topics too. The course is a series of lectures on the topics of strategy, innovation, corporate finance, leadership, design thinking and corporate social responsibility. While the 14 different lectures provide the theoretical and conceptual foundations, the experiential learning outcome is from the interactive business game. The purpose of the business game is to analyse the innovative needs of a large multinational company and develop a business case for the company to grow. This business case is as relevant to someone exploring innovation within an organisation as it is if you are planning to start your own business. By discovering the key aspects of entrepreneurial management, the purpose of the course is to advance students' understanding of factors driving innovation, entrepreneurship, and company success.

**Objective**: The course broadens the view and understanding of technology by linking it with its commercial applications and with society. The lectures are designed to introduce students to topics related to strategy, corporate innovation, leadership, corporate and entrepreneurial finance, value chain analysis, corporate social responsibility, and business model innovation. Practical examples from industry experts will stimulate the students to critically assess these issues. Creative skills will be trained by the business game exercise, a participant-centered learning activity, which provides students with the opportunity to place themselves in the role of Chief Innovation Officer of a large multinational company. As they learn more about the specific case and identify the challenge they are faced with, the students will have to develop an innovative business case for this multinational corporation. Doing so, this exercise will provide an insight into the context of managerial problem-solving and corporate innovation, and enhance the students' appreciation for the complex tasks companies and managers deal with. The business game presents a realistic model of a company and provides a valuable learning platform to integrate the increasingly important development of the skills and competences required to identify entrepreneurial opportunities, analyse the future business environment and successfully respond to it by taking systematic decisions, e.g. critical assessment of technological possibilities.

**Content**: The course covers common numerical algorithms and statistical methods used by chemical engineers to solve typical problems arising in industrial and research practice. The focus is on application of these algorithms to real world problems, while the underlying mathematical principles are also explained. The MATLAB environment is adopted to integrate computation, visualization and programming.

**Lecture notes**: For the numerics part, see http://www.sam.math.ethz.ch/~karoger/numci/2016/

**Literature**: Scripts are available on line on the web page of the Morbidelli group.

**Objective**: Discovering Management aims to broaden the students' understanding of the principles of business management, emphasizing the interdependence of various topics in the development and management of a firm. The lectures introduce students not only to topics relevant for managing large corporations, but also touch upon the different aspects of starting up your own venture. The lectures will be presented by the respective area specialists at D-MTEC.
Discovering Management is designed to suit the needs and expectations of Bachelor students at all levels as well as Master and PhD students not belonging to D-MTEC. By providing an overview of Business Management, this course is an ideal enrichment of the standard curriculum at ETH Zurich.

No prior knowledge of business or economics is required to successfully complete this course.

Examination Block Catalysis and Heterogeneous Process Engineering

Subjects will be given in spring semester

Examination Block Process Engineering

Subjects will be given in spring semester

Laboratory Courses and Case Studies

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0549-01L</td>
<td>Case Studies in Process Design I</td>
<td>O</td>
<td>3 credits</td>
<td>3A</td>
<td>K. Hungerbühler, E. Capón García,</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>U. Fischer</td>
</tr>
<tr>
<td>Abstract</td>
<td>The focus of part I of the case study course lies on the literature-based comparison of chemical process alternatives. Based on this compilation and selected quantitative as well as qualitative measures a process assessment and comparison is conducted and the most promising process alternative is chosen for further evaluation, and a basic flowsheet and mass and energy balances are generated.</td>
<td></td>
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</tr>
</tbody>
</table>
| Objective   | - to obtain knowledge about different databases and sources of information  
- application of the knowledge obtained in lectures  
- problem-oriented problem solving (application of different methods to the same subject)  
- team work  
- report writing and presentation techniques |
| Content     | The focus of part I of the case study course lies on the literature-based comparison of chemical process alternatives. For this purpose relevant substance data (i.e. physico-chemical, toxicological, safety, and environmental data) as well as information about synthesis routes and technical implementations (i.e. on reaction kinetics; possible separation operations; economic, safety, and environmental aspects) are collected from the literature. Based on this compilation and selected quantitative as well as qualitative measures a process assessment and comparison is conducted and the most promising process alternative is chosen for further evaluation. For this alternative a basic flowsheet and mass and energy balances are generated. |

529-0639-01L Chemical Engineering Laboratory I 

Abstract

Introduction to various tools of chemical engineering techniques with reference to the lectures. In groups of two, students will conduct experiments in the following areas: thermodynamics and phase equilibria including electrochemistry, transport phenomena, kinetics and selectivity of complex reactions, characterisation of ideal and real reactors.

Objective

Introduction to various tools of chemical engineering techniques with reference to the running lectures.

Content

In groups of two, students will conduct selected experiments in the following areas: thermodynamics and phase equilibria including electrochemistry, transport phenomena, kinetics and selectivity of complex reactions, characterisation of ideal and real reactors.

GESS Science in Perspective

see GESS Science in Perspective: Type A: Enhancement of Reflection Capability

see GESS Science in Perspective: Language Courses ETH/UBH

Recommended GESS Science in Perspective (Type B) for D-CHAB

Chemical Engineering Bachelor - Key for Type

| E- | Recommended, not eligible for credits |
| Z | Courses outside the curriculum |
| Dr | Suitable for doctorate |
| O | Compulsory |
| W+ | Eligible for credits and recommended |
| W | Eligible for credits |

Key for Hours

| V | lecture |
| G | lecture with exercise |
| U | exercise |
| S | seminar |
| K | colloquium |
| P | practical/laboratory course |
| A | independent project |
| D | diploma thesis |
| R | revision course / private study |

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
## Core Seminars

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>857-0001-00L</td>
<td>Methods I: Research Design, Qualitative Methods, and Data Collection</td>
<td>O</td>
<td>8</td>
<td>2U+2S</td>
<td>F. Schimmelfennig, J. Thiel, T. Winzen</td>
</tr>
<tr>
<td>857-0007-00L</td>
<td>Democracy</td>
<td>O</td>
<td>8</td>
<td>2S</td>
<td>F. Schimmelfennig, D. Kübler</td>
</tr>
<tr>
<td>857-0008-00L</td>
<td>Political Violence</td>
<td>O</td>
<td>8</td>
<td>2S</td>
<td>A. Wenger, C. Bara</td>
</tr>
<tr>
<td>857-0091-00L</td>
<td>Methods II: Quantitative Methods</td>
<td>O</td>
<td>4</td>
<td>2S</td>
<td>M. Steenbergen</td>
</tr>
<tr>
<td>857-0098-00L</td>
<td>Technology Governance and International Security</td>
<td>W</td>
<td>8</td>
<td>2S</td>
<td>M. Dunn Cavelty</td>
</tr>
<tr>
<td>857-0052-00L</td>
<td>Comparative and International Political Economy</td>
<td>W</td>
<td>8</td>
<td>2S</td>
<td>V. Koubi, L. Beiser-McGrath</td>
</tr>
<tr>
<td>857-0051-00L</td>
<td>Comparative and EU Politics</td>
<td>W</td>
<td>8</td>
<td>2S</td>
<td>F. Schimmelfennig</td>
</tr>
</tbody>
</table>

**Content Literature**
- see [http://www.cis.ethz.ch/education/macis/courses](http://www.cis.ethz.ch/education/macis/courses)

**Abstract**
- The seminar covers basic issues of research design, small-n research, and data collection. It deals with issues of causality, conceptualization, case study design and QCA. Data collection includes interviews, surveys, and text analysis.
- The seminar focuses on seminal books and articles as well as brand new analyses on topical issues of democratic theory and practice. After reviewing theoretical models and different types of democracy, the seminar deals with core problems of democratic governance and with challenges to democracy stemming from globalization and international institutions.
- At the end of the seminar, students are familiar with the relevant theoretical and empirical literature on democracy and democratization in national and international contexts. They are able to reflect on contemporary challenges to democracy in particular those stemming from the internationalization of politics.
- After this course, students should be able to assemble a dataset, prepare descriptive statistics, develop and test hypotheses, and present their results in a high-quality presentation or paper.
- This research seminar at the intersection between Security Studies and Science and Technology Studies focuses on how sociotechnical innovations (cyberspace, chemical and biological agents and robots) impact security politics and military strategy, and will look at the possibilities and limitations for international governance and arms control, with specific attention on the challenge of 'dual-use'. Students will learn about national technosensitive projects such as strategic bombing, the creation of cyberspace, the weaponization of chemical and biological agents, and the move towards 'Lethal Autonomous Weapons Systems'. Furthermore, students will learn about problems and solutions for the international governance of technologies and arms control. By the conclusion of the course, students should be able to frame problems related to technology and security in an analytical framework that makes clear their complexity as well as the points at which policy might intervene successfully.
- This seminar is restricted to students enrolled in the MACIS program.

**Objective**
- This MACIS core seminar covers basic issues of research design, small-n research, and data collection. It familiarizes students with general research design problems such as defining research questions, analyzing causality, and designing single and comparative case studies. It then introduces them to basic issues in small-n research. Students acquire an understanding of the specific challenges and design problems in qualitative analysis. Finally, students are introduced to exemplary methods of data collection. By the end of the course, students would be able to use the principal methods of data collection used by political scientists/have a critical understanding of the advantages and disadvantages of the methods, and should be able to reflect on and discuss the methods in light of research questions of their interest.
- This course offers an introduction to political violence in domestic and international politics. The course covers explanations of interstate wars, theories of civil and ethnic wars and regional conflict. Other topics include new threats, including transnational terrorist networks and other non-state actors, and the relationship between conflict and nation-building and democratization processes.
- This course offers an introduction to political violence in domestic and international politics. The course covers explanations of interstate wars, theories of civil and ethnic wars and regional conflict. Other topics include new threats, including transnational terrorist networks and other non-state actors, and the relationship between conflict and nation-building and democratization processes.
- Students will be able to write a research seminar paper that makes clear their complex as well as the points at which policy might intervene successfully.
- Because the number of students will be very small, the Political Economy core course runs in parallel, and research interests will be heterogeneous, the general approach will be informal and decentralized. Before the seminar starts we will identify what research topics - within the broader field of Comparative and International Political Economy - the participating students are most interested in. In the first two weeks of the semester, we will meet twice for two hours each as a group to discuss how to write a good research seminar paper, and to identify more closely what each student will be working on. Each student will then receive a reading list, so that she/he can get familiar with the state-of-the-art in her/his area of interests and develop a research design in close consultation with Profs. Bernauer and Koubi as well as postdocs from Prof. Bernauer's group. The group as a whole meets again ca. in week 7 of the semester to discuss the provisional research designs. Research then continues in a decentralized fashion - again in consultation with Profs. Bernauer and Koubi as well as postdocs from Prof. Bernauer's group. The group as a whole meets again in the second to last week of the semester. Each student reports on progress in her/his research during that meeting. The research seminar paper must be finalized and submitted by the end of July 2015.
### Electives

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>857-0003-00L</td>
<td>Introduction to Security Studies</td>
<td>W</td>
<td>4</td>
<td>2S</td>
<td></td>
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<tr>
<td></td>
<td>Does not take this semester.</td>
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<tr>
<td></td>
<td>Number of participants limited to 15.</td>
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<tr>
<td></td>
<td>MACIS students are given priority.</td>
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<tr>
<td>Abstract</td>
<td>This course focuses on how the concept of security and security studies as a subfield of international relations have evolved from the Cold War to today's 'globalized' security environment. It looks at the changing landscape of threats that states and societies face, the way states organize themselves to confront these threats, and how security studies' theories can explain these developments.</td>
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<tr>
<td>Objective</td>
<td>The aim of the course is to promote a critical engagement with a wide range of empirical and theoretical literature in Security Studies and by applying this theoretical material to contemporary developments in world politics. By the end of the course students should be able to understand competing contemporary definitions and theories of security and to formulate academically informed opinions about contemporary security issues and policy.</td>
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<tr>
<td>Content</td>
<td>This course draws upon a variety of theoretical perspectives in security studies to analyze the complex ways in which the world order has been threatened during and after the Cold War. To this end, the first part of the course concentrates on traditional approaches to security, while the second provides students with an overview of approaches that have broadened and deepened the concept of security: away from military concerns to include economic, societal, and environmental sectors, and away from the state towards notions of global and human security.</td>
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<tr>
<td>Lecture notes</td>
<td>The seminar is an opportunity to explore in depth particular issues and to engage in discussions in a small group. Students will be expected to contribute to such discussions and present short position papers. Most importantly, students will also be expected to engage in continuous independent study.</td>
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<tr>
<td>Literature</td>
<td>All texts will be available online.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Class will only take place with a minimum of 5 students and is limited to approx. 15 participants. MACIS students are given priority.</td>
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<tr>
<td>Literature</td>
<td>No prerequisite is necessary.</td>
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<tr>
<td>Literature</td>
<td>All texts will be available online.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>No prerequisite is necessary.</td>
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<tr>
<td>851-0594-00L</td>
<td>International Environmental Politics</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>T. Bernauer</td>
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<tr>
<td></td>
<td>Particularly suitable for students of D-ITET, D-USYS</td>
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<tr>
<td>Abstract</td>
<td>This course focuses on the conditions under which cooperation in international environmental politics emerges and the conditions under which such cooperation and the respective public policies are effective and/or efficient.</td>
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<tr>
<td>Objective</td>
<td>The objectives of this course are (1) gain an overview of relevant questions in the area of international environmental politics from a social sciences viewpoint; (2) learn how to identify interesting/innovative questions concerning this policy area and how to answer them in a methodologically sophisticated way; (3) gain an overview of important environmental problems.</td>
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<tr>
<td>Content</td>
<td>This course deals with how and why international cooperation in environmental politics emerges, and under what circumstances such cooperation is effective and efficient. Based on theories of international political economy and theories of government regulation various examples of international environmental politics are discussed: the management of international water resources, the problem of unsafe nuclear power plants in eastern Europe, nuclear responses to global warming, the protection of the stratospheric ozone layer, the reduction of long-range transboundary air pollution in Europe, and the prevention of pollution of the oceans, etc.</td>
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<tr>
<td>Lecture notes</td>
<td>The course is open to all ETH students. Participation does not require previous coursework in the social sciences. After passing an end-of-semester test (requirement: grade 4.0 or higher) students will receive 3 ECTS credit points. The workload is around 90 hours (meetings, reading assignments, preparation of test).</td>
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<tr>
<td>Literature</td>
<td>Visiting students (e.g., from the University of Zurich) are subject to the same conditions. Registration of visiting students in the web-based system of ETH is compulsory.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Assigned reading materials and slides will be available at <a href="http://www.ib.ethz.ch/teaching.html">http://www.ib.ethz.ch/teaching.html</a>. Select link 'Registered students, please click here for course materials' at top of that page. Log in with your nethz name and password. Questions concerning access to course materials can be addressed to Milke Hudecheck (Mike Hudecheck @ student.ethz.ch). All assigned papers must be read ahead of the respective meeting. Following the course on the basis of on-line slides and papers alone is not sufficient. Physical presence in the classroom is essential. Many books and journals covering international environmental policy issues can be found at the D-GE explanatory library at the IFW building, Haldeneggsteig 4, B-floor, or in the library of D-USYS.</td>
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<tr>
<td>Literature</td>
<td>Assigned reading materials and slides will be available at <a href="http://www.ib.ethz.ch/teaching.html">http://www.ib.ethz.ch/teaching.html</a>. Select link 'Registered students, please click here for course materials' at top of that page. Log in with your nethz name and password. Questions concerning access to course materials can be addressed to Milke Hudecheck (Mike Hudecheck @ student.ethz.ch).</td>
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<tr>
<td>Prerequisites / notice</td>
<td>No prerequisite is necessary.</td>
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<tr>
<td>857-0027-00L</td>
<td>International Organizations (Field Trip)</td>
<td>W</td>
<td>2</td>
<td>1S</td>
<td>F. Schimmelfennig</td>
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<td></td>
<td>Only for Comparative and International Studies MSc.</td>
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<tr>
<td>Abstract</td>
<td>A three-day visit to international organizations in Geneva - e.g., the World Trade Organization, the World Health Organization and the International Committee of the Red Cross. Teams of 2-3 students prepare a 2-3 page background reading for the group on a specific international organization and lead the discussion with representatives of that organization during the visit.</td>
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<tr>
<td>Objective</td>
<td>Become familiar with the work and challenges of international organizations based in Geneva.</td>
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<tr>
<td>Content</td>
<td>A three-day visit to international organizations in Geneva - e.g., the World Trade Organization, the World Health Organization and the International Committee of the Red Cross. Teams of 2-3 students prepare a 2-3 page background reading for the group on a specific international organization and lead the discussion with representatives of that organization during the visit.</td>
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<tr>
<td>860-0001-00L</td>
<td>Public Institutions and Policy-Making Processes</td>
<td>W</td>
<td>3</td>
<td>3G</td>
<td>T. Bernauer, S. Bechtold, F. Schimmelfennig</td>
</tr>
</tbody>
</table>
Governing the Energy Transition

Students acquire the contextual knowledge for analyzing public policies. They learn why and how public policies and laws are developed, designed, and implemented at national and international levels, and what challenges arise in this regard.

Objective

Public policies result from decision-making processes that take place within formal institutions of the state (parliament, government, public administration, courts). That is, policies are shaped by the characteristics of decision-making processes and the characteristics of public institutions and related actors (e.g. interest groups). In this course, students acquire the contextual knowledge for analyzing public policies. They learn why and how public policies and laws are developed, designed, and implemented at national and international levels, and what challenges arise in this regard. The course is organized in three modules. The first module (Stefan Bechtold) examines basic concepts and the role of law, law-making, and law enforcement in modern societies. The second module (Thomas Bernauer) deals with the functioning of legislatures, governments, and interest groups. The third module (Frank Schimmelfennig) focuses on the European Union and international organisations.

Content

Schedule (for up-to-date information, see the syllabus that will be distributed to participants electronically):
W1: Bechtold, Bernauer: Introduction
  How are laws created and interpreted? How are they enforced?
W2: Bechtold: Why do we need laws and why do people and firms usually obey the law? What are possible goals of legal systems? What is the relationship between laws, social norms, and moral values?
W3: Bechtold: What role does scientific evidence play in the creation and enforcement of the law? How does the law deal with non-quantifiable factors or incomensurable values?
W4: no class
W5: Bernauer: How are parliaments (legislatures) elected, how do they work, and how do their characteristics and processes affect policy-making?
W6: Bernauer: Why do forms of government differ and how does this affect policy-making? Why and in what respect are public administrations efficient/effective, and why sometimes not?
W7: Bernauer: How do interest groups and social movements affect policy-making.
W8: Study week
W9: Schimmelfennig: Governance beyond the state: why and how states create international institutions.
W10: Schimmelfennig: International organizations and regimes: case studies of global governance.
W11: Schimmelfennig: Institutions and policy-making in the European Union.
W12: Schimmelfennig: International organizations and policy diffusion.
W13: End-of-semester exam

An add-on module to this course (3 ECTS) involves an essay. This part of the course is accessible only to ISTP MSc students and requires enrollment in the main course (3 ECTS). ISTP MSc students must enrol in both parts. Other students can only enrol in the main course. 3rd week of January: deadline for review essay

Lecture notes

Reading materials will be distributed electronically to the students when the semester starts.

Literature


This is a Master level course. The course is capped at 25 students, with ISTP Master students having priority.

Prerequisites / notice

851-0609-06L Governing the Energy Transition

Number of participants limited to 30.

W 2 credits 2V T. Schmidt

Abstract

They learn why and how public policies and laws are developed, designed, and implemented at national and international levels, and what challenges arise in this regard.

Objective

This course addresses the role of policy and its underlying politics in the transformation of the energy sector. It covers historical, socio-economic, and political perspectives and applies various theoretical concepts to specific aspects of governing the energy transition.

- To gain an overview of the history of the transition of large technical systems
- To recognize current challenges in the energy system to understand the theoretical frameworks and concepts for studying transitions
- To demonstrate knowledge on the role of policy and politics in energy transitions
### Content

Climate change, access to energy and other societal challenges are directly linked to the way we use and create energy. Both the recent United Nations Paris climate change agreement and the UN Sustainable Development Goals make a fast and extensive transition of the energy system necessary.

This course introduces the social and environmental challenges involved in the energy sector and discusses the implications of these challenges for the rate and direction of technical change in the energy sector. It compares the current situation with historical socio-technical transitions and derives the consequences for policy-making. It then introduces theoretical frameworks and concepts for studying innovation and transitions. It then focuses on the role of policy and policy change in governing the energy transition, considering the role of political actors, institutions and policy feedback.

The course has a highly interactive (seminar-like) character. Students are expected to actively engage in the weekly discussions and to give a presentation (15-20 minutes) on one of the weekly topics during that particular session. The presentation (30%) and participation in the discussions (20%) will form one part of the final grade, the remaining 50% of the final grade will be formed by a final exam.

### 857-0075-00L Contemporary European Politics

**W** 4 credits 2S  
C. Kaya, F. Karstens, J. Moreno Rocabert, R. Schrama, T. Winzen

#### Abstract

How have the EU's powers developed until now and what are the problems facing the Union today? In this course, we will discuss the development of European integration. Furthermore, the course will address key issues such as the EU's democratic deficit, the consequences from enlargement to Central and Eastern Europe, the prospects for future entrants, the Euro-crisis, and the refugee crisis.

#### Objective

Since its start in the fifties, the European Union has evolved into an ever more important multilevel system of integration in terms of decision-making competences and scope of policy. The course 'Contemporary European Politics' discusses the development of the EU's powers and the problems that the Union faces today. At the end of this course, the participants will be familiar with the major theories and debates in the EU studies. Based on this knowledge, the participants should be able to identify the strengths and weaknesses of existing studies as well as to formulate and to defend their own arguments.

The course is divided into two parts. The first part discusses the development of European integration in terms of the functioning of the EU institutions and the policy-making process (i.e. agenda-setting, decision-making and implementation). In the second part of the course, we analyze the problems confronting Europe during the process of European integration, as well as current issues associated with the EU's expansion of powers and membership. For example, key questions include: Is there a "democratic deficit" in the EU in terms of responsiveness to public opinion? To what extent does the existing EU institutional structure allow for representation? How can we explain patterns of "differenitized integration" across policy areas and countries? What are the consequences for the EU's enlargement on the "new" Central and Eastern European member states and the prospects for future entrants? We will conclude with a discussion about the Euro-crisis and the European refugee crisis.

### 857-0067-00L Foundations of Sustainable Development Practice

**W** 1 credit 1G  
D. Molnar, R. Batliner

#### Abstract

Two MACIS students will be admitted to this course. MACIS students are asked to directly contact the MAS administration NADEL for course enrollment.

The course provides students with an introduction to concepts of sustainable development, with an emphasis on the Sustainable Development Goals (SDGs). Both conceptual and practical issues are presented, with the intention of challenging students to critically assess and debate on current issues of global development.

#### Objective

The students are able to:
- define the main underlying concepts of the SDGs like "sustainability" and "development";
- explain the background of the Agenda 2030, its intention, the process of its development and the guiding principles for its implementation;
- discuss practical difficulties in pursuing and achieving sustainable development through development & cooperation interventions;
- describe the relevant actors and their roles and responsibilities;
- discuss the merits and the limitations of such an ambitious, multi-disciplinary, universally agreed upon framework;
- examine what the SDGs could mean for "developed nations" like Switzerland.

### 855-0010-02L Food Security and Agriculture

**W** 2 credits 3G  
L. B. Nielsen

#### Abstract

Food security has been on top of the policy agenda for decades, but still a considerable proportion of the population in developing countries remains hungry and malnourished. This lecture series will explore how we produce and distribute food; analyse the concept of food security and discuss ways and means for increasing the availability and accessibility of food in developing countries.

#### Objective

The student will be able to:
- describe the most important milestones in the history of food and agriculture
- understand the concept of food security and discuss causes and impact of food insecurity
- compare different approaches to promote and increase crop- and livestock production in a sustainable manner
- reflect on some of the main economic challenges of the world food system and understand some of the tradeoffs between smallholders' decisions of labor, income, consumption, and production of food
- give insights in how international organizations work with farmers and governments in developing countries to ensure availability and equal access to food

### 860-0006-00L Applied Statistics and Policy Evaluation

**W** 3 credits 3G  
I. Günther, K. Hartgen

#### Abstract

This course introduces students to key statistical methods for analyzing social science data with a special emphasis on causal inference and policy evaluation. Students learn to choose appropriate analysis strategies for particular research questions and to perform statistical analyses with the statistical Software Stata.
Objective

- have a sound understanding of linear and logit regression
- know strategies to test causal hypotheses using regression analysis and/or experimental methods
- are able to formulate and implement a regression model for a particular policy question and a particular type of data
- are able to critically interpret results of applied statistics, in particular, regarding causal inference
- are able to critically read and assess published studies on policy evaluation
- are able to use the statistical software STATA for data Analysis

Content

The topics covered in the first part of the course are a revision of basic statistics and linear and logit regression analysis. The second part of the course focuses on causal inference and introduces methods such as panel data analysis, difference-in-difference methods, instrumental variable estimation, and randomized controlled trials mostly used for policy evaluation. The course shows how the various methods differ in terms of the required identifying assumptions to infer causality as well as the data needs.

Students will apply the methods from the lectures by solving weekly assignments using statistical software and data sets provided by the instructors. These data sets will cover topics at the interface of policy, technology and society. Solving the assignments contributes to the final grade with a weight of 30%. Students are assisted in solving the assignments during the exercises session.

Master's Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>857-0019-00L</td>
<td>Master's Thesis Colloquium</td>
<td>O</td>
<td>4 credits</td>
<td>3K</td>
<td>D. Bischof</td>
</tr>
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</table>

Permission to begin master thesis is required to take part in Colloquium.

Abstract

In this colloquium, students enrolled in the MACIS program first present and discuss research design and methods issues concerning their prospective MA theses. Towards the end of the semester they present preliminary findings from their MA thesis work.

Objective

It is the goal of the colloquium to help students with the initial steps of writing their master theses. During the colloquium, they will develop a relevant research question and hypotheses and select appropriate methods and data.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>857-0021-00L</td>
<td>Master's Thesis</td>
<td>O</td>
<td>26 credits</td>
<td>56D</td>
<td>Professors</td>
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</table>

Only students who fulfill the following criteria are allowed to begin with their master thesis: a. successful completion of the bachelor programme; b. fulfilling of any additional requirements necessary to gain admission to the master programme.

Abstract

The Master Thesis is an independent piece of research on an issue in comparative and international politics. It combines theory, methods, and empirical work.

Objective

The Thesis should demonstrate the students’ ability to conduct independent research on the basis of the theoretical and methodological knowledge acquired during the MA program.

Comparative and International Studies Master - Key for Type

<table>
<thead>
<tr>
<th>O</th>
<th>Compulsory</th>
<th>E-</th>
<th>Recommended, not eligible for credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
<td>Suitable for doctorate</td>
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</table>

Key for Hours

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
<th>P</th>
<th>practical/laboratory course</th>
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<tbody>
<tr>
<td>G</td>
<td>lecture with exercise</td>
<td>A</td>
<td>independent project</td>
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<tr>
<td>U</td>
<td>exercise</td>
<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>S</td>
<td>seminar</td>
<td>R</td>
<td>revision course / private study</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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</table>

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Computational Biology and Bioinformatics Master
More informations at: https://www.bsse.ethz.ch/studies/master/the-programme.html

Core Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>262-5120-00L</td>
<td>Principles of Evolution: Theory (University of Zurich)</td>
<td>W</td>
<td>6</td>
<td>3V</td>
<td>University lecturers</td>
</tr>
<tr>
<td></td>
<td>No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: BIO351</td>
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<td></td>
<td>Mind the enrolment deadlines at UZH:</td>
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<td><a href="http://www.uzh.ch/studies/application/mobilitaet_en.html">http://www.uzh.ch/studies/application/mobilitaet_en.html</a></td>
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<tr>
<td></td>
<td>&quot;Nothing in Biology Makes Sense Except in the Light of Evolution&quot;.</td>
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<tr>
<td></td>
<td>Evolutionary theory and methods are essential in all branches of modern biology.</td>
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<td>Subject specific skills:</td>
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<td>By the end of the course, students will be able to:</td>
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<td>o describe basic evolutionary theory and its applications</td>
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<td>o discuss ongoing debates in evolutionary biology</td>
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<td>o critically assess the presentation of evolutionary research in the popular media</td>
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<td>Key skills:</td>
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<td>By the end of the course, students will be able to:</td>
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<td>o approach biological questions from an evolutionary perspective</td>
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<td>Content</td>
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<td>This course will provide a broad overview of current evolutionary thought, including the mechanisms of evolutionary change, adaptation and the history of life and will involve practical field and lab work as well as lecture material.</td>
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<tr>
<td>401-6282-00L</td>
<td>Statistical Analysis of High-Throughput Genomic and Transcriptomic Data (University of Zurich)</td>
<td>W</td>
<td>5</td>
<td>3G</td>
<td>H. Rehrauer, M. Robinson</td>
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<td>No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: STA426</td>
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<td>Mind the enrolment deadlines at UZH:</td>
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<td><a href="http://www.uzh.ch/studies/application/mobilitaet_en.html">http://www.uzh.ch/studies/application/mobilitaet_en.html</a></td>
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<td>A range of topics will be covered, including basic molecular biology, genomics technologies and in particular, a wide range of statistical and computational methods that have been used in the analysis of DNA microarray and high throughput sequencing experiments.</td>
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<td></td>
<td>- Understand the fundamental &quot;scientific process&quot; in the field of Statistical Bioinformatics</td>
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<td>- Be equipped with the skills/tools to preprocess genomic data (Unix, Bioconductor, mapping, etc.) and ensure reproducible research (Sweave)</td>
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<td></td>
<td>- Have a general knowledge of the types of data and biological applications encountered with microarray and sequencing data</td>
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<td>- Have the general knowledge of the range of statistical methods that get used with microarray and sequencing data</td>
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<td>- Gain the ability to apply statistical methods/knowledge/software to a collaborative biological project</td>
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<td>- Gain the ability to critical assess the statistical bioinformatics literature</td>
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<td>- Write a coherent summary of a bioinformatics problem and its solution in statistical terms</td>
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<td><strong>Content</strong></td>
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<td>Lectures will include: microarray preprocessing; normalization; exploratory data analysis techniques such as clustering, PCA and multidimensional scaling; Controlling error rates of statistical tests (FPR versus FDR versus FWER); limma (linear models for microarray analysis); mapping algorithms (for RNA/ChIP-seq); RNA-seq quantification; statistical analyses for differential count data; isoform switching; epigenomics data including DNA methylation; gene set analyses; classification</td>
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<td><strong>Lecture notes</strong></td>
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<td>Lecture notes, published manuscripts</td>
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<td><strong>Prerequisites / notice</strong></td>
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<td>Prerequisites: Basic knowledge of the programming language R, sufficient knowledge in statistics</td>
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<tr>
<td>551-0307-00L</td>
<td>Molecular and Structural Biology I: Protein Structure and Function</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>R. Glockshuber, K. Locher, E. Weber-Ban</td>
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<td>D-BIOL BSc students are obliged to take part I and part II (next semester) as a two-semester course</td>
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<td></td>
<td><strong>Abstract</strong></td>
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<td></td>
<td>Biophysics of protein folding, membrane proteins and biophysics of membranes, enzymatic catalysis, catalytic RNA and RNAi, current topics in protein biophysics and structural biology.</td>
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<td><strong>Objective</strong></td>
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<td></td>
<td>Understanding of structure-function relationships in proteins and in protein folding, detailed understanding of biophysics and physical methods as well as modern methods for protein purification and microanalytics.</td>
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<td></td>
<td><strong>Lecture notes</strong></td>
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<td>Scripts on the individual topics can be found under <a href="http://www.mol.biol.ethz.ch/teaching">http://www.mol.biol.ethz.ch/teaching</a>.</td>
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<tr>
<td></td>
<td><strong>Literature</strong></td>
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<td>Basics:</td>
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<td></td>
<td>- Creighton, T.E., Proteins, Freeman, (1993)</td>
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<td>Current topics: References will be given during the lectures.</td>
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<tr>
<td>636-0007-00L</td>
<td>Computational Systems Biology</td>
<td>W</td>
<td>6</td>
<td>3V+2U</td>
<td>J. Stelling</td>
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<td>Study of fundamental concepts, models and computational methods for the analysis of complex biological networks. Topics: Systems approaches in biology, biology and reaction network fundamentals, modeling and simulation approaches (topological, probabilistic, stoichiometric, qualitative, linear / nonlinear ODES, stochastic), and systems analysis (complexity reduction, stability, identification).</td>
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<td><strong>Objective</strong></td>
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<td>The aim of this course is to provide an introductory overview of mathematical and computational methods for the modeling, simulation and analysis of biological networks.</td>
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</table>
Biology has witnessed an unprecedented increase in experimental data and, correspondingly, an increased need for computational methods to analyze this data. The explosion of sequenced genomes, and subsequently, of bioinformatics methods for the storage, analysis and comparison of genetic sequences provides a prominent example. Recently, however, an additional area of research, captured by the label "Systems Biology", focuses on how networks, which are more than the mere sum of their parts' properties, establish biological functions. This is essentially a task of reverse engineering. The aim of this course is to provide an introductory overview of corresponding computational methods for the modeling, simulation and analysis of biological networks.

We will start with an introduction into the basic units, functions and design principles that are relevant for biology at the level of individual cells. Making extensive use of example systems, the course will then focus on methods and algorithms that allow for the investigation of biological networks with increasing detail. These include (i) graph theoretical approaches for revealing large-scale network organization, (ii) probabilistic (Bayesian) network representations, (iii) structural network analysis based on reaction stoichiometries, (iv) qualitative methods for dynamic modeling and simulation (Boolean and piece-wise linear approaches), (v) mechanistic modeling using ordinary differential equations (ODEs) and finally (vi) stochastic simulation methods.

**Literature**


**Objective**

The goal of this course is to understand and to appreciate mathematical models and computational methods that provide insight into the evolutionary process.

**Content**

Evolution is the one theory that encompasses all of biology. It provides a single, unifying concept to understand the living systems that we observe today. We will introduce several types of mathematical models of evolution to describe gene frequency changes over time in the context of different biological systems, focusing on axenial populations. Viruses and cancer cells provide the most prominent examples of such systems and they are at the same time of great biomedical interest. The course will cover some classical mathematical population genetics and population dynamics, and also introduce several new approaches. This is reflected in a diverse set of mathematical concepts which make their appearance throughout the course, all of which are introduced from scratch. Topics covered include the quasispecies equation, evolution of HIV, evolutionary game theory, birth-death processes, evolutionary stability, evolutionary graph theory, somatic evolution of cancer, stochastic tunneling, cell differentiation, hematopoietic tumor stem cells, genetic progression of cancer and the speed of adaptation, diffusion theory, fitness landscapes, neutral networks, branching processes, evolutionary escape, and epistasis.

**Prerequisites**

Prerequisites: Basic mathematics (linear algebra, calculus, probability)

**Lecture notes**

https://www.ethz.ch/content/specialinterest/bsse/computational-systems-biology/en/education/lectures/csb/LectureMaterial.html

636-0009-00L

Evolutionary Dynamics

<table>
<thead>
<tr>
<th>W</th>
<th>5 credits</th>
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<td>2V+1U</td>
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N. Beerwenkel

Evolutionary dynamics is concerned with the mathematical principles according to which life has evolved. This course offers an introduction to mathematical modeling of evolution, including deterministic and stochastic models.

636-0017-00L

Computational Biology

<table>
<thead>
<tr>
<th>W</th>
<th>4 credits</th>
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<tbody>
<tr>
<td>3G</td>
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T. Stadler, C. Magnus

The aim of the course is to provide up-to-date knowledge on how we can study biological processes using genetic sequencing data. Computational algorithms extracting biological information from genetic sequence data are discussed, and statistical tools to understand this information in detail are introduced.

**Objective**

Attendees will learn which information is contained in genetic sequencing data and how to extract information from them using computational tools. The main concepts introduced are:

* stochastic models in molecular evolution
* phylogenetic & phylodynamic inference
* maximum likelihood and Bayesian statistics

Attendees will apply these concepts to a number of applications yielding biological insight into:

* epidemiology
* pathogen evolution
* macroevolution of species

**Content**

The course consists of four parts. We first introduce modern genetic sequencing technology, and algorithms to obtain sequence alignments from the output of the sequencers. We then present methods to directly analyze this alignment (such as BLAST algorithm, GWAS approaches). Second, we introduce mechanisms and concepts of molecular evolution, i.e. we discuss how genetic sequences change over time. Third, we employ evolutionary concepts to infer ancestral relationships between organisms based on their genetic sequences, i.e. we discuss methods to infer genealogies and phylogenies. We finally introduce the field of phylodynamics. The aim of that field is to understand and quantify the population dynamic processes (such as transmission in epidemiology or speciation & extinction in macroevolution) based on a phylogeny. Throughout the class, the models and methods are illustrated on different datasets giving insight into the epidemiology and evolution of a range of infectious diseases (e.g. HIV, HCV, influenza, Ebola). Applications of the methods to the field of macroevolution provide insight into the evolution and ecology of different species clades. Students will be trained in the algorithms and their application both on paper and in silico as part of the exercises.

**Lecture notes**

Slides of the lecture will be available online.

https://www.bsse.ethz.ch/cevo/education/cb-materials.html

**Literature**


**Prerequisites**

Basic knowledge in linear algebra, analysis, and statistics will be helpful. Some programming experience will be useful for the exercises, but is not required. Programming skills will not be tested in the examination.

636-0706-00L

Spatio-Temporal Modelling in Biology

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<th>W</th>
<th>5 credits</th>
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</table>

D. Iber

This course focuses on modeling spatio-temporal problems in biology, in particular on the cell and tissue level. A wide range of mathematical techniques will be presented as part of the course, including concepts from non-linear dynamics (ODE and PDE models), stochastic techniques (SDE, Master equations, Monte Carlo simulations), and thermodynamic descriptions.

**Objective**

The aim of the course is to introduce students to state-of-the-art mathematical modelling of spatio-temporal problems in biology. Students will learn how to choose from a wide range of modelling techniques and how to apply these to further our understanding of biological mechanisms. The course aims at equipping students with the tools and concepts to conduct successful research in this area; both classical as well as recent research work will be discussed.
Content
1. Introduction to Modelling in Biology
2. Morphogen Gradients
3. Turing Pattern
4. Travelling Waves & Wave Pinning
5. Application Example 1: Dorsal-ventral axis formation
6. Chemotaxis, Cell Adhesion & Migration
7. Introduction to Numerical Methods
8. Simulations on Growing Domains
9. Image-Based Modelling
10. Branching Processes
11. Cell-based Simulation Frameworks
12. Application Example 2: Limb Development
13. Summary

Lecture notes
All lecture material will be made available online
https://www.bsse.ethz.ch/cobi/education/636-0706-00L_Spatial_Modelling_in_Biology.html

Literature
Murray, Mathematical Biology, Springer
Keener and Sneyd, Mathematical Physiology, Springer
Fall et al., Computational Cell Biology, Springer
Szalasi et al., System Modeling in Cellular Biology, MIT Press
Wolfknecht, Systems Biology
Kreyszig, Engineering Mathematics, Wiley

Prerequisites / notice
The course builds on introductory courses in Computational Biology. The course assumes no background in biology but a good foundation regarding mathematical and computational techniques.

Advanced Courses and Methods of Computer Science

Advanced Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>252-0025-00L</td>
<td>Discrete Mathematics</td>
<td>W</td>
<td>7</td>
<td>4V+2U</td>
<td>U. Maurer</td>
</tr>
</tbody>
</table>

Abstract
Content: Mathematical reasoning and proofs, abstraction. Sets, relations (e.g. equivalence and order relations), functions, (un-)countability, number theory, algebra (groups, rings, fields, polynomials, subalgebras, morphisms), logic (propositional and predicate logic, proof calculi).

Objective
The primary goals of this course are (1) to introduce the most important concepts of discrete mathematics, (2) to understand and appreciate the role of abstraction and mathematical proofs, and (3) to discuss a number of applications, e.g. in cryptography, coding theory, and algorithm theory.

Content
See course description.

Lecture notes
available (in english)

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>227-1033-00L</td>
<td>Neuromorphic Engineering I</td>
<td>W</td>
<td>6</td>
<td>2V+3U</td>
<td>T. Delbrück, G. Indiveri, S.C. Liu</td>
</tr>
</tbody>
</table>

Abstract
Registration in this class requires the permission of the instructors. Class size will be limited to available lab spots. Preference is given to students that require this class as part of their major.

Objective
Understanding the characteristics of neuromorphic circuit elements.

Content
Neuromorphic circuits are inspired by the organizing principles of biological neural circuits. Their computational primitives are based on physics of semiconductor devices. Neuromorphic architectures often rely on collective computation in parallel networks. Adaptation, learning and memory are implemented locally within the individual computational elements. Transistors are often operated in weak inversion (below threshold), where they exhibit exponential I-V characteristics and low currents. These properties lead to the feasibility of high-density, low-power implementations of functions that are computationally intensive in other paradigms. Application domains of neuromorphic circuits include silicon retinas and cochleas for machine vision and audition, real-time emulations of networks of biological neurons, and the development of autonomous robotic systems. This course covers devices in CMOS technology (MOS transistor below and above threshold, floating-gate MOS transistor, phototransducers), static circuits (differential pair, current mirror, transconductance amplifiers, etc.), dynamic circuits (linear and nonlinear filters, adaptive circuits), systems (silicon neuron, silicon retina and cochlea) and an introduction to multi-chip systems that communicate events analogous to spikes. The lectures are accompanied by weekly laboratory sessions on the characterization of neuromorphic circuits, from elementary devices to systems.

Literature
S.-C. Liu et al.: Analog VLSI Circuits and Principles; various publications.

Prerequisites / notice
Particular: The course is highly recommended for those who intend to take the spring semester course ‘Neuromorphic Engineering II’, that teaches the conception, simulation, and physical layout of such circuits with chip design tools.

Prerequisites: Background in basics of semiconductor physics helpful, but not required.

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<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>227-1037-00L</td>
<td>Introduction to Neuroinformatics</td>
<td>W</td>
<td>6</td>
<td>2V+1U</td>
<td>K. A. Martin, M. Cook, V. Mante, M. Pfeiffer</td>
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</tbody>
</table>

Abstract
The course provides an introduction to the functional properties of neurons. Particularly the description of membrane electrical properties (action potentials, channels), neuronal anatomy, synaptic structures, and neuronal networks. Simple models of computation, learning, and behavior will be explained. Some artificial systems (robot, chip) are presented.

Objective
Understanding computation by neurons and neuronal circuits is one of the great challenges of science. Many different disciplines can contribute their tools and concepts to solving mysteries of neural computation. The goal of this introductory course is to introduce the monocultures of physics, math, computer science, engineering, biology, psychology, and even philosophy and history, to discover the enchantments and challenges that we all face in taking on this major 21st century problem and how each discipline can contribute to discovering solutions.
This course considers the structure and function of biological neural networks at different levels. The function of neural networks lies fundamentally in their wiring and in the electro-chemical properties of nerve cell membranes. Thus, the biological structure of the nerve cell needs to be understood if biologically-realistic models are to be constructed. These simpler models are used to estimate the electrical current flow through dendritic cables and explore how a more complex geometry of neurons influences this current flow. The active properties of nerves are studied to understand both sensory transduction and the generation and transmission of nerve impulses along axons. The concept of local neuronal circuits arises in the context of the rules governing the formation of nerve connections and topographic projections within the nervous system. Communication between neurons in the network can be thought of as information flow across synapses, which can be modified by experience. We need an understanding of the action of inhibitory and excitatory neurotransmitters and neuromodulators, so that the dynamics and logic of synapses can be interpreted. Finally, the neural architectures of feedforward and recurrent networks will be discussed in the context of co-ordination, control, and integration of sensory and motor information in neural networks.

For more information: www.csms.ethz.ch/education/CSCBP

1. Antibody phage technology
   - Phage display selection methodologies
   - Antibody libraries
   - Phagemid and phage vectors
   - V genes, CDRs, basics of antibody engineering
   - Principles of phage display

2. Proteins: chemical modification and detection of biomolecular interactions
   - DNA-encoded chemical libraries
   - Other phage libraries (peptides, globular proteins, enzymes)
   - Alternative screening/selection methodologies
   - Phage display selection methodologies

3. Genomics: Applications to Human Biology
   - DNA cloning and expression
   - Some foundations of genetic analysis
   - Knock-out technologies
   - Transcripts
   - Proteomics
   - Recombinant vaccines

4. Pharmaceuticals: Focus on Discovery
   - Ligand Discovery
   - Half-life extension
   - Cancer therapy
   - Gene therapy

In addition, citations from the original literature relevant to the individual lectures will be assigned weekly.

For more about the lecture: www.csms.ethz.ch/education/CSCBP

529-0004-00L  Computer Simulation in Chemistry, Biology and Physics

Objective
Introduction to computer simulation of (bio)molecular systems, development of skills to carry out and interpret computer simulations of biomolecular systems.

Content
Molecular models, Force fields, Boundary conditions, Electrostatic interactions, Molecular dynamics, Analysis of trajectories, Quantum-mechanical simulation, Structure refinement, Application to real systems. Exercises: Analysis of papers on computer simulation, Molecular simulation in practice, Validation of molecular dynamics simulation.

For more information: www.csms.ethz.ch/education/CSCBP

529-0773-00L  Enzymes

Abstract
Principles of enzymatic catalysis, enzyme kinetics, mechanisms of enzyme-catalyzed reactions (group transfer reactions, carbon-carbon bond formation, eliminations, isomerisations and rearrangements), cofactor chemistry, enzymes in organic synthesis and the biosynthesis of natural products, catalytic antibodies.

Objective
Overview of enzymes, enzyme-catalyzed reactions and metabolic processes.

Content
Principles of enzymatic catalysis, enzyme kinetics, mechanisms of enzyme-catalyzed reactions (group transfer reactions, carbon-carbon bond formation, eliminations, isomerisations and rearrangements), cofactor chemistry, enzymes in organic synthesis and the biosynthesis of natural products, catalytic antibodies.

For more information: www.csms.ethz.ch/education/CSCBP

535-0810-00L  Gene Technology

Abstract
The course will provide a solid overview of the science and issues in gene technology and its pharmaceutical applications.

Objective
The aim of the lecture course is to provide a solid overview of gene technology, with a special focus on drug development. Topics: Antibody phage technology, DNA-encoded chemistry, protein modification technology, genome sequencing, transcriptomics, proteomics, functional genomics, principle of drug discovery. The course is suited for advanced undergraduate and early graduate students in pharmaceutical sciences or related fields.

Content
1. Antibody phage technology
   - The antibody molecule
   - V genes, CDRs, basics of antibody engineering
   - Principles of phage display

2. Proteins: chemical modification and detection of biomolecular interactions
   - Homo- and hetero-dimerization of proteins
   - Chemical modifications of proteins
   - Antibody-drug conjugates
   - Radioactive labeling of proteins
   - Kinetic association and dissociation constants
   - Affinity constant: definition and its experimental measurement

3. Genomics: Applications to Human Biology
   - Protein cloning and expression
   - DNA sequencing
   - Some foundations of genetic analysis
   - Knock-out technologies
   - Transcripts
   - Proteomics
   - Recombinant vaccines

4. Pharmaceuticals: Focus on Discovery
   - Ligand Discovery
   - Half-life extension
   - Cancer therapy
   - Gene therapy

In addition, citations from the original literature relevant to the individual lectures will be assigned weekly.

For more information: www.csms.ethz.ch/education/CSCBP
Biophysics of protein folding, membrane proteins and biophysics of membranes, enzymatic catalysis, catalytic RNA and RNAi, current topics in protein biophysics and structural biology.

Understanding of structure-function relationships in proteins and in protein folding, detailed understanding of biophysics and physical methods as well as modern methods for protein purification and microanalytic.

Scripts on the individual topics can be found under http://www.mol.biol.ethz.ch/teaching.

Current topics: References will be given during the lectures.

551-0309-00L Concepts in Modern Genetics W 6 credits 4V Y. Barral, D. Bopp, A. Hajnal, M. Stoffel, O. Voinnet

Concepts of modern genetics and genomics, including principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

This course focuses on the concepts of classical and modern genetics and genomics.

The topics include principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

This course is a co-production of the University of Zurich and ETH Zurich, and will be taught in English. The course takes place on Monday afternoon at ETH Hoenggerberg, and on Tuesday morning at UZH Irchel.

551-0313-00L Microbiology (Part I) W 3 credits 2V W.D. Hardt, L. Eberl, H.M. Fischer, J. Piel, M. Pilhofer

Advanced lecture class providing a broad overview on bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

This concept class will be based on common concepts and introduce to the enormous diversity among bacteria and archaea. It will cover the current research on bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

Advanced course offering the state of the research in bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

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

551-0317-00L Immunology I W 3 credits 2V A. Oxenius, M. Kopf

Introduction into structural and functional aspects of the immune system.

Basic knowledge of the mechanisms and the regulation of an immune response.

This concept class will be based on common concepts and introduce to the enormous diversity among bacteria and archaea. It will cover the current research on bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

This concept class will be based on common concepts and introduce to the enormous diversity among bacteria and archaea. It will cover the current research on bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

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

Introduction to basic techniques and problems in mathematical optimization, and their applications to problems in engineering.

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

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

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

Methods of Computer Science

Data: 06.03.2019 12:57  Autumn Semester 2016  Page 395 of 1571
This lecture gives an introduction to theoretical computer science, presenting the basic concepts and methods of computer science in its historical context. We present computer science as an interdisciplinary science which, on the one hand, investigates the border between the possible and the impossible and the quantitative laws of information processing, and, on the other hand, designs, analyzes, verifies, and implements computer systems.

The main topics of the lecture are:
- alphabets, words, languages, measuring the information content of words, representation of algorithmic tasks
- finite automata, regular and context-free grammars
- Turing machines and computability
- complexity theory and NP-completeness
- design of algorithms for hard problems

Lecture notes
The lecture is covered in detail by the textbook "Theoretical Computer Science".


Lecture notes
Basic literature:

Further reading:

More exercises and examples in:
6. A. Asteroth, Ch. Baier: Theoretische Informatik

Prerequisites / notice
During the semester, two non-obligatory test exams will be offered.

252-0535-00L Machine Learning W 8 credits 3V+2U+2A J. M. Buhmann

Abstract
Machine learning algorithms provide analytical methods to search data sets for characteristic patterns. Typical tasks include the classification of data, function fitting and clustering, with applications in image and speech analysis, bioinformatics and exploratory data analysis. This course is accompanied by practical machine learning projects.

Objective
Students will be familiarized with the most important concepts and algorithms for supervised and unsupervised learning; reinforce the statistics knowledge which is indispensable to solve modeling problems under uncertainty. Key concepts are the generalization ability of algorithms and systematic approaches to modeling and regularization. A machine learning project will provide an opportunity to test the machine learning algorithms on real world data.

Content
The theory of fundamental machine learning concepts is presented in the lecture, and illustrated with relevant applications. Students can deepen their understanding by solving both pen-and-paper and programming exercises, where they implement and apply famous algorithms to real-world data.

Topics covered in the lecture include:
- Bayesian theory of optimal decisions
- Maximum likelihood and Bayesian parameter inference
- Classification with discriminant functions: Perceptrons, Fisher's LDA and support vector machines (SVM)
- Ensemble methods: Bagging and Boosting
- Regression: least squares, ridge and LASSO penalization, non-linear regression and the bias-variance trade-off
- Non parametric density estimation: Parzen windows, nearest neighbour
- Dimension reduction: principal component analysis (PCA) and beyond

Lecture notes
No lecture notes, but slides will be made available on the course webpage.


Prerequisites / notice
The course requires solid basic knowledge in analysis, statistics and numerical methods for CSE as well as practical programming experience for solving assignments. Students should at least have followed one previous course offered by the Machine Learning Institute (e.g., CIL or LIS) or an equivalent course offered by another institution.

401-0663-00L Numerical Methods for CSE W 7 credits 4V+2U R. Hiptmair

Abstract
The course gives an introduction into fundamental techniques and algorithms of numerical mathematics which play a central role in numerical simulations in science and technology. The course focuses on fundamental ideas and algorithmic aspects of numerical methods. The exercises involve actual implementation of numerical methods in C++.

Objective
- Knowledge of the fundamental algorithms in numerical mathematics
- Knowledge of the essential terms in numerical mathematics and the techniques used for the analysis of numerical algorithms
- Ability to choose the appropriate numerical method for concrete problems
- Ability to interpret numerical results
- Ability to implement numerical algorithms efficiently

Prerequisites / notice

Autumn Semester 2016
Content
1. Direct Methods for linear systems of equations
2. Least Squares Techniques
3. Data Interpolation and Fitting
4. Filtering Algorithms
8. Approximation of Functions
9. Numerical Quadrature
10. Iterative Methods for non-linear systems of equations
11. Single Step Methods for ODEs
12. Stiff Integrators

Lecture notes
Lecture materials (PDF documents and codes) will be made available to participants:
- Lecture Git repository: https://gitlab.math.ethz.ch/NumCSE/NumCSE
- Tablet classroom notes: http://www.sam.math.ethz.ch/~grsam/HS16/NumCSE/NCSE16_Notes/

Literature
- M. Hanke-Bourgeois "Grundlagen der Numerischen Mathematik und des wissenschaftlichen Rechnens", BG Teubner, 2002

Prerequisites / notice
The course will be accompanied by programming exercises in C++ relying on the template library EIGEN. Familiarity with C++, object oriented and generic programming is an advantage. Participants of the course are expected to learn C++ by themselves.

151-0104-00L Uncertainty Quantification for Engineering & Life Sciences
ECTS: 4 credits
Hours: 3G
Lecturer: P. Koumoutsakos

Abstract
Quantification of uncertainties in computational models pertaining to applications in engineering and life sciences. Exploitation of massively available data to develop computational models with quantifiable predictive capabilities. Applications of Uncertainty Quantification and Propagation to problems in mechanics, control, systems and cell biology.

Objective
The course will teach fundamental concept of Uncertainty Quantification and Propagation (UQ+P) for computational models of systems in Engineering and Life Sciences. Emphasis will be placed on practical and computational aspects of UQ+P including the implementation of relevant algorithms in multicore architectures.

Prerequisites / notice
The course will be accompanied by programming exercises in C++ relying on the template library EIGEN. Familiarity with C++, object oriented and generic programming is an advantage. Participants of the course are expected to learn C++ by themselves.

Applications (Research Projects)

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>262-0500-00L</td>
<td>Lab Rotation in Experimental Biology</td>
<td>O</td>
<td>3</td>
<td>6A</td>
<td>Lecturers</td>
</tr>
<tr>
<td>Abstract</td>
<td>Flexible, short research project (lab rotation) with an emphasis on experimental biology.</td>
<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>The course provides a practical overview of an experimental biology research area, applying concepts taught in the General and Core courses, and preparing for further specialization through the Master thesis.</td>
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</tbody>
</table>

| 262-0600-00L | Lab Rotation in Computer Science | O    | 3    | 6A    | Lecturers |
| Abstract  | Flexible, short research project (lab rotation) with emphasis on computer science/theory |
| Objective | The course provides a practical overview of a computer science research area, applying concepts taught in the General and Core courses, and preparing for further specialization through the Master thesis. |

| 262-0700-00L | Lab Rotation in Bioinformatics | O    | 3    | 6A    | Lecturers |
| Abstract  | Flexible, short research project within the field of computational biology/bioinformatics. |
| Objective | The course provides a practical overview of a bioinformatics research area, applying concepts taught in the General and Core courses, and preparing for further specialization through the Master thesis. |

Content
Students learn to transfer and apply their knowledge by working independently in the laboratory or on projects. By applying knowledge acquired from the core and advanced courses, and the Methods of Computer Science course, students gain insight into different research areas.

GESS Science in Perspective

see GESS Science in Perspective: Type A: Enhancement of Reflection Capability

see GESS Science in Perspective: Language Courses

ETH/UZH
# Master's Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>262-0800-00L</td>
<td>Master's Thesis</td>
<td>O</td>
<td>30</td>
<td>64D</td>
<td>Professors</td>
</tr>
</tbody>
</table>

- Only students who fulfill the following criteria are allowed to begin with their master thesis:
  - a. successful completion of the bachelor programme;
  - b. fulfilling of any additional requirements necessary to gain admission to the master programme.

**Abstract**
The Master Thesis is the result of an independent scientific research and/or constructive development project in the chosen area of specialization.

**Objective**
The Master thesis concludes the Master programme. By writing up the Master thesis, students show their ability to independently produce a coherent and scientific piece of work.

**Content**
The program concludes with a Master thesis of 6 months duration that includes a written report and an oral presentation. The topic of the thesis can be chosen according to the student's interests in the field of computational biology & bioinformatics.

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## Course Units for Additional Admission Requirements

The courses below are only available for MSc students with additional requirements.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>252-0002-AAL</td>
<td>Data Structures and Algorithms</td>
<td>E-</td>
<td>7</td>
<td>15R</td>
<td>P. Widmayer</td>
</tr>
</tbody>
</table>

**Abstract**
This course is about fundamental algorithm design paradigms (such as induction, divide-and-conquer, backtracking, dynamic programming), classic algorithmic problems (such as sorting and searching), and data structures (such as lists, hashing, search trees). The connection between algorithms and data structures is explained for geometric and graph problems.

**Objective**
An understanding of the design and analysis of fundamental algorithms and data structures.

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<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>252-0835-AAL</td>
<td>Computer Science I</td>
<td>E-</td>
<td>4</td>
<td>9R</td>
<td>F. O. Friedrich</td>
</tr>
</tbody>
</table>

**Abstract**
The course covers the fundamental concepts of computer programming with a focus on systematic algorithmic problem solving. Taught language is C++. No programming experience is required.

**Objective**
Primary educational objective is to learn programming with C++. When successfully attended the course, students have a good command of the mechanisms to construct a program. They know the fundamental control and data structures and understand how an algorithmic problem is mapped to a computer program. They have an idea of what happens "behind the scenes" when a program is translated and executed.

**Secondary goals** are an algorithmic computational thinking, understanding the possibilities and limits of programming and to impart the way of thinking of a computer scientist.

**Content**
The course covers fundamental data types, expressions and statements, (Limits of) computer arithmetic, control statements, functions, arrays, structural types and pointers. The part on object orientation deals with classes, inheritance and polymorphism, simple dynamic data types are introduced as examples. In general, the concepts provided in the course are motivated and illustrated with algorithms and applications.

**Literature**
- Andrew Koenig and Barbara E. Moo: Accelerated C++, Addison-Wesley, 2000
- Bjarne Stroustrup: The Design and Evolution of C++, Addison-Wesley, 1994

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<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>406-0242-AAL</td>
<td>Analysis II</td>
<td>E-</td>
<td>7</td>
<td>15R</td>
<td>M. Akveld, C. Busch</td>
</tr>
</tbody>
</table>

**Abstract**
Mathematical tools of an engineer

**Objective**
Mathematics as a tool to solve engineering problems, mathematical formulation of problems in science and engineering. Basic mathematical knowledge of an engineers.

**Content**
Multi variable calculus; gradient, directional derivative, chain rule, Taylor expansion, Lagrange multipliers. Multiple integrals: coordinate transformations, path integrals, integrals over surfaces, divergence theorem, applications in physics. Ordinary differential equations.

**Literature**
- J. Stewart: Multivariable Calculus, Thomson Brooks/Cole
- V. I. Smirnov: A course of higher mathematics. Vol. II. Advanced calculus
- M. Akveld, R. Sperb, Analysis II, vdf
- L. Papula: Mathematik für Ingenieure 2, Vieweg Verlag

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<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>406-0603-AAL</td>
<td>Stochastics (Probability and Statistics)</td>
<td>E-</td>
<td>4</td>
<td>9R</td>
<td>M. Kalisch</td>
</tr>
</tbody>
</table>

**Abstract**
Introduction to basic methods and fundamental concepts of statistics and probability theory for non-mathematicians. The concepts are presented on the basis of some descriptive examples. Learning the statistical program R for applying the acquired concepts will be a central theme.
Objective

The objective of this course is to build a solid fundament in probability and statistics. The student should understand some fundamental concepts and be able to apply these concepts to applications in the real world. Furthermore, the student should have a basic knowledge of the statistical programming language "R".

Content

From "Statistics for research" (online)
Ch 1: The Role of Statistics
Ch 2: Populations, Samples, and Probability Distributions
Ch 3: Binomial Distributions
Ch 6: Sampling Distribution of Averages
Ch 7: Normal Distributions
Ch 8: Student's t Distribution
Ch 9: Distributions of Two Variables

From "Introductory Statistics with R (online)"
Ch 1: Basics
Ch 2: The R Environment
Ch 3: Probability and distributions
Ch 4: Descriptive statistics and tables
Ch 5: One- and two-sample tests
Ch 6: Regression and correlation

Literature

- "Statistics for research" by S. Dowdy et. al. (3rd edition); Print ISBN: 9780471267355; Online ISBN: 9780471477433; DOI: 10.1002/0471477435
From within the ETH, this book is freely available online under: http://onlinelibrary.wiley.com/book/10.1002/0471477435

From within the ETH, this book is freely available online under: http://www.springerlink.com/content/m17578/

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Computational Biology and Bioinformatics Master - Key for Type

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

Key for Hours

<table>
<thead>
<tr>
<th>Key</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

ECTS European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
### Diploma Project

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-1101-00L</td>
<td>How to Write Scientific Texts in Engineering Sciences</td>
<td>E-</td>
<td>0</td>
<td></td>
<td>J. Leuthold</td>
</tr>
<tr>
<td></td>
<td>Strongly recommended prerequisite for Semester Projects and Master Theses at D-ITET (MSc BME, MSc EEIT, MSc EST).</td>
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</tbody>
</table>

**Abstract**

The 4 hour lecture covers the basics of writing & presenting a scientific text. The focus will be on the structure and elements of a scientific text and not on the language. Citation rules, good practice of scientific writing and an overview on software tools will be part of the training. The lecture will be thought on two afternoons. Some exercises will be built into the lecture.

**Objective**

Knowledge on structure and content of a scientific text. The course further is arranged to stimulate a discussion on how to properly write a legible scientific text versus writing an interesting novel. We will further discuss the practice of properly citing and critically reflect on recent plagiarism allegations.

**Content**

- * Topic 1: Structure of a Scientific Text (The Title, the author list, the abstract, State-of-the Art, the “in this paper” paragraph, the scientific part, the summary, Equations, Figures).
- * Topic 3: Citation Rules and Citation Software.
- * Topic 4: Guidelines for Research Integrity.

**Literature**

ETH "Citation Etiquette", see www.plagiate.ethz.ch.


**Prerequisites / notice**

Students should already have a Bachelor degree and plan to do either a semester project or a master thesis in the immediate future.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-3001-00L</td>
<td>Diploma Thesis</td>
<td>O</td>
<td>12</td>
<td></td>
<td>Professors</td>
</tr>
<tr>
<td></td>
<td>Only for DAS in Information Technology and Electrical Engineering.</td>
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</tbody>
</table>

**Abstract**

The Diploma of Advanced Studies finishes with a 3-months diploma thesis which is directed by a professor of the department ITET. Students prove their ability to conduct independent scientific research on a specific research problem, using skills and knowledge acquired during the program. The thesis includes a written report and an oral presentation.

**Objective**

see above

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### DAS in Information Technology and Electrical Engineering - Key for Type

<table>
<thead>
<tr>
<th>O</th>
<th>W+</th>
<th>W</th>
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<tbody>
<tr>
<td>O</td>
<td>W+</td>
<td>W</td>
</tr>
<tr>
<td>O</td>
<td>W+</td>
<td>W</td>
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</tbody>
</table>

**Recommended, not eligible for credits**

**Courses outside the curriculum**

**Suitable for doctorate**

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### Key for Hours

<table>
<thead>
<tr>
<th>V</th>
<th>G</th>
<th>U</th>
<th>S</th>
<th>K</th>
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<tbody>
<tr>
<td>V</td>
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<td>S</td>
<td>K</td>
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<tr>
<td>V</td>
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<td>U</td>
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<td>K</td>
</tr>
<tr>
<td>V</td>
<td>G</td>
<td>U</td>
<td>S</td>
<td>K</td>
</tr>
</tbody>
</table>

**P** practical/laboratory course

**A** independent project

**D** diploma thesis

**R** revision course / private study

---

### ECTS

**European Credit Transfer and Accumulation System**

**Special students and auditors need special permission from the lecturers.**
Military History I (without Exercises)
The lecture series treats high-impact theories of strategic studies from antiquity to the present.

Objective
- Distinguish between military history as a subject and historiography as a way of describing events;
- Analyse the modern developments regarding armed forces and warfare in the context of socio-economic changes;
- Based on the approach regarding revolution in military affairs, describe the evolution of the armed forces and of warfare;
- Exemplify the issues regarding the evolution of the combat (First and Second World War, Vietnam War and Algerian War).

Content
The lecture first examines the bases of the science of (military) history. It focuses on how military history developed from war history, on specific similarities and differences between military history and general historiography, the different ways of dealing with history in Switzerland, Germany, France and in the Anglo-Saxon cultural area (different approaches) as well as on institutions which deal with military history such as universities, military academies, national and international commissions and associations etc.

The lecture is structured along the lines of the concept of "Military Revolution" and starts with the formation of modern, European armed forces after the Oranian Army reform in the 17th century.

Based on the "Military Revolution" approach, the lecture examines the structural changes regarding the armed forces and the development of warfare from the 18th to the 20th century. Special emphasis will be put on how the battlefield was revolutionized due to the Napoleonic wars, the industrialization in the 19th century, the First World War, the mechanization and totalization during the Second World War and the period of the Cold War.

Literature

World Politics Since 1945: The History of International Relations
Only for Public Policy BA and DAS Military Sciences

Abstract
This lecture series provides students with an overview of the development of international relations since the end of World War II. The first part of the series deals with the development of and changes in Cold War security policy structures. The second part deals with the period after the transformation of 1989/91; the focus here is on current issues in international security policy.

Objective
By the end of the semester, participants should have a solid knowledge of the history and theoretical foundations of International Relations since the end of the Second World War.

Content

Literature
- Peter Paret, Makers of Modern Strategy. From Machiavelli to the Nuclear Age, Princeton 1986.

Strategic Studies I

Abstract
The lecture series treats high-impact theories of strategic studies from antiquity to the present.

Objective
- The participants know in what ways the understanding of strategy has evolved over time.
- They understand the balance of strategy's basic components: ends, ways and means.
- They know the most important classics of strategy and war theory, especially against their specific background.
- Based on the analysis of historical and contemporary examples, they are aware the ambiguity of declaration and implementation of strategies.
- They are capable of analyzing critically original texts and modern scholarly works in the field of strategic studies.

Content
The two-term lecture series treats classic texts of strategic studies from antiquity to the present. Term 1 covers the theories up until roughly 1900, term 2 the theories ever since. Theories are deemed classic, if they were prominent in their respective times and if they had a strong reception after, be it in literature, in academic debates or as guidelines for action. Each out of some 50 theories is discussed in three steps: historical context, core messages and reception.

Literature
- Peter Paret, Makers of Modern Strategy. From Machiavelli to the Nuclear Age, Princeton 1986

Military Psychology and Pedagogy I (without Exercises)

Abstract
Examine the fundamentals of the two sciences and establish links with military life. Discuss various schools of thought in psychology and focus on content and process theories of motivation. Explore characteristics of pedagogical thinking and discuss the values of military education with reference to the young adult serving in the armed forces.

Objective
- Becoming acquainted with basic psychological views of human behaviour and experience.
- Knowing content- and process theories of motivation and being able to transfer them to the military context.
- Knowing the possibilities and limitations of military education and deriving consequences.

Data: 06.03.2019 12:57 Autumn Semester 2016 Page 401 of 1571
Overall, the objective is to become acquainted with the basics of both scientific areas and to make references to military practice. Military psychology is a branch of applied psychology; consequently selected aspects of psychological principles will be covered. Military pedagogy hasn't yet established itself firmly as an independent scientific discipline, it nevertheless can draw on a deep-seated tradition in Switzerland. Thus, the great importance that has been attached to the discussion of education in Swiss society and academia will be taken into account.

Subjects:
- History of military psychology
- Psychological images of humanity (psychoanalysis, behaviourism, behavioural biology, humanistic psychology, cognitivism)
- Motivational theories
- Defence-, service-, operational- and combat motivation
- Swiss military pedagogy
- Education as defining feature of pedagogic thinking and acting

- Annen, H., Steiger, R. & Zwygart, U.: Gemeinsam zum Ziel, Huber, Frauenfeld 2004 (provided as pdf)
- Stadelmann, J.: Führung unter Belastung, Huber, Frauenfeld 1998 (provided as pdf)

The lecture is supported by a virtual learning environment containing relevant documents (presentations and texts) and information to further literature.

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**Learning Environments for Training: Planning, Operation, Assessment**

*Only for Public Policy BA and DAS Military Sciences.*

**Abstract**
Beside of the most important terms of sociology, demographic changes and the related value and structure change will be analysed. The second part focuses on organizational sociology. Thirdly, the course examines to which extent armed forces can be considered as organizations like any other and to which extent they constitute a special case from an organizational and normative point of view.

**Objective**
Recognize and explain current changes (social change) in modern society (individualisation, pluralisation); describe demographic changes in Switzerland; explain the structures of societies; define issues and fields of research in modern military sociology and explain the foundations of organisational sociology; explain the military in terms of organisational sociology and identify specific traits of the military as an organisation.

**Content**
Societal change; organizations as societal phenomena; aims, structures, environments of organizations; specifics of the military as an organization; impacts of technological and societal changes on the armed forces in modern societies.

**Literature**
A reader with a set of texts will be handed out.

**Leadership I**

<table>
<thead>
<tr>
<th>Code</th>
<th>Content</th>
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</thead>
<tbody>
<tr>
<td>853-0064-00L</td>
<td>Military Sociology I</td>
</tr>
<tr>
<td>Abstract</td>
<td>Beside of the most important terms of sociology, demographic changes and the related value and structure change will be analysed. The second part focuses on organizational sociology. Thirdly, the course examines to which extent armed forces can be considered as organizations like any other and to which extent they constitute a special case from an organizational and normative point of view.</td>
</tr>
<tr>
<td>Objective</td>
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<tr>
<td>Content</td>
<td>Societal change; organizations as societal phenomena; aims, structures, environments of organizations; specifics of the military as an organization; impacts of technological and societal changes on the armed forces in modern societies.</td>
</tr>
<tr>
<td>Literature</td>
<td>A reader with a set of texts will be handed out.</td>
</tr>
</tbody>
</table>

**Leadership II**

<table>
<thead>
<tr>
<th>Code</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>853-0033-00L</td>
<td>Leadership II</td>
</tr>
<tr>
<td>Abstract</td>
<td>The lectures &quot;Leadership I&quot; (WS) and &quot;Leadership II&quot; (SS) have been designed as a two-semester lecture series, but may also be followed independently of one another or in reverse order. &quot;Leadership I&quot; covers the following fields: leadership basics, leadership theories and leadership styles, the concept of leadership responsibility and the role of communication in practical leadership. The aim of this lecture is to give students an introductory overview of relevant topics regarding leadership research and practice, thus enabling them to gain a deeper understanding of the leadership phenomenon. Students should understand different concepts of leadership in the complex interaction between individuals, groups, organisation, context and situation. They should be informed about the evolution of the understanding of mankind in relation to working processes and its impact on organizations and the understanding of leadership theory in the past 100 years. They should grasp the concept of leadership responsibility (leadership ethics) and be able to derive consequences for leadership in practical situations. They should recognize the fundamental importance of communication in leadership situations and receive input which enables them to communicate adequately in specific situations.</td>
</tr>
<tr>
<td>Objective</td>
<td>The 1-hour written exam will take place during the last lecture in the semester.</td>
</tr>
<tr>
<td>Prerequisites</td>
<td>The lectures &quot;Leadership I&quot; (WS) and &quot;Leadership II&quot; (SS) have been designed as a two-semester lecture series, but may also be followed independently of one another or in reverse order.</td>
</tr>
<tr>
<td>Notice</td>
<td>The lectures &quot;Leadership I&quot; (WS) and &quot;Leadership II&quot; (SS) have been designed as a two-semester lecture series, but may also be followed independently of one another or in reverse order.</td>
</tr>
</tbody>
</table>

**Key for Hours**

<table>
<thead>
<tr>
<th>Hours</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
</tr>
</tbody>
</table>

**ECTS**

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
## First Series of Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>535-0521-00L</td>
<td>Pharmacology and Toxicology I</td>
<td>W</td>
<td>2 credits</td>
<td>2V</td>
<td>U. Quitterer</td>
</tr>
</tbody>
</table>

**Abstract**
The two-semester lecture course will provide a detailed understanding of the fundamentals of drug action and the mechanisms of action and therapeutic use of the important classes of drugs. The lectures are intended for students of pharmaceutical sciences.

**Objective**
The lectures will provide a comprehensive survey of pharmacology and toxicology. Special emphasis is placed on the interrelationship between pharmacological, pathophysiological and clinical aspects.

**Content**
Topics include disease-relevant macroscopic, microscopic, pathobiochemical and functional disturbances of specific organs and organ systems. The lectures integrate disease pathology with mechanisms of drug action, usage, metabolism, pharmacokinetics, side effects, toxicology, contraindications and dosage of relevant drug classes. Basic principles of clinical pharmacology and pharmacotherapy will be covered.

**Lecture notes**
Für jede Vorlesung wird ein Skript abgegeben, das eine Zusammenfassung mit den wichtigsten Stichpunkten beinhaltet.

**Literature**
Recommended reading:


or

Comprehensive overview:

The classic textbook in Pharmacology:

**Prerequisites / notice**
Voraussetzungen: Abschluss Grundstudium

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>535-0165-00L</td>
<td>Clinical Microbiology</td>
<td>W</td>
<td>1 credit</td>
<td>1V</td>
<td>K. Lucke</td>
</tr>
</tbody>
</table>

**Abstract**
Thorough knowledge of major pathogens involved in infectious diseases; principles of laboratory diagnosis of pathogenic bacteria and fungi.

**Objective**
Thorough knowledge of all major pathogens involved in infectious diseases; principles of laboratory diagnosis of pathogenic bacteria and fungi.

**Content**
Basics and principles of clinical microbiology:
- host-pathogen interaction
- symptoms and diagnosis of major bacterial pathogens
- therapeutic regimens commonly used against bacterial disease
- major aspects of medical mycology, virology and parasitology
- epidemiology

**Literature**
- Brock, Mikrobiologie, Pearson, 13. aktualisierte Auflage
- Kayser F. et al., Medizinische Mikrobiologie, Thieme, Stuttgart, New York
- Aktuellste Auflage (derzeit 12. Auflage 2010)

**Prerequisites / notice**
Voraussetzungen: Grundstudium

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>535-0810-00L</td>
<td>Gene Technology</td>
<td>W</td>
<td>2 credits</td>
<td>2G</td>
<td>D. Neri</td>
</tr>
</tbody>
</table>

**Abstract**
The course will provide a solid overview of the science and issues in gene technology and its pharmaceutical applications.

**Objective**
The aim of the lecture course is to provide a solid overview of gene technology, with a special focus on drug development. Topics: Antibody phage technology, DNA-encoded chemistry, protein modification technology, genome sequencing, transcriptomics, proteomics, functional genomics, principal of drug discovery. The course is suited for advanced undergraduate and early graduate students in pharmaceutical sciences or related fields.
1. Antibody phage technology
The antibody molecule
V genes, CDRs, basics of antibody engineering
Principles of phage display
Phagemid and phage vectors
Antibody libraries
Phage display selection methodologies
Other phage libraries (peptides, globular proteins, enzymes)
Alternative screening/selection methodologies
DNA-encoded chemical libraries

2. Proteins: chemical modification and detection of biomolecular interactions
Homo- and hetero-dimerization of proteins
Chemical modifications of proteins
Antibody-drug conjugates
Radioactive labeling of proteins
Kinetic association and dissociation constants
Affinity constant: definition and its experimental measurement

3. Genomics: Applications to Human Biology
Protein cloning and expression
DNA sequencing
Some foundations of genetic analysis
Knock-out technologies
Transcriptomics
Proteomics
Recombinant vaccines

4. Pharmaceuticals: Focus on Discovery
Ligand Discovery
Half-life extension
Cancer therapy
Gene therapy

Lecture notes
Skript "Gene Technology" by Prof. Dario Neri and slides of the lecture

535-0830-00L  Pharmaceutical Immunology  W  2 credits  2G  D. Neri, C. Halin Winter
Abstract
Get Students familiar with basic Immunological concepts of pharmaceutical relevance.
Objective
Get Students familiar with basic Immunological concepts of pharmaceutical relevance.
Content
Chapters 1 - 11 of the Janeway's ImmunoBiology, by Kenneth Murphy (9th Edition; Garland).
Literature
Janeway's ImmunoBiology, by Kenneth Murphy (9th Edition).

535-0421-00L  Galenical Pharmacy I  W  2 credits  2G  J.C. Leroux, B. A. Gander
Abstract
Principles and technologies for the manufacturing of dosage forms and drug delivery systems. Knowledge of pharm. excipients, materials, containers, liquid and semi-solid dosage forms, their production, function, quality and application. Comprehension of molecular interactions in solution and colloidal systems. Comprehension of interfacial phenomena and stabilization measures in dosage forms.
Objective
Knowledge of the most important pharmaceutical excipients, materials, containers, liquid and semi-solid dosage forms, of their production, function, quality, stability and application. Comprehension of the molecular interactions in solution and colloidal systems. Comprehension of interfacial phenomena and stabilization measures in disperse dosage forms.
Content
Introduction and overview of important fundamentals, principles and technologies for the development and manufacturing of dosage forms and drug delivery systems. Overview of the most important pharmaceutical excipients and polymers, their structure, properties and processing; importance of materials properties for containers. Pharmaceutical solvents, fundamentals of solubility and solubilization of drugs. Water treatment processes, sterilization techniques and quality requirements of pharmaceutical water. Parenteral dosage forms and liquid ophthalmics. Surfactants, micel formation and colloidal systems. Liquid suspensions and emulsions. Stabilization measures in dosage forms.
Literature
C.-D. Herzfeld und J. Kreuter (Hrsg.) Grundlagen der Arzneiformenlehre, Springer Verlag, Berlin 1999
H. Leuenberger (Hrsg.) Martin - Physikalische Pharmazie, Wissenschaftliche Verlagsgesellschaft, Stuttgart 2002
R. Voigt, Pharmazeutische Technologie, 10. Auflage, Deutscher Apotheker Verlag, Stuttgart, 2006
R. Voigt, Pharmazeutische Technologie, 10. Auflage, Deutscher Apotheker Verlag, Stuttgart, 2006
Prerequisites / notice
Language: German and English

535-0250-00L  Biotransformation of Drugs and Xenobiotics  W  1 credit  1V  S.D. Krämer
Abstract
Knowledge of the major reactions of biotransformation in drug therapy, prediction of possible metabolites of drugs and xenobiotics, recognition of structure elements and reactions which can lead to toxic metabolites. Knowledge of inter- and intraindividual factors influencing metabolism.
Objective
Goals: knowledge of the major reactions of biotransformation in drug therapy, prediction of possible metabolites of drugs and xenobiotics, recognition of structure elements and reactions which can lead to toxic metabolites. Knowledge of inter- and intraindividual factors influencing metabolism.
Content
Major reactions of biotransformation. Major enzymes and reaction partners involved in the biotransformation of drugs and xenobiotics. Toxic reactions of metabolites. Factors which affect the biotransformation.
Lecture notes
Biotransformation of drugs and xenobiotics
In this course, various topics related to the development, GMP production and application of therapeutic proteins will be discussed.

**Pharmacology and Toxicology III**  
Pharmacoepidemiology and Drug Safety

**Objective**
- To familiarize participants with the principle methods and applications of pharmacoepidemiology and drug safety that is relevant for industry, regulatory affairs, but also for clinical pharmacists in hospitals and office pharmacies.
- Perform independently a causality assessment of suspected adverse drug reactions in patients
- Study designs and biostatistics used for the quantitative evaluation of drug safety
- Setup of programs that can effectively reduce medication errors and improve drug safety in clinical practice, particularly in hospitals

**Content**
- Historical landmarks of drug safety
- Pharmacovigilance and causality assessment
- Drug safety in premarketing clinical trials
- Descriptive, cohort and case-control drug safety study designs; Data analysis and control of confounding
- Pharmacoepidemiology and regulatory decision making in drug safety; Risk management plans (RMPs)
- Medication errors, clinical pharmacology / clinical pharmacy
- Clinical Decision Support Systems, Interventional Pharmacoepidemiology
- Pharmacoepidemiological databases, Big Data
- Interactive discussion of many real-life examples for each topic

**Lecture notes**
This course will be a combination of formal lectures, group discussions and self-directed studies. Course material will be taught through seminars, case studies in small groups. Reading material and scripts will be provided for each week.

**Literature**
- Recommended literature
  - Rothman: Introduction to Epidemiology
  - Strom, Kimmel, Hennessy: Textbook of Pharmacoepidemiology

**535-0030-00L**  
Therapeutic Proteins

**Abstract**
In this course, various topics related to the development, GMP production and application of therapeutic proteins will be discussed. Furthermore, students will expand their training in pharmaceutical immunology and will be introduced to the basic concepts of pharmaceutical product quality management.

**Objective**
- Students know and understand:
  - basic mechanisms and regulation of the immune response
  - the pathogenic mechanisms of the most important immune-mediated disorders
  - the most frequently used expression systems for the production of therapeutic proteins
  - the use of protein engineering tools for modifying different features of therapeutic proteins
  - the mechanism of action of selected therapeutic proteins and their application
  - basic concepts in the GMP production of therapeutic proteins

**Content**
The course consists of two parts:
- In a first part, students will complete their training of pharmaceutical immunology (Chapter 13 - 16 Immunobiology VIII textbook). This part particularly focuses on the pathogenic mechanisms of immune-mediated diseases. Deepened knowledge of immunology will be relevant for understanding the mechanism of action of many therapeutic proteins, as well as for understanding one major concern related to the use of protein-based drugs, namely, immunogenicity.
- The second part focuses on topics related to the development and application of therapeutic proteins, such as protein expression, protein engineering, reducing immunogenicity, and GMP production of therapeutic proteins. Furthermore, selected examples of approved therapeutic proteins will be discussed.

**Lecture notes**
Handouts to the lectures will be available for downloading under http://www.pharma.ethz.ch/scripts/index

**Literature**
- Chapters 13-16 of the Immunobiology VIII book (Janeway et al.)
- Lecture Handouts
- Paper References provided in the Scripts
- EMEA Dossier for Humira

**535-0041-00L**  
Pharmacology and Toxicology III

**Abstract**
The course is divided into two parts. The first part provides a detailed understanding of drugs and pharmacotherapy of infectious diseases and cancer. The second part gives an overview of the field of pharmacogenomics with a special focus on the role of genetic polymorphisms in disease susceptibility, drug response and adverse effects.

**Objective**
The course advances basic knowledge in pharmacology and toxicology. Special emphasis is placed on the interrelationship between pharmacological, pathophysiological and clinical aspects of drug therapy in the fields of infectious diseases and cancer. The course also provides an overview of the field of pharmacogenomics, with a special focus on the role of genetic polymorphisms in disease susceptibility, drug response and adverse effects.

**Content**
Topics include the pharmacology and pharmacotherapy of infectious diseases and cancer. In the field of pharmacogenomics, the course is focused on genetics, genome-wide association studies, genetic disease predisposition, examples of genetic variability of drug metabolism and drug responses, identification of new drug targets, relevance of pharmacogenomics for clinical drug development, and toxicogenomics.

**Lecture notes**
A script is provided for each lecture course. The scripts define important and exam-relevant contents of lectures. Scripts do not replace the lecture.

**Literature**
Recommended reading:
- The classic textbook in Pharmacology: Goodman and Gilman’s The Pharmacological Basis of Therapeutics
- Laurence Brunton, Bruce Chabner, Bjoern Knollman. 12th edition - 1808 pages

or
- 11th edition - 1216 pages
- 2013; Urban & Fischer (Elsevier, München)

**Second Series of Courses**

**Compulsory Block Courses**
<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>535-5501-00L</td>
<td>Applied Pharmacology</td>
<td>O</td>
<td>6</td>
<td>7G</td>
<td>P. Wiedemeier, S. Enni, B. Falch, K. Fünfschilling, A. Gutzeit, I. S. Vogel Kahmann</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
<td></td>
<td></td>
<td>Overview of the most important clinical pictures: symptoms, recognition, differentiation, pharmacotherapy for the most important general and special medical indications. Groups of pharmaceutical compounds, active pharmaceutical ingredients, proprietary medicinal products: mechanisms of action, contraindications, therapeutic patterns, side effects, interactions.</td>
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<tr>
<td></td>
<td>Objective</td>
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<td></td>
<td>Students have a thorough knowledge of all clinical pictures and their symptoms regarding outpatient treatment. They know the main groups of indications including active pharmaceutical self-medication and ingredients, mechanisms of action, pharmacokinetics, pharmacodynamics and dosage. They are also able to identify the relevant side effects and interactions.</td>
</tr>
<tr>
<td></td>
<td>Content</td>
<td></td>
<td></td>
<td></td>
<td>Pathophysiology of selected clinical pictures and their main symptoms and clinical parameters. Recognition of alarm symptoms and distinction between pharmaceutical self-medication and the need for medical treatment. Detailed coverage of the pharmacotherapy of all fields of indication encountered in outpatient treatment. Outlining of therapeutic strategies and patterns with regard to suitable pharmaceutical compounds, active pharmaceutical ingredients and representative range of proprietary medicinal products. Discussion of the most important mechanisms of action, contraindications, side effects and interactions.</td>
</tr>
<tr>
<td>535-5502-00L</td>
<td>Pharmaceutical Manufacturing in Small Quantities</td>
<td>O</td>
<td>3</td>
<td>3G</td>
<td>J. Fröhlich, H. Hartenberg, C. Meier</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
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<td></td>
<td>Hands-on course in pharmaceutical manufacturing in the pharmacy according to &quot;GMP regulations for small quantities&quot; defined in the pharmacopoeia: Design and practical approach in compounding of formulas using the most important dosage forms including their risks and quality assurance.</td>
</tr>
<tr>
<td></td>
<td>Objective</td>
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<td></td>
<td>Students are able to manufacture, to package, to quality-control and document pharmaceutical compounding on their own, &quot;best practice&quot; and according to GMP regulations, using the appropriate techniques. They know the most important properties of active ingredients and excipients frequently used. They achieve the necessary knowledge including the relevant literature and other sources of information, as well as the legal requirements regarding pharmaceutical manufacturing in small quantities.</td>
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<tr>
<td></td>
<td>Content</td>
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<td></td>
<td>To impart knowledge about the principal techniques and processes in the manufacturing of pharmaceuticals in small quantities (formulas), focusing on the design, manufacturing, quality assurance and risk-based self-appraisal including the patient-specific dispensing. During the practical training periods: by means of pharmaceutical relevant examples and training, the manufacturing including the correct use of the equipment, the in-process control, the packaging and the quality assurance are practiced for various dosage forms and recipes. Quality assurance and control are mainly risk adapted considering as well hygiene regulations according to current pharmaceutical practice. The participants will thus improve their general GMP knowledge and skills.</td>
</tr>
<tr>
<td>535-5503-00L</td>
<td>Institutional Pharmacy</td>
<td>O</td>
<td>3</td>
<td>3G</td>
<td>P. Wiedemeier, J. Beney, M. Lutters, I. S. Vogel Kahmann</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
<td></td>
<td></td>
<td>Organisation of institutional environments (emergency hospitals), with special focus on the medication process and institutional pharmacy care (continuum of care).</td>
</tr>
<tr>
<td></td>
<td>Objective</td>
<td></td>
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<td></td>
<td>Students understand the concept of continuum of care and its practical implementation. They know the medication process within an institutional environment. They are able to find the necessary information and deal with problems in connection with pharmaceuticals, to evaluate them and to communicate and documentate their findings adequately. They know how a hospital is organised (procedures, possible problems), responsibilities of the different members of the staff and, most importantly, what the function of a hospital pharmacy is.</td>
</tr>
<tr>
<td></td>
<td>Content</td>
<td></td>
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<td></td>
<td>Principals of the organisation of institutional environments (emergency hospitals), with special focus on medication processes and institutional pharmaceutical care (circulation of medication, continuum of care). Hygiene regulations, medical products, applications, drug formularies, patient files, SOAP notes, kardex study. Participation at interdisciplinary visits, internal trainings and doctors' reports as well as visitation of the emergency room. Drug interaction, generic substitution, quality management and pharmacovigilance.</td>
</tr>
<tr>
<td>535-5504-00L</td>
<td>Basics of Practical Pharmacy</td>
<td>O</td>
<td>6</td>
<td>7G</td>
<td>P. Wiedemeier, S. Enni, B. Falch, K. Fünfschilling, I. S. Vogel Kahmann</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
<td></td>
<td></td>
<td>Introduction to managed care systems (Pharmaceutical Care und Public Health): problems with regard to therapy and approaches to solutions, service, first aid and medicinal products. Methods of illness prevention and health promotion. Important additional assortments including complementary medicine. Law and economy in everyday pharmacy, structures of the national health care system.</td>
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<tr>
<td></td>
<td>Objective</td>
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<td></td>
<td>Students know the most important concepts and methods of pharmaceutical care of patients with regard to OTC and Rx-only drugs as well as the essential concepts and methods of public health, prevention and health care. They master the basic rules concerning the pharmaceutical triage and their implications. For the clinical pictures covered during the course, they are able to make therapeutic plans or accompany and optimize doctor’s orders. Students show an adequate understanding of the rights and duties of pharmacists as medical personnel regarding medical care, the framework of the Swiss health care system. They are capable of handling important medical products and instructing patients about their use. Students have the necessary basic skills and applications of first aid and emergency medicine. They know the essence, chances and limits with reference to additional assortments, therapeutic options like phytotherapy, complementary medicine, veterinary pharmacy and non-medicinal methods of healing. Students have the essential knowledge of legal aspects and regulations concerning pharmacists and know the basics of business administration.</td>
</tr>
<tr>
<td></td>
<td>Content</td>
<td></td>
<td></td>
<td></td>
<td>Pharmaceutical Care: possibilities of pharmaceutical care of patients regarding OTC and Rx-only drugs in the officinal pharmacy. Good pharmaceutical triage in practice, introduction to the pharmaceutic validation of prescriptions, recognition of medicinal, patient related, therapeutic problems and the finding of solutions: Choice of therapy (OTC), accompanying and optimizing therapies (Rx), compliance, correct administration of drugs, cooperation with other pharmaceutical professions in the field of outpatient treatment. Traditional and proactive pharmaceutical service: development of adequate means of documentations of intervention and consultation as well as pharmaceutical follow-up care. Public health: role and possibilities of officinal pharmacies as partners within the Swiss health care system: primary health care, prevention, campaigns, early detection, instruction and medication, referral to doctors. Needs of customers, patients and employees, and social interaction. Significance of the medical profession (illness, suffering, promotion of health and well-being). Basic training in first aid, emergency medicine and wound care. Medical products: handling of important applications and instruction of patients. Important and additional forms of therapy and assortments: phytotherapy, complementary medicine, veterinary pharmacy, non-medicinal methods of healing. Economy and law in everyday pharmacy: overview of the Swiss legal system. Relevant legal framework, jurisdiction and regulations and their meaning with regard to quality assurance for practicing pharmacists. Basics of finance and accounting as well as personnel management and insurance matters. Organisation and competencies of the various partners within the Swiss health care system, focusing on the intermediate position and the role of pharmacists as part of the medical community.</td>
</tr>
</tbody>
</table>

**DAS Preparation for the Swiss Federal Examination in Pharmacy - Key for Type**

| Type | Description | Eligible
<table>
<thead>
<tr>
<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>W</td>
<td>Suitable for doctorate</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>W+</td>
<td>Recommended, not eligible for credits</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>Z</td>
<td>Compulsory</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>Key for Hours</td>
<td>ECTS</td>
<td>European Credit Transfer and Accumulation System</td>
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<tr>
<td>--------------</td>
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<td>-------------------------------------------------</td>
</tr>
<tr>
<td>V</td>
<td>lecture</td>
<td>V lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
<td>G lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
<td>U exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
<td>S seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
<td>K colloquium</td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
<td>P practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
<td>A independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
<td>D diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
<td>R revision course / private study</td>
</tr>
</tbody>
</table>

Special students and auditors need special permission from the lecturers.
Doctoral Department of Architecture

Doctoral and Post-Doctoral Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>064-0003-16L</td>
<td>Postgraduate Colloquium on the History of</td>
<td>W</td>
<td>3</td>
<td>2K</td>
<td>to be announced</td>
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<tr>
<td></td>
<td>Art and Architecture</td>
<td></td>
<td>credits</td>
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<tr>
<td></td>
<td>Does not take place this semester.</td>
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<td></td>
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</tr>
<tr>
<td>Abstract</td>
<td>The Postgraduate Colloquium mainly addresses doctoral students of the Chair. It is aimed at presenting and further discussing the current research, thus focusing on the argumentation and verification of contextual and methodical questions. The Colloquium provides a basis for exchange and further education and to establish and promote networking.</td>
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</tr>
<tr>
<td>Objective</td>
<td>The Colloquium focuses on the presentation and further discussion of the current research of doctoral students. It concentrates on the discussion and verification of contextual and methodical questions and provides a basis for exchange and networking among the participants.</td>
<td></td>
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</tr>
<tr>
<td>Content</td>
<td>The Themenschwerpunkte der jeweiligen Veranstaltung richten sich nach den präsentierten Forschungsarbeiten. Inhaltlich korrespondieren sie mit den Forschungsschwerpunkten der Professor.</td>
<td></td>
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</tr>
<tr>
<td>Prerequisites / notice</td>
<td>Mehrtägiges Kolloquium. Veranstaltungszeit und -ort nach Vereinbarung.</td>
<td></td>
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<td></td>
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</tbody>
</table>

| 064-0005-16L  | Doctoral Seminar: Methods in the History of | W    | 3    | 2K    | I. Heinze-Greenberg, L. Stalder, |
|               | Architecture (M. Angéli)                   |      | credits |       | P. Ursprung                      |
| Abstract      | gta-re-vue: Workshop on the occasion of the 50th jubilee of the Institute for the History and Theory of Architecture |
| Objective     | The development of the material is conceived as a joint form-finding process. The basic idea is to create a revue-like series of various "numbers": a dynamic mixture of book and lecture texts, historical documents and spontaneously evolving conversations. The final product will be performed by workshop contributors during the anniversary celebrations. |
| Content       | The motivation behind the workshop is to focus on the beginnings of the gta on the occasion of its 50th anniversary. Among the founding fathers there were fascinating protagonists such as Adolf Max Vogt, Bernhard Hoesli, and Paul Hofer. Based on an understanding of their concepts, methods and ideas, a text collage will culminate in a script for a one-hour-long performance reading. In addition to the graphically significant gta publications produced at this time ("Rainbow"-books), contemporary image and film materials can be integrated as well as interviews with contemporary witnesses and the present gta chair. The result intends both contextualization as well as critical revision. |
| Prerequisites / notice | The seminar addresses the fellows of the Doctoral Program in History and Theory of Architecture. All other doctoral students of the Faculty of Architecture are welcome. |

| 064-0009-16L  | Research Colloquium in Architecture and Urbanism (M. Angéli) | W    | 3    | 1K    | M. Angéli |
| Abstract      | This colloquium is open to doctoral candidates in fields related to Architecture and Urbanism. Its focus will be on contemporary topics in urbanism and will involve two or three one-day sessions over the course of the semester, each of which will be attended by an invited scholar. |
| Objective     | The sessions will involve brief presentations of dissertation work by the participants followed by discussions with the guests. |
| Content       | This colloquium is open to doctoral candidates in fields related to Architecture and Urbanism. Its focus will be on contemporary topics in urbanism and will involve two or three one-day sessions over the course of the semester, each of which will be attended by an invited scholar. |
| Prerequisites / notice | Space is limited and participation is subject to approval from the organizers. |

| 064-0013-16L  | Methods in the History and Theory of Architecture | W    | 2    | 2S    | I. Heinze-Greenberg |
| Abstract      | Introduction to methodological approaches in the history and theory of architecture; presentation and discussion of individual doctoral projects. |
| Objective     | The doctoral students analyze critically relevant approaches in the history and theory of architecture and discuss fundamental questions with regard to their individual research projects, to produce and hand in their proposals. |
| Content       | The two-semester course in the first year of the doctoral program in the history and theory of architecture has a twofold objective: First, reading sessions on central approaches in the history and theory of architecture provide a methodological basis for the doctoral students. Secondly, by both, reading sessions and presentation and discussion sessions on the individual research projects, the doctoral students gain insight in the production of the proposal which they work on and which they have to present after the first year. |
| Prerequisites / notice | Languages: German and English |

| 064-0015-16L  | PhD Colloquium Theory of Information Technology for Architects | W    | 2    | 2K    | L. Hovestadt |
| Abstract      | Information technology plays an increasingly important role in research. To meet this challenging development, it is not only important to acquire respective skills, but also to consider and understand information technology in what sets it apart from other gestalts of technics (like mechanics, dynamics, or thermodynamics). |
| Objective     | The aim of this colloquium is to counter an observable tendency, that proportional to the degree in which students master practical skills in computing, they increasingly submit uncritically, in their understanding and framing of problems, to the dictation of schemata and templates implemented by technical systems. |
| Content       | The starting point for this colloquium is to comprehend computing not in terms of skills, but as a literacy which we can experience emerging today. Like in the case of writing as well, computing cannot exhaustively be reduced to either logics, grammar, arithmetics, or analytics. Rather, computation, if comprehended as a literacy, relates to any of the established categories of learning and raises questions of an architectonic kind. This colloquium draws from the principal richness of cultural forms of knowing and learning and thematizes approaches to formulate a theoretical stance on information technology for architecs which is driven by and resting on the actual reality of computability today. In this, it is complementary to those theory courses on technology offered by the historical disciplines at ETH. |
| Prerequisites / notice | To benefit from this course, you should have a practical affinity to technics, as well as an abstract interest in information technology in its comprehensive cultural context. |

| Abstract      | Advanced PhD candidates of urban studies, urban and landscape design and urban sociology report about their experiences and insights in the concrete application of methods utilized for their research and scientific publications. Discussion of ongoing individual work, methodological questions, critical perspectives on urban and landscape design and city's relation to society. |
| Objective     | The seminar seeks to provide participants with a differentiated knowledge of methods in the field of the urbanism. Furthermore, it provides a platform to exchange contemporary urban research experiences across disciplinary boundaries, drawing from different geographies of knowledge production. Possible meta-themes include modes of data assessment in urban studies, ways of progressing from hypothesis to synthesis, and research by design as method. |
The programme revolves around the depleting resource sand and the question of how to develop alternative building materials for future.

PhD students at ETH Zurich working in the broad area of energy present their research to their colleagues, to their advisors and to the scientific community.

Every week there are two presentations, each structured as follows: 15 min introduction to the research topic, 15 min presentation of the results, 15 min discussion with the audience.

Enrolment on agreement with the lecturer only.

<table>
<thead>
<tr>
<th>Course Catalogue of ETH Zurich</th>
</tr>
</thead>
<tbody>
<tr>
<td>862-0002-16L</td>
</tr>
<tr>
<td>Research Colloquium History of Knowledge (HS 2016)</td>
</tr>
<tr>
<td>Only for MAGPW students, D-GEES PHD and D-ARCH PHD students.</td>
</tr>
<tr>
<td>This colloquium is highly recommended for first and second semester MAGPW students.</td>
</tr>
<tr>
<td>Objective</td>
</tr>
<tr>
<td>Content</td>
</tr>
<tr>
<td>Prerequisites / notice</td>
</tr>
<tr>
<td>Lecture notes</td>
</tr>
</tbody>
</table>

Credit points can be gained by regular attending and by writing an essay. In addition to the five colloquia there will be a deepening seminar on offer (lecturer K. Espahangiziz).

Free childcare available.

The programme revolves around the depleting resource sand and the question of how to develop alternative building materials for future cities. The course is for 30 master and doctoral students from ETH Zurich and other academic institutions (from different disciplines related to the topic), joined by faculty members and external experts from fields of expertise related to the winter school topic.

The E4D summer school 2016 aims to develop an integrated vision to a global challenge of today's construction industry. The programme revolves around the depleting resource sand and the question of how to develop alternative building materials for future cities. Led by different experts from around the world, students will not only learn the thematic but also the practical aspects of material computation and digital fabrication. The workshops will be a blend of theoretical and practical knowledge, and will provide students with hands-on experience in digital fabrication, material computation, and design thinking.

Content
Sand is the most commonly used raw material for the production of goods on our planet. It is found in concrete, glass, computers, detergents and toothpaste. Sand is the megastar of the industrial and digital era - our culture is literally built upon this resource. But sand is not equal to sand: the construction industry requires grain sizes and rough shapes that are only found in river beds, lakes and the oceans. Mining of aquatic sand comes at high environmental and social costs; Its growing demand cannot be met sustainably. Sand is mostly composed of quartz, a mineral form of silicon dioxide. Silicon is one of the most abundant materials on earth and also one of the strongest.

Microbiologically Induced Calcite Precipitation (MICP), Chemical Crystallization Processes and 3D printing.

Sustainability is often referred to as an interaction of social, cultural, economic, and ecological aspects. In the construction industry sustainability has been perceived as the optimisation of existing material and energy uses, yet the fundamental energetic and material character of these base resources has not been questioned. The speed of consumption of these resources increases constantly due to demographic pressure and resulting construction, as seen around the world and in particular in developing and emerging countries. A fundamental understanding of metabolic processes is required to frame the question of material and energetic sustainability. At the same time the definition of resources expands to include previously undervalued materials and waste. Finally, advances in digital technology and science have opened new avenues for alternative materials and processes.

The summer school presents three areas that could mobilise sand alternatives for construction and other applications:
I. Microbiologically Induced Calcite Precipitation (MICP), Also known as bio-cementation it is a process utilised in self-healing concrete and soil stabilisation. The application to sand will produce naturally grown structural sand bricks. This workshop will explore MICP for various sand types, building wastes and bacterial cultures.
II. Chemical Crystallization Processes: Based on material computation experiments pioneered by architect and engineer Frei Otto, this workshop combines form finding properties of sand with structural and thinking and chemical crystallization processes.
III. 3D Printing: 3D Printing with sand and building waste, finally, explores the potential of sand as a substrate within a binding agent. In combination with a robotic arm, 3D printing of sand is an in situ digitally controlled construction process. It overcomes the need for traditional form-work and transportation of material, thereby reducing the grey energy.
Compulsory
2 credits
Summer School: Assembling Cities. Studing Urban Matters in Practice

Costs: CHF 500, including board and accommodation. All participants are responsible for organising and financing their own domestic or international travel to Delft, The Netherlands.

The Engineering for Development (E4D) Winter School 2016 will invite 30 master and doctoral students from different disciplines related to the topic of the summer school. Applicants will be selected based on their academic record and previous work experiences. Applicants must send a one-page CV and one-page letter of motivation in PDF format stating their interest, to Ms. Maria Ubierna Aparicio (ubierna@ifu.baug.ethz.ch)

Deadline: 31 March 2016

Notifcation: 15 April 2016

051-0829-16L Summer School: Assembling Cities. Studing Urban Matters in Practice

W 2 credits
4U D. Eberle

Abstract
In particular, the summer school addresses research exploring the borderlands of the diverse fields of STS and urban studies. It will be of particular interest to PhD candidates who have already begun their research and are in the stages before or after conducting field studies. As participants are required to enrol in one of three thematic groups, their stages of research may differ per group.

Objective
The objective of the summer school is to support PhD researchers in their individual research and specific research stages by sharing their work with keynotes and colleagues. Accordingly, participants are expected to develop their skills of articulating and communicating their ideas, examine various STS methods and techniques of approaching cities, and to discuss their research and obstacles in an academic setting. The three sessions; problematizing, describing and assembling, allow participants in various stages of their research to learn about the relevance of STS methodologies and concepts of urban research in general, and for their particular interest and research stage. They are also aimed at researchers not yet familiar with the approach and interested in learning a subset of its concepts (eg. networks/artefacts) and methodologies (eg. ethnography/digital methods). Throughout the sessions participants will learn to: question the city from a STS perspective (problematizing), they will be introduced to the methodologies that tackle these questions (describing), and they will encounter ways of thinking through questions and answers (assembling). Specifically, participants are to write a full paper, design a poster and make a presentation. All deliverables will be evaluated by the keynote speakers, four external reviewers, and the organizers. The poster presentation will take place in front of a full audience, while paper presentations in the workgroup only. The organizers are inquiring for publishing opportunities of outstanding papers (eg. plaNext from the AESOP YA, Contour at the EPFL or Spatium at the IAUS). The website will be updated with the posters and a review of following the event.

The Assembling Cities summer school aims to bring together an interdisciplinary group of doctoral students who treat the city as their empirical site. Academic backgrounds include, but are not limited to: anthropology, architecture, geography, history, philosophy, political science, sociology, visual arts, and urban planning. In particular, the summer school addresses research exploring the borderlands of the diverse fields of STS and urban studies. It will be of particular interest to PhD candidates who have already begun their research and are in the stages before or after conducting field studies. As participants are required to enrol in one of three thematic groups, their stages of research may differ per group. In other words, the three themes can be interpreted to speak to various stages of research (problematizing, describing, and assembling respectively). The summer school is positioned at the intersection of science and technology studies (STS), urban studies and planning studies. The program emphasizes the development of conceptual and methodological insights as part of innovative approaches to contemporary urban phenomena. To the fields of urban studies it provides a more varied and dynamic conceptualisation of the city; it does not reduce urban phenomena to the logic of a capitalist mode of production. This endeavour relating urban studies with STS presents new, cross-cutting ways of examining arising planning issues. Planning studies can benefit from new tools of interpreting problems of interconnection and expertise.

Content
The relevance of STS in urban research is explored with three themes: problematizing, describing and assembling (cities). Participants will be distributed in thematic groups, and lectures will be held by keynote speakers according to theme. Following the call, participants are required to indicate which theme fits their paper best as they will be shared within the thematic groups. The first day will include a keynote presentation followed by an informal poster session for each thematic group. The poster sessions are a chance for the other two groups to learn about participants’ research and ask questions. The following day two sessions will be held with the support of the respective keynote.

During the first (morning) session the participants will present their papers (max 15 min) within their thematic groups followed by a general 20 min discussion. During this time, key points will be noted and later discussed in the second (afternoon) session in which each group will prepare a plenary discussion and presentation for the final day. The final day consists of a plenary discussion of each theme opened by the respective keynote and moderated by members of the thematic group. Each thematic group will summarize their discussions and findings in a final presentation. The framework for the discussion and presentations will be defined together with the keynotes and could be, for example, a specific question and/or obstacle, a clear toolbox, or excerpts from selected presentations related to each respective theme.

The summer school will open with an excursion to the housing project Hunzikerareal by the housing cooperative Mehr als wohnen in Zurich. This large mixed-use area development is used as an illustration of how institutions, individuals and artefacts mediate the planning process towards an inclusionary and diverse project.

Notices

Prerequisites / notice
Taking place from 4 to 22 July 2016 at the TU Delft in The Netherlands.

Doctrinal Department of Architecture - Key for Type

O Compulsory
W+ Eligible for credits and recommended
W Eligible for credits

Contents

Key for Hours

V lecture
G lecture with exercise
U exercise
S seminar
K colloquium

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.

Data: 06.03.2019 12:57
Autumn Semester 2016

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### Additional Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0906-00L</td>
<td>Frontiers in Energy Research</td>
<td>W</td>
<td>2 credits</td>
<td>2S</td>
<td>M. Mazzotti, R. S. Abhari, J. Carmeliet, M. Filippini</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract</strong></td>
<td></td>
<td></td>
<td></td>
<td>PhD students at ETH Zurich working in the broad area of energy present their research to their colleagues, to their advisors and to the scientific community.</td>
</tr>
<tr>
<td></td>
<td><strong>Objective</strong></td>
<td></td>
<td></td>
<td></td>
<td>Knowledge of advanced research in the area of energy.</td>
</tr>
<tr>
<td></td>
<td><strong>Content</strong></td>
<td></td>
<td></td>
<td></td>
<td>PhD students at ETH Zurich working in the broad area of energy present their research to their colleagues, to their advisors and to the scientific community. Every week there are two presentations, each structured as follows: 15 min introduction to the research topic, 15 min presentation of the results, 15 min discussion with the audience.</td>
</tr>
<tr>
<td></td>
<td><strong>Lecture notes</strong></td>
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<td>Slides will be distributed.</td>
</tr>
</tbody>
</table>

**Course Catalogue of ETH Zurich**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>102-1227-16L</td>
<td>Advanced Life Cycle Assessment (HS16) ■</td>
<td>W</td>
<td>2 credits</td>
<td>4S</td>
<td>C. L. Mutel</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract</strong></td>
<td></td>
<td></td>
<td></td>
<td>The summer school examines in depth the systemic choices and assumptions used in life cycle assessment models of the world economy and biosphere, and then have the students apply this knowledge by making their own choices and building their own version of a life cycle inventory database. Software to apply these system modelling choices would be built specifically for the summer school.</td>
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<tr>
<td></td>
<td><strong>Objective</strong></td>
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<td></td>
<td>To improve ones understanding of life cycle assessment, and the broader issues in modeling, improving, and understanding sustainability assessments.</td>
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<tr>
<td></td>
<td><strong>Prerequisites / notice</strong></td>
<td></td>
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<td></td>
<td>Students should be familiar with either life cycle assessment, environmental science, or economic modeling. This seminar is intended to be primarily for Ph.D. students.</td>
</tr>
</tbody>
</table>

### Doctoral Department of Civil, Environmental and Geomatic Engineering - Key for Type

<table>
<thead>
<tr>
<th>O</th>
<th>Compulsory</th>
<th>Z</th>
<th>Courses outside the curriculum</th>
</tr>
</thead>
<tbody>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
</tbody>
</table>

### Key for Hours

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
<th>P</th>
<th>practical/laboratory course</th>
</tr>
</thead>
<tbody>
<tr>
<td>G</td>
<td>lecture with exercise</td>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
<td>R</td>
<td>revision course / private study</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
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</tbody>
</table>

### ECTS

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
### Doctoral and Post-Doctoral Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-1159-00L</td>
<td>Molecular Systems Biology</td>
<td>E-</td>
<td>0</td>
<td>1K</td>
<td>U. Sauer, R. Aebersold</td>
</tr>
<tr>
<td>Abstract</td>
<td>Seminar series on current research topics in systems biology</td>
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<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>An overview of systems biology research</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Content</td>
<td>Seminar series on current research topics in systems biology</td>
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</tr>
<tr>
<td>Lecture notes</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Literature</td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>701-0265-00L</td>
<td>Ecology and Evolution</td>
<td>W</td>
<td>1</td>
<td>2S</td>
<td>E. Postma, J. Jokela</td>
</tr>
<tr>
<td>Abstract</td>
<td>A course dedicated to the reading and discussion of the relevant literature. The actual list of theme papers will be proposed anew for every year. Students then choose a topic and prepare themselves for a general discussion with their colleagues and peers. In the process, current and controversial topics will be discussed and studied.</td>
<td></td>
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<tr>
<td>Objective</td>
<td>To become proficient in reading scientific literature, to understand how to look at publications, to understand them and to be able to put them in context. The course also trains the skills needed for the presentation of scientific contributions and the ability to put things into a broader context. Training in how to participate in a scientific discussion, how to make an argument and how to listen to arguments of others.</td>
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<tr>
<td>Content</td>
<td>All topics focus on themes from ecology and evolution, notably so on studies on adaptation of organisms, their evolutionary history, or on questions of current methodology.</td>
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<tr>
<td>Lecture notes</td>
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</tr>
<tr>
<td>Literature</td>
<td>The actual content, i.e. the theme papers, will be determined and allocated to the participants at the start of the course each year. Takes place at Uni Irchel. Please refer to notes on board or ask secretary Mrs. Rita Jenny (<a href="mailto:Rita.Jenny@env.ethz.ch">Rita.Jenny@env.ethz.ch</a>).</td>
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Requirements: Knowledge of ecology and evolution, e.g., lectures during basic and advanced study period. The course is meant for advanced and PhD students.

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-1791-00L</td>
<td>Introductory Course in Neuroscience I (University of Zurich)</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>J.M. Fritschy, W. Knecht</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course gives an introduction to human and comparative neuroanatomy, molecular, cellular and systems neuroscience.</td>
<td></td>
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<tr>
<td>Objective</td>
<td>The course gives an introduction to human and comparative neuroanatomy, molecular, cellular and systems neuroscience.</td>
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</tbody>
</table>
| Content     | 1) Human Neuroanatomy I&II  
2) Comparative Neuroanatomy  
3) Development I&II  
4) Membran and Action Potential  
5) Synaptic Transmission & Plasticity I&II  
6) Glia and Blood-Brain-BARRIER  
7) Somatosensory and Motor System  
8) Visual System  
9) Auditory System  
10) Circuits underlying Emotion  
11) Modeling of Neural Circuits |
| Prerequisites / notice | For doctoral students of the Neuroscience Center Zurich (ZNZ). |

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-1795-00L</td>
<td>Advanced Course in Neurobiology I (Functional Anatomy of the Rodent Brain) (University of Zurich)</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>J.M. Fritschy, H. U. Zeilhofer</td>
</tr>
<tr>
<td>Abstract</td>
<td>The goal of this Advanced Course in Neurobiology is to provide students with a broader knowledge in several important areas of neurobiology. The course consists of four parts: Part I deals with various topics in developmental neurobiology. Part II is devoted to aspects of signal transduction. Part III focuses on synaptic transmission. Part IV gives deeper insights into systems neuroscience.</td>
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</tr>
<tr>
<td>Objective</td>
<td>This credit point course is designed for doctoral students who have successfully completed the Introductory Course in Neuroscience at the Neuroscience Center Zürich. The goal is to provide students with a broader and deeper knowledge in several important areas of neurobiology.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Für Doktorierende des Zentrums für Neurowissenschaften Zürich. Nicht für Master-Studierende geeignet.</td>
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<thead>
<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0255-00L</td>
<td>Energy Conversion and Transport in Biosystems</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>D. Poulakakos, A. Ferrari</td>
</tr>
<tr>
<td>Abstract</td>
<td>Theory and application of thermodynamics and energy conversion in biological systems with focus on the cellular level.</td>
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</tbody>
</table>
Objective: Theory and application of energy conversion at the cellular level. Understanding of the basic features governing solute transport in the principal systems of the human cell. Connection of characteristics and patterns from other fields of engineering to bioluidics. Heat and mass transport processes in the cell, generation of forces, work and relation to biomedical technologies.

Content: Mass transfer models for the transport of chemical species in the human cell. Organization and function of the cell membrane and of the cell cytoskeleton. The role of molecular motors in cellular force generation and their function in cell migration. Description of the functionality of these systems and of analytical experimental and computational techniques for understanding of their operation. Introduction to cell metabolism, cellular energy transport and cellular thermodynamics.

Lecture notes: Material in the form of hand-outs will be distributed.

Lecture notes and references therein.

Literature: Lecture notes and references therein.

151-0927-00L Rate-Controlled Separations in Fine Chemistry W 4 credits 3G M. Mazzotti

Abstract: The students are supposed to obtain detailed insight into the fundamentals of separation processes that are frequently applied in modern life sciences processes in particular, fine chemistry and biotechnology.

Objective: The students are supposed to obtain detailed insight into the fundamentals of separation processes that are frequently applied in modern life sciences processes in particular, fine chemistry and biotechnology.

Content: The class covers separation techniques that are central in the purification and downstream processing of chemicals and bio-pharmaceuticals. Examples from both areas illustrate the utility of the methods: 1) Liquid-liquid extraction; 2) Adsorption and chromatography; 3) Membrane processes; 4) Crystalization and precipitation.

Prerequisites / notice: Requirements: Thermal separation Processes I (151-0926-00) and Modelling and mathematical methods in process and chemical engineering (151-0940-00)

401-0649-00L Applied Statistical Regression W 5 credits 2V+1U M. Dettling

Abstract: This course offers a practically oriented introduction into regression modeling methods. The basic concepts and some mathematical background are included, with the emphasis lying in learning “good practice” that can be applied in every student’s own projects and daily work life. A special focus will be laid in the use of the statistical software package R for regression analysis.

Objective: The students acquire advanced practical skills in linear regression analysis and are also familiar with its extensions to generalized linear modeling.

Content: The course starts with the basics of linear modeling, and then proceeds to parameter estimation, tests, confidence intervals, residual analysis, model choice, and prediction. More rarely touched but practically relevant topics that will be covered include variable transformations, multicollinearity problems and model interpretation, as well as general modeling strategies.

Prerequisites / notice: The last third of the course is dedicated to an introduction to generalized linear models: this includes the generalized additive model, logistic regression for binary response variables, binomial regression for grouped data and poisson regression for count data.

551-1615-00L NMR Methods for Studies of Biological Macromolecules W 1 credit 1S G. Wider

Prerequisites: Basic knowledge in biological NMR spectroscopy.

Abstract: Seminar series on technical aspects of high resolution nuclear magnetic resonance (NMR) spectroscopy with biological macromolecules.

Objective: Introduction and discussion of advanced methods for recording and analysis of NMR data with biological macromolecules.

Content: Seminar series on technical aspects of high-resolution nuclear magnetic resonance (NMR) spectroscopy with biological macromolecules.

551-1619-00L Structural Biology W 1 credit 1K R. Glockshuber, F. Allain, N. Ban, K. Locher, E. Weber-Ban, G. Wider, K. Wüthrich

Abstract: The course consists of a series of research seminars on Structural Biology, Biochemistry and Biophysics, given by both scientists of the National Center of Competence in Research (NCCR) in Structural Biology and external speakers. Information on the individual seminars is provided on the following websites:

http://www.structuralbiology.uzh.ch/educ002.asp
http://www.biol.ethz.ch/dbiol-cal/index

Objective: The goal of this course is to provide doctoral and postdoctoral students with a broad overview on the most recent developments in biochemistry, structural biology and biophysics.

851-0180-00L Research Ethics W 2 credits 2G G. Achermann

Prerequisites: Particularly suitable for students of D-BIOL, D-CHAB, D-HEST

Abstract: This course has its focus on the responsible conduct of research (RCR) and the ethical dimensions of the biological and biomedical sciences.

Objective: The main goal of this course is to enhance the student's ability to:
- recognize and identify ethical issues and conflicts,
- analyze and develop well-reasoned responses to the kinds of ethical problems a scientist is likely to encounter.

Additionally, students will become familiar with regulations and ethical guidelines relevant for their research field on the international, governmental, institutional and professional level.

To achieve these objectives, teaching methods will include lectures, discussions, case study work (alone and in groups), moral games, paper work and exercises.
I. Ethics & the Process of Ethical Inquiry

Introduction in Ethics and Research Ethics
- What is ethics? What ethics is not...
- Awareness: what constitutes an ethical question? Distinguishing ethical questions from other kinds of questions; Science & ethics: a comparison;
- The ethics movement in the biological and health sciences;
- What is research ethics and why is it important?
- Values (personal, cultural & ethical) in science & principles for ethical conduct in research;
- Professional codes of conduct: functions and limitations

Ethical approaches in the conduct of research (Normative Ethics)
- Overview over important theories for research ethics: virtue theories, duty-based theories (rights theory, categorical imperative, prima facie duties), consequentialist theories, other theories;
- The plurality of ethical theories and its consequences;
- The concept of dignity

Moral reasoning I: Arguments
- Why arguments? What is a good argument? The structure of (moral) arguments;
- Deductive and inductive arguments; Validity and soundness;
- Assessing moral arguments

Moral reasoning II: Decision-making
- How (not) to approach ethical issues...; Is there a correct method for answering moral questions?
- Models of method in Applied Ethics: a) Top-down approaches; b) the reflective equilibrium; c) a bottom-up approach: casuistry (or reasoning-by-analogy);
- Is there a right answer?

II. Research Ethics / Responsible Conduct of Research (RCR)

Integrity in Research & Research Misconduct
- What is "integrity" in scientific research? What is research misconduct (falsification, fabrication, plagiarism - FFP) and questionable research practices (QRP)?
- Factors leading to misconduct; Procedure for responding to allegations of research misconduct;
- The confidant of ETH Zurich

Data Management
- Data collection and recordkeeping; Analysis and selection of data;
- Ownership of data; retention and sharing of data;
- Falsification and fabrication of data

Research involving animals
- The moral status of animals; Ethical approaches to animal experimentation: Animal welfare (Peter Singer) and Animal rights (Tom Regan);
- The 3 R's (replacement, reduction, refinement);
- Ethical assessment of conflicting issues in animal experimentation;
- The dignity of animals in the Swiss constitution;

Research involving human subjects
- History & guidelines (Nuremberg Code; Declaration of Helsinki; Belmont Report; International Ethical Guidelines for Biomedical Research Involving Human Subjects (CIOMS Guidelines); Convention on Human Rights and Biomedicine (Oviedo Convention);
- Informed consent; confidentiality and anonymity; research risks and benefits; vulnerable subjects;
- Clinical trials;
- Biobanks
- Ethics Committees / Institutional Review Boards (IRB)

Authorship & Peer review
- Criteria for authorship;
- Plagiarism;
- Challenges to openness and freedom in scientific publication;
- Open access
- Peer review

Social responsibility
- What is social responsibility? Social responsibility: whose obligation?
- Public advocacy by researchers

Course material (handouts, case studies, exercises, surveys and papers) will be available during the lectures and on the course homepage.

Recommended literature:
- "Introduction to the Responsible Conduct of Research" (http://ori.dhhs.gov/education/products/RCRintro/)

Detailed literature lists for the different topics of the course will be provided in the script/handout or on the course work space.


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There will be about 5 talks on how statistical methods are applied in practice.

This is not a lecture. There is no exam and no credit points will be awarded. The current program can be found on the web:
http://stat.math.ethz.ch/events/zukost

Course language is English or German and may depend on the speaker.

551-1109-00L
Seminars in Microbiology
E- 0 credits 2K
M. Aebi, H.M. Fischer, W.D. Hardt, J. Piel, J. Vorholt-Zambelli

Abstract
Seminars by invited speakers covering selected microbiology themes.

Objective
Discussion of selected microbiology themes presented by invited speakers.

551-0030-01L
Doctoral Thesis
E- 0 credits
Professors

Abstract
Doctoral Thesis

401-0620-00L
Statistical Consulting
E- 0 credits 0.1K
M. Kalisch, L. Meier

Abstract
The Statistical Consulting service is open for all members of ETH, including students, and partly also to other persons.

Objective
Advice for analyzing data by statistical methods.

Content
Students and researchers can get advice for analyzing scientific data, often for a thesis.

Prerequisites / notice
This is not a course, but a consulting service. There are no exams nor credits.

Contact: beratung@stat.math.ethz.ch . Tel. 044 632 2223. See also http://stat.ethz.ch/consulting

Requirements: Knowledge of the basic concepts of statistics is desirable.

551-0512-00L
Current Topics in Molecular and Cellular Neurobiology
W 2 credits 1S U. Suter

Abstract
The course is a literature seminar or "journal club". Each Friday a student, or a member of the Suter Lab in the Institute of Molecular Health Sciences, will present a paper from the recent literature.

Objective
The course introduces you to recent developments in the fields of cellular and molecular neurobiology. It also supports you to develop your skills in critically reading the scientific literature. You should be able to grasp what the authors wanted to learn i.e. their goals, why the authors chose the experimental approach they used, the strengths and weaknesses of the experiments and the data presented, and how the work fits into the wider literature in the field. You will present one paper yourself, which provides you with practice in public speaking.

Content
You will present one paper yourself. Give an introduction to the field of the paper, then show and comment on the main results (all the papers we present are available online, so you can show original figures with a beamer). Finish with a summary of the main points and a discussion of their significance.

You are expected to take part in the discussion and to ask questions. To prepare for this you should read all the papers beforehand (they will be announced a week in advance of the presentation).

Lecture notes
Presentations will be made available after the seminars.

Prerequisites / notice
You must attend at least 80% of the journal clubs, and give a presentation of your own. At the end of the semester there will be a 30 minute oral exam on the material presented during the semester. The grade will be based on the exam (45%), your presentation (45%), and a contribution based on your active participation in discussion of other presentations (10%).

551-0737-00L
Experimental Ecology: Evolution and Ecology
W 2 credits 2S S. Bonhoeffer

Abstract
Interaction seminar. Student-mediated presentations, guests and discussions on current themes in ecology, evolutionary and population biology.

Objective
Getting familiar with scientific arguments and discussions. Overview of current research topics. Making contacts with fellow students in other groups.

Content
Scientific talks and discussions on changing subjects.

Lecture notes
None

Literature
None

Prerequisites / notice
For information and details: http://www.eco.ethz.ch/news/zis
or contact: Lehre-eve@env.ethz.ch

551-0509-00L
Current Immunological Research in Zürich
E- 0 credits 1K R. Spörrli, M. Detmar, C. Halin Winter, W.D. Hardt, M. Kopf, A. Lanzavecchia, S. R. Leibundgut, A. Oxenius, University lecturers

Abstract
This monthly meeting is a platform for Zurich-based immunology research groups to present and discuss their ongoing research projects. At each meeting three PhD students or Postdocs from the participating research groups present an ongoing research project in a 30 min seminar followed by a plenary discussion.

Objective
The aim of this monthly meeting is to provide further education for master and doctoral students as well as Postdocs in diverse topics of immunology and to give an insight in the related research. Furthermore, this platform fosters the establishment of science- and technology-based interactions between the participating research groups.

Content
Presentation and discussion of current research projects carried out by various immunology-oriented research groups in Zurich.

Lecture notes
None

Course Catalogue of ETH Zurich

Doctoral Department Biology - Key for Type

<table>
<thead>
<tr>
<th>W</th>
<th>Eligible for credits</th>
<th>O</th>
<th>Compulsory</th>
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<tbody>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
<td>W+</td>
<td>Eligible for credits and recommended</td>
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<td>Dr</td>
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<td>Z</td>
<td>Courses outside the curriculum</td>
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<td>Key for Hours</td>
<td>Description</td>
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<tr>
<td>V</td>
<td>lecture</td>
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<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<td></td>
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<tr>
<td>A</td>
<td>independent project</td>
<td></td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
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**ECTS**
- European Credit Transfer and Accumulation System
- Special students and auditors need special permission from the lecturers.
### Doctoral and Post-Doctoral Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
</table>

**Abstract**
This seminar will feature invited lectures about recent advances and developments in systems biology, including topics from biology, bioengineering, and computational biology.

**Objective**
To provide an overview of current systems biology research.

**Content**
The final list of topics will be available at [http://www.bsse.ethz.ch/education/](http://www.bsse.ethz.ch/education/).

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>636-0309-00L</td>
<td>Advances in Molecular Biotechnology</td>
<td>W</td>
<td>2 credits</td>
<td>2S</td>
<td>M. Fussenegger</td>
</tr>
</tbody>
</table>

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**Doctoral Department of Biosystems Science and Engineering - Key for Type**

<table>
<thead>
<tr>
<th>O</th>
<th>Compulsory</th>
<th>E-</th>
<th>Recommended, not eligible for credits</th>
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<tr>
<td>W+</td>
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<td>Z</td>
<td>Courses outside the curriculum</td>
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<tr>
<td>W</td>
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<td>Dr</td>
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</table>

**Key for Hours**

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<tr>
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<th>lecture</th>
<th>P</th>
<th>practical/laboratory course</th>
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<tr>
<td>G</td>
<td>lecture with exercise</td>
<td>A</td>
<td>independent project</td>
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<tr>
<td>U</td>
<td>exercise</td>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
<td>R</td>
<td>revision course / private study</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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</table>

**ECTS**

- European Credit Transfer and Accumulation System
- Special students and auditors need special permission from the lecturers.

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Doctoral Department of Chemistry and Applied Biosciences


► Doctoral and Post-Doctoral Courses

★★ Doctoral Studies in Inorganic Chemistry

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>529-0169-00L</td>
<td>Instrumental Analysis</td>
<td>E-</td>
<td>0</td>
<td>2S</td>
<td>D. Günther</td>
</tr>
<tr>
<td>Abstract</td>
<td>Group seminar on elemental analysis and isotope ratio determinations using various plasma sources</td>
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<tr>
<td>Content</td>
<td>Developments in plasma mass spectrometry and alternative plasma sources</td>
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<tr>
<td>529-0198-00L</td>
<td>Main Group Element and Coordination Chemistry</td>
<td>E-</td>
<td>0</td>
<td>2S</td>
<td>H. Grützmacher</td>
</tr>
<tr>
<td>529-0199-00L</td>
<td>Inorganic and Organometallic Chemistry</td>
<td>E-</td>
<td>0</td>
<td>2K</td>
<td>C. Copéret, H. Grützmacher, D. Günther, M. Kovalenko, A. Mezzetti, A. Togni</td>
</tr>
</tbody>
</table>

529-0455-00L  Micro- and Nanostructures: Laser Applications in Research and Industry

W  2 credits  2V  T. Lippert

Abstract
Introduction to the fundamentals of lasers and their applications with an emphasis on micro- and nano-structured materials. Several applications are still in the research state, will be discussed together with industrial applications, such as microlithography and laser welding. Other aspects are the materials that are applied in these applications, e.g. photoresists and their functioning.

Objective
Introduction to the fundamentals of lasers and their applications with an emphasis on micro- and nano-structuring. Several applications which are still in the research state, e.g. non-optical lithographies, will be discussed together with industrial applications, such as micro lithography and laser welding. Other aspects are the materials that are applied in these applications, e.g. photoresists and their functioning.

Content
Introduction to lasers, Overview of micro- and nanotechnology, microlithography, photoresists: classical types and new developments, laser cutting and welding, laser cleaning, laser ablation, polymer ablation: designed polymers, lasers and surfaces, laser spectroscopy, laser chemical vapor deposition, pulsed laser deposition (PLD), special materials by PLD, alternative structuring methods.

Lecture notes
The script (a copy of the slides) will be handed out during the first lecture.

Literature
FSRM, CD-ROM: An Introduction to the World of Microsystems, Neuchatel.

★★ Doctoral Studies in Organic Chemistry

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<tr>
<td>529-0280-00L</td>
<td>Analytical Chemistry Seminar</td>
<td>E-</td>
<td>0</td>
<td>1K</td>
<td>R. Zenobi, P. S. Dittrich</td>
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<tr>
<td>Abstract</td>
<td>Analytical Chemistry Seminar</td>
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<tr>
<td>Objective</td>
<td>Presentation and discussion of current research topics in analytical chemistry</td>
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<tr>
<td>Content</td>
<td>Presentation and discussion of current research topics in analytical chemistry</td>
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<tr>
<td>529-0290-00L</td>
<td>Organic Chemistry (Seminar)</td>
<td>E-</td>
<td>0</td>
<td>2S</td>
<td>E. M. Carreira, J. W. Bode, F. Diederich, P. S. Dittrich, D. Hilvert, H. Wennemers, R. Zenobi</td>
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<tr>
<td>529-0299-00L</td>
<td>Organic Chemistry</td>
<td>E-</td>
<td>0</td>
<td>1.5K</td>
<td>J. W. Bode, E. M. Carreira, P. Chen, F. Diederich, P. S. Dittrich, D. Hilvert, H. Wennemers, R. Zenobi</td>
</tr>
<tr>
<td>529-1100-00L</td>
<td>Fragrance Chemistry</td>
<td>W</td>
<td>1</td>
<td>1V</td>
<td>P. Kraft</td>
</tr>
<tr>
<td>Abstract</td>
<td>The lecture provides a journey into the molecular world of scents from the chemical secrets behind Chanel N°5 to structure-odor relationships, industrial processes, and total synthesis of terpenoids. Each subunit is centered on one odorant family and highlights a certain class of chemical reactions, illustrated by prominent perfumery examples.</td>
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<tr>
<td>Objective</td>
<td>After completion of this lecture module the students know all the major perfumery materials of the important odor families with their academic and industrial uses, their olfactory properties, their usage, their historic perspective, and today's economic importance. The students can explain the significance of important building blocks and industrial transformations, and can estimate how attractive chemical processes are on large scale. They can retrosynthetically plan academic and industrial syntheses of fragrant compounds and terpenoids, and the acquired knowledge on structure-odor relationships enables them to predict and design new odorants. The students can approximate the conformational space of odorants and especially macrocycles on the basis of simple rules, and know how olfactophore models are used. The students understand and can explain the molecular mechanism of smell, the biosynthesis of terpenes, and the basics of perfumery composition. The latter enables them to further their education in perfumery at specialized Universities such as the ISIPCA in Versailles; yet, the student also knows about the links of Fragrance Chemistry with Pharmaceutical Chemistry and the Specialty Chemicals business in general.</td>
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★★ Doctoral Studies in Physical Chemistry

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<thead>
<tr>
<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>529-0490-00L</td>
<td>Special Topics in Theoretical Chemistry</td>
<td>E-</td>
<td>0</td>
<td>1S</td>
<td>M. Reither</td>
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<tr>
<td>Abstract</td>
<td>Weekly seminar programme on special topics in theoretical and quantum chemistry. Talks delivered by PhD students and PostDocs as well as by external speakers.</td>
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<tr>
<td>Objective</td>
<td>advanced course for PhD students and postdoctoral fellows</td>
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</tr>
<tr>
<td>Content</td>
<td>current research topics in theoretical chemistry</td>
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<tr>
<td>Lecture notes</td>
<td>none</td>
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</table>
529-0460-00L  Computer Simulation  E-  0 credits  1S  P. H. Hünenberger, S. Riniker

Prerequisites / notice

529-0427-00L  Electron Spectroscopy  W  2 credits  2S  F. Merkt

Abstract  Group seminar on electron spectroscopy, photoelectron spectroscopy, vacuum ultraviolet spectroscopy.

Prerequisites / notice


Abstract  Seminar on theoretical chemistry, molecular spectroscopy and dynamics.

529-0480-00L  Nuclear Magnetic Resonance Seminar  E-  0 credits  3S  B. H. Meier

Abstract  Research seminar on current problems in nuclear magnetic resonance spectroscopy

529-0489-00L  Introduction to the Construction of Measurement Devices in Physical Chemistry  W  2 credits  2P  B. H. Meier

Abstract  Basic concepts of the construction of instrumentation in physical chemistry. Practical exercises in mechanical construction and electronic circuits.

Lecture notes  Unterlagen in der ersten Stunde verteilt.

Prerequisites / notice


Abstract  Institute-Seminar covering current research Topics in Physical Chemistry

529-0491-00L  Seminar in Computational Chemistry C4  E-  0 credits  2S  H. P. Lüthi, P. H. Hünenberger, M. Reiher, S. Riniker

529-0495-00L  Seminar on Special Problems in Physical Chemistry  W  1 credit  3S  M. Quack


Abstract  Research colloquium

529-0481-00L  Advanced High Resolution Molecular Spectroscopy  W  1 credit  1V  S. Albert

Abstract  The course teaches advanced topics in molecular spectroscopy: techniques for analysing rotationally and rovibrationally resolved spectra will be discussed, the basics of FTIR spectroscopy will be reviewed, and the sources which may be used in high resolution infrared spectroscopy will be described. The fields in which high resolution infrared /THz spectroscopy is applied will also be reviewed.

Objective  The students will understand how to use the tools needed to analyze simple highly resolved spectra. They will become familiar with experimental techniques in high resolution molecular spectroscopy and will understand how molecular spectroscopy can be applied to solve problems with respect to atmospheric pollutants and the detection of molecules in interstellar space.

Content  The students will learn how to record rotationally and rovibrationally resolved spectra in the THz and IR frequency range. For that purpose state-of-the-art sources like synchrotrons, FELs and other THz sources will be discussed. In this context, the basics of Fourier transform infrared spectroscopy will also be reviewed. The analysis of such spectra with interactive programs will then be explained. Finally, applications of high resolution molecular spectroscopy in the field of atmospheric and interstellar chemistry will be discussed. The identification and the quantitative determination of atmospheric pollutants will be discussed in detail. In addition, the identification of interstellar molecules in the context of the origin of life will be reviewed. The question of the identification of the interstellar unidentified infrared bands and of the interstellar diffuse bands will also be addressed. Finally, high resolution molecular spectroscopy of chiral molecules in the context of molecular parity violation will be discussed

Literature  Will be given in the lecture

529-0470-00L  Literature Seminar in Theoretical Chemistry  Z  0 credits  2S  M. Reiher

Abstract  In depth study of selected recent papers on theoretical chemistry

Objective  Doktorats- und Mitarbeiterschulung

Content  Variert nach aktuellem Stand der Forschung

Literature  Will be announced on www.reiher.ethz.ch/courses-and-seminars.html

529-0477-00L  Molecular Quantum Dynamics  Z  0 credits  1V  R. Marquardt

Abstract  This lecture covers advanced topics in ultra-fast time resolved molecular spectroscopy and kinetics. Although primarily theoretical, and focused on quantum phenomena, contents include the discussion of certain modern experimental techniques.

Objective  Goals are: acquisition of the basic knowledge in modern, ultra-fast Spectroscopy and chemical kinetics and of some knowledge of theoretical methods currently used to interpret experimental data; exercise the interpretation of computational results related to molecular quantum dynamics on selected examples and discussion of the problems involved.

Content  The lecture is intended to be a brief introduction to essential aspects regarding quantum dynamics, in particular regarding molecular physics and the primary steps of chemical reactions. It proposes also an introduction to the methods and computational algorithms used in the theoretical treatment of molecular quantum dynamics, in particular of short time propagation of wave packets. A practical course in handling computer programs specifically devised for quantum dynamics is offered.

Lecture notes  A program and handouts can be downloaded from the indicated web site or will be delivered in the first session. Handouts are in English.
The course is constituted of a series of seminars on various topics of relevance in chemical engineering, with specific emphasis on those of direct interest in the research area of the group. Speakers are invited from various national and international institutions. The ICB seminar series covers the umbrella of diverse research activities encompassed within the institute, including catalysis, functional materials, polymer engineering, separations, microfluidics, process design, and systems engineering. This series was founded with the aim of promoting cross-disciplinary scientific discourse and interaction with other distinguished groups working worldwide.

A solid knowledge in quantum mechanics is helpful, but not a condition to assist the lecture.

### 529-0485-00L
**Calculating Free Energy Differences from Molar Simulation: Theory and Practical Applications**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0485-00L</td>
<td>Calculating Free Energy Differences from Molar Simulation: Theory and Practical Applications</td>
<td>W</td>
<td>1 credit</td>
<td>1V</td>
<td>N. Hansen</td>
</tr>
<tr>
<td></td>
<td>This is a block course and will be held from January 16th - 20th, 2017, 9 to 12 h</td>
<td></td>
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<tr>
<td></td>
<td>Theoretical analysis as well as issues of practical implementation of state of the art free energy methods.</td>
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<tr>
<td></td>
<td>Recognition of the concepts that underlie the different approaches devised for the determination of free energies</td>
<td></td>
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<tr>
<td></td>
<td>A wide variety of fundamental chemical quantities such as binding or equilibrium constants, solubilities, partition coefficients, and adsorption coefficients are related to the difference in free energy between particular (non)physical states of a system. A maze of computational techniques to calculate free energies is nowadays available that differ in efficiency and accuracy. However, most of them are rooted in a few basic ideas.</td>
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<tr>
<td></td>
<td>In the lecture state of the art methods are discussed in light of these basic ideas.</td>
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<td></td>
<td>Handouts will be provided</td>
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</table>

#### Doctoral Studies in Chemical and Bioengineering

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>This comprises a series of seminars on current topics regarding environmental impact and safety of chemical products and processes. Invited national and international speakers from public and industrial research institutions present their latest developments and applications, and show future trends.</td>
<td></td>
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<tr>
<td></td>
<td>Giving the students the opportunity to experience recent research progress at first hand; encouraging participation in discussions with speaker and audience.</td>
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</tr>
<tr>
<td>529-0072-00L</td>
<td>Chemical Process Technology</td>
<td>W</td>
<td>1 credit</td>
<td>2S</td>
<td>M. Morbidelli</td>
</tr>
<tr>
<td></td>
<td>The course is constituted of a series of seminars on various topics of relevance in chemical engineering, with specific emphasis on those of direct interest in the research area of the group. Speakers are invited from various national and international institutions.</td>
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<td></td>
<td>Expose the students to the most recent advances in the general area of chemical engineering.</td>
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<tr>
<td></td>
<td>The course is constituted of a series of seminars on various topics of relevance in chemical engineering, with specific emphasis on those of direct interest in the research area of the group. Speakers are invited from various national and international institutions.</td>
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<tr>
<td></td>
<td>When available, will be distributed at the end of the single seminar.</td>
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<tr>
<td>529-0690-00L</td>
<td>ICB Seminars on Chemical and Biochemical Engineering</td>
<td>W</td>
<td>1 credit</td>
<td>1V</td>
<td>A. de Mello</td>
</tr>
<tr>
<td></td>
<td>The ICB seminar series covers the umbrella of diverse research activities encompassed within the institute, including catalysis, functional materials, polymer engineering, separations, microfluidics, process design, and systems engineering. This series was founded with the aim of promoting cross-disciplinary scientific discourse and interaction with other distinguished groups working worldwide.</td>
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<tr>
<td></td>
<td>Students are expected to attend all seminars in one academic year, and should register at the beginning of each seminar. Additionally they must deliver a two page written report at the end of the year describing the topics covered, main conclusions, and interrelationships between the different themes.</td>
<td></td>
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<tr>
<td></td>
<td>The ICB seminar series covers the umbrella of diverse research activities encompassed within the institute, including catalysis, functional materials, polymer engineering, separations, microfluidics, process design, and systems engineering. This series was founded with the aim of promoting cross-disciplinary scientific discourse and interaction with other distinguished groups working worldwide, and is targeted at individuals who have made outstanding contributions within their fields. Each year, around 7 distinguished scientists and technologists will be invited to speak on topics of current interest in Chemical and Biochemical Engineering. PhD students are particularly encouraged to attend in order to broaden their perception and enrich their scientific horizons.</td>
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</tr>
<tr>
<td>151-1049-00L</td>
<td>Seminar in Fundamentals of Process Engineering</td>
<td>W</td>
<td>1 credit</td>
<td>1S</td>
<td>P. Rudolf von Rohr</td>
</tr>
<tr>
<td></td>
<td>Only for master and doctoral students of Process and Chemical Engineering.</td>
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<tr>
<td></td>
<td>This seminar covers actual subjects from the specific research areas of the laboratory of transport processes and reactions.</td>
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<tr>
<td></td>
<td>Scientific discussion on actual research topics</td>
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<tr>
<td></td>
<td>The contents are announced through the group’s webpage.</td>
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</table>

#### Doctoral Studies in Polymer Science

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0585-00L</td>
<td>Reactivity in Micelles and Vesicles</td>
<td>W</td>
<td>1 credit</td>
<td>1V</td>
<td>P. J. Walde</td>
</tr>
<tr>
<td></td>
<td>Discussion of different aspects of the chemical reactivity in micelles and in vesicles (liposomes) as polymeric compartments.</td>
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<tr>
<td></td>
<td>Deeper understanding of micelles and vesicles as self-organizing reaction compartments.</td>
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<td></td>
<td>With a few selected recent examples, properties of micelles and vesicles will be discussed with respect to applications as reaction compartments.</td>
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</table>

#### Doctoral Studies in Pharmaceutical Sciences

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>535-2000-00L</td>
<td>Seminar für Mitarbeiter</td>
<td>W</td>
<td>0 credits</td>
<td>2S</td>
<td>G. Schneider</td>
</tr>
</tbody>
</table>
Weekly group seminar, in which members of the research team present and discuss the results of their projects and selected reports from the current scientific literature.

Participants learn to present scientific studies and discuss own results in greater context.

Seminars on Drug Discovery and Development

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>535-0900-00L</td>
<td>Seminars on Drug Discovery and Development</td>
<td>E-</td>
<td>1</td>
<td>1K</td>
<td>J.C. Leroux, K.H. Altmann,</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>S. M. Ametamey, M. Detmar,</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td>B. A. Gandet, C. Halin Winter,</td>
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<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>J. Hall, D. Neri, U. Quitterer,</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>R. Schibli, G. Schneider,</td>
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<td></td>
<td></td>
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<td></td>
<td>H. U. Zeilhofer</td>
</tr>
</tbody>
</table>

State-of-the-art information on drug discovery and development by experts from academia and industry.

State-of-the-art information on drug discovery and development.

Seminars of the Institute of Pharmaceutical Sciences. Experts from academia and industry report on relevant topics.

Lectures and Optional subjects in MSc Pharmaceutical Sciences

Additional Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0195-00L</td>
<td>Scientific Information Retrieval &amp; Management in Life</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>O. Renn</td>
</tr>
<tr>
<td></td>
<td>Sciences and Chemistry</td>
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</tr>
</tbody>
</table>

Students will learn how to effectively retrieve, critically judge, analyze and manage published scientific information - important skill sets in chemistry and life sciences where scientists need to deal with vast amounts of information. The course, being based on practical examples, also covers scientific writing & communication and state-of-the-art technologies for analysis such as text mining.

Ability to select appropriate, subject-specific databases or tools for a given specific scientific question based on a sound understanding on how a tool or database has been developed and maintained, thus building the personal capacity of doing research effectively and efficiently by integrating scientific information into the research process when needed. Ability to communicate own scientific results using additional distribution channels. Ability to easily write-up the Ph.D. thesis or first paper.

The course has been primarily designed for Ph.D. students, also for the Life Science Zurich Graduate School, but is also open to Master students. In a series of 13 lectures, which always include practical examples (for some lectures an own notebook is required), the use of scientific information is taught not in a database-centric view but corresponding to the steps through which scientific research is conducted - including the dissemination of scientific results. This is particularly interesting for students who are about to write-up their first paper or thesis.

Students will learn about the different types of information resources and tools, get an insight into the numerous databases and tools that exists and how those are built and maintained, enabling them to critically judge the value and trustworthy of a information resource. Additionally, they will learn how to communicate their own scientific results properly, using also additional measures that are reflected by alternative metrics.

The following topics are covered:
1. The World of Scientific Publishing
2. Searching and Retrieving Scientific Information Using Search Engines and Using Literature Databases
3. Searching and Retrieving Scientific Information Using Subject-specific Databases in Chemistry
4. Searching and Retrieving Scientific Information Using Subject-Specific Databases in Life Sciences
5. Tools for Managing the Retrieved Scientific Information
7. Patents
8. Text(Literature) and Data Mining
9. Communicating & Analyzing the Impact of (Your) Science
10. Scientific Writing & Good Scientific Practice

The slide deck and supplementary materials will be made available in the teaching document repository (ILIAS) after each lecture. Additional literature and reference are provided in the course material.

Course Catalogue of ETH Zurich

Frontiers in Energy Research

This course is only for doctoral students.

PhD students at ETH Zurich working in the broad area of energy present their research to their colleagues, to their advisors and to the scientific community.

Knowledge of advanced research in the area of energy.

PhD students at ETH Zurich working in the broad area of energy present their research to their colleagues, to their advisors and to the scientific community. Every week there are two presentations, each structured as follows: 15 min introduction to the research topic, ability to select appropriate, subject-specific databases or tools for a given specific scientific question based on a sound understanding on how a tool or database has been developed and maintained, thus building the personal capacity of doing research effectively and efficiently by integrating scientific information into the research process when needed. Ability to communicate own scientific results using additional distribution channels. Ability to easily write-up the Ph.D. thesis or first paper.

Students will learn about the different types of information resources and tools, get an insight into the numerous databases and tools that exists and how those are built and maintained, enabling them to critically judge the value and trustworthy of a information resource. Additionally, they will learn how to communicate their own scientific results properly, using also additional measures that are reflected by alternative metrics.

The following topics are covered:
1. The World of Scientific Publishing
2. Searching and Retrieving Scientific Information Using Search Engines and Using Literature Databases
3. Searching and Retrieving Scientific Information Using Subject-specific Databases in Chemistry
4. Searching and Retrieving Scientific Information Using Subject-Specific Databases in Life Sciences
5. Tools for Managing the Retrieved Scientific Information
7. Patents
8. Text(Literature) and Data Mining
9. Communicating & Analyzing the Impact of (Your) Science
10. Scientific Writing & Good Scientific Practice

The slide deck and supplementary materials will be made available in the teaching document repository (ILIAS) after each lecture. Additional literature and reference are provided in the course material.

Doctoral Department of Chemistry and Applied Biosciences - Key for Type

W+ Eligible for credits and recommended
W  Eligible for credits
E-  Recommended, not eligible for credits

Z Courses outside the curriculum
Dr Suitable for doctorate
O Compulsory

Key for Hours

V lecture
G lecture with exercise
U exercise
S seminar
K colloquium

P practical/laboratory course
A independent project
D diploma thesis
R revision course / private study

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Doctoral Department of Earth Sciences


Doctoral and Post-Doctoral Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>651-0254-00L</td>
<td>Seminar Geochemistry and Petrology</td>
<td>E-</td>
<td>0 credits</td>
<td>2S</td>
<td>O. Bachmann, M. Schönbachler, C. A. Heinrich, M. W. Schmidt, D. Vance</td>
</tr>
</tbody>
</table>

**Abstract**
Seminar series with external and occasional internal speakers addressing current research topics. Changing programs announced via D-ERDW homepage (Veranstaltungskalender)

**Objective**
Presentations on isotope geochemistry, cosmochemistry, fluid processes, economic geology, petrology, mineralogy and experimental studies. Mostly international speakers provide students, department members and interested guests with insight into current research topics in these fields.

**Content**
Wöchentliches Seminar mit Fachvorträgen eingeladener oder interner Wissenschafter, vornehmlich zu Themen der Geochemie, Isotopengeochemie, Hydrothermalgeochemie, Lagerstättenbildung, Petrologie, Mineralogie und experimentelle Studien.

---

1 credit

**E-**

**Course Catalogue of ETH Zurich**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>651-1617-00L</td>
<td>Geophysical Fluid Dynamics and Numerical Modelling</td>
<td>E-</td>
<td>0 credits</td>
<td>1S</td>
<td>P. Tackley, M. D. Ballmer, T. Gerya, D. A. May</td>
</tr>
</tbody>
</table>

**Abstract**
Seminar series with external and occasional internal speakers addressing current research topics in Petrology. Changing programs announced via D-ERDW homepage (Veranstaltungskalender)

**Objective**

**Content**
Seminar series addressing current research topics in Petrology (Magmatic Petrology and Crystalline Geology and Experimental Petrology)

---

1 credit

**W**

**Course Catalogue of ETH Zurich**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>651-4931-00L</td>
<td>Heat and Mass Transfers in Magmatology</td>
<td>W</td>
<td>1 credit</td>
<td>1S</td>
<td>O. Bachmann, J. Leuthold</td>
</tr>
</tbody>
</table>

**Abstract**
Heat and mass transfers in the crust control many aspects of the differentiation of our planet, including (1) type of volcanic eruptions we should expect at the surface of our planet, (2) the volcanic/plutonic ratio in the crust, and (3) how volcanic degassing occurs, with important consequences on the climate response following volcanic eruptions.

**Objective**
The goal of this class is to learn about the modern methods and ideas on heat and mass transfers in magmatology through recently published papers and computer softwares. The class will allow students to explore some of the most challenging concepts in this field, and become familiar with state-of-the-art techniques to model these processes.

**Content**
The class will focus mostly on reading recent literature on topics of interests, and will contain some computer exercises to allow students to work by themselves on some well-defined problems.

---

1 credit

**W Dr**

**Course Catalogue of ETH Zurich**

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>651-4123-00L</td>
<td>Earthquake Physics and Numerical Modelling Paper Discussions</td>
<td>W Dr</td>
<td>1 credit</td>
<td>1S</td>
<td>D. A. May</td>
</tr>
</tbody>
</table>

**Abstract**
Biweekly paper discussion series on current challenges and state-of-the-art practices in earthquake physics and seismic cycle and geodynamic modeling.

**Objective**
To understand and evaluate current challenges and state-of-the-art practices in earthquake physics and seismic cycle and geodynamic modeling. Besides obtaining an overview of this field, participants can expect to improve their skills to:
- critically analyze (to be) published papers
- disseminate knowledge within their own and neighboring research fields
- formulate their opinion, new ideas and broader implications
- present their findings to an audience
- ask questions and actively participate in discussions on new scientific ideas
- understand what it takes to get their own research work published

**Content**
Exact topics will depend on the research interests and projects of the participants, but are likely to include:
- earthquake physics from an observational, theoretical and modeling perspective
- seismic cycle aspects and governing physical processes, including interseismic, coseismic, and postseismic phenomena
- constitutive relations for friction and continuum materials based on laboratory measurements
- numerical modeling methods for short- and long-term deformation and wave propagation
- inverse and data assimilation methods and applications applied to individual and recurring sources

**Prerequisites / notice**
This course will not be given Fall 2016. Instead I refer to a potential option Spring 2016 or Earthquake Source Physics given Fall 2017.

PhD or advanced MSc students are expected to present one paper relating to their research interests and read papers discussed by the other students. The grading is based on participation in discussions and the given oral presentations.

Doctoral Department of Earth Sciences - Key for Type

<table>
<thead>
<tr>
<th>W+</th>
<th>Eligible for credits and recommended</th>
<th>Z</th>
<th>Courses outside the curriculum</th>
</tr>
</thead>
<tbody>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
<td>O</td>
<td>Compulsory</td>
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</table>

**Key for Hours**

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
<th>P</th>
<th>practical/laboratory course</th>
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<tbody>
<tr>
<td>G</td>
<td>lecture with exercise</td>
<td>A</td>
<td>independent project</td>
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<tr>
<td>U</td>
<td>exercise</td>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
<td>R</td>
<td>revision course / private study</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
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</table>

**ECTS**
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.

Data: 06.03.2019 12:57 Autumn Semester 2016 Page 422 of 1571
## Doctoral and Post-Doctoral Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0125-03L</td>
<td>Research Colloquium for Ph.D.-Students and Members of Staff</td>
<td>E-</td>
<td>0</td>
<td>1K</td>
<td>L. Wingert</td>
</tr>
<tr>
<td></td>
<td>Open for Master students on personal invitation. Personal registration</td>
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<td></td>
<td>required to Mr. Wingert.</td>
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<tr>
<td>Abstract</td>
<td>Ph.D. students and members of staff report on their research.</td>
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<tr>
<td>Objective</td>
<td>Key problems of research projects will be discussed. Participants will</td>
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<tr>
<td></td>
<td>learn to know arguments and ideas dealing with systematic problems</td>
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<tr>
<td></td>
<td>in philosophy.</td>
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<tr>
<td>851-0551-00L</td>
<td>Colloquium for Master and Ph.D. Students</td>
<td>W</td>
<td>2</td>
<td>1K</td>
<td>G. Hürlimann</td>
</tr>
<tr>
<td>Abstract</td>
<td>Colloquium for master and doctoral students preparing a thesis in the</td>
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<tr>
<td></td>
<td>history of technology.</td>
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<tr>
<td>Objective</td>
<td>Goals: to identify, discuss, and resolve methodological problems that</td>
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<td>Gisela Hürlimann (<a href="mailto:gisela.huerlimann@history.gess.ethz.ch">gisela.huerlimann@history.gess.ethz.ch</a>).</td>
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<td>851-0587-00L</td>
<td>CIS Colloquium</td>
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<td>L.E. Cederman, M. Steenbergen</td>
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<td>Abstract</td>
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<td>Comparative and International Studies, CIS.</td>
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<td>Research Colloquium Science Studies</td>
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<td>P. Holtrup Mostert</td>
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<td>WebClass Introductory Course History of Technology</td>
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<td>G. Hürlimann</td>
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<td>Number of participants limited to 100.</td>
<td>Particularly suitable for students of D-BAUG, D-INFK, D-ITET, D-MATL, D-MAVT.</td>
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<td>851-0626-02L</td>
<td>PhD Colloquium in Development Economics</td>
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<td>I. Günther</td>
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<tr>
<td>Abstract</td>
<td>PhD students interested in empirical development economics will</td>
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<td>present their ongoing work, with a particular focus on the methods</td>
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<td>to be used and challenges faced. Participants are expected to read</td>
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<td>the drafts/papers/presentations beforehand and give constructive</td>
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<td>feedback to the PhD student presenting.</td>
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<td>Objective</td>
<td>PhD students learn how to present and discuss their own research</td>
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<td>questions, methods, results and problems. PhD students get familiar</td>
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<td>with the challenges of empirical research in developing countries.</td>
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<td>Prerequisites/notice</td>
<td>The colloquium will take place about 8 times per semester. The schedule will be arranged together with the PhD students at the beginning of the semester.</td>
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<td>851-0735-10L</td>
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Participants should learn to get an overview of the state of the art in the field, to present it in a well understandable way to an audience. Furthermore, participants will make acquaintance with founding texts of the natural rights property concept (John Locke). They will see the connection between inalienable self-ownership, prohibition of slavery, derivative commercial rights and modern personal rights. They will learn about the problems of self-ownership today concerning property in one's body and intellectual property. Critical alternatives to the property paradigm will be discussed.

The workshop and lecture series will present a mix of speakers who represent the wide range of current social science research methods applied to intellectual property, innovation, antitrust policy and technology policy issues. In particular, theoretical models, empirical and experimental research as well as legal research methods will be represented.

Papers discussed in the workshop and lecture series are posted in advance on the course web page.

This course starts with a discussion of the typical and often counter-intuitive features of complex dynamical systems such as self-organization, emergence, (sudden) phase transitions at “tipping points”, multi-stability, systemic instability, deterministic chaos, and turbulence. It then discusses phenomena in networked systems such as feedback, side and cascade effects, and the problem of radical uncertainty. The course progresses by demonstrating the relevance of these properties for understanding societal and, at times, global-critical questions. In essence, participants should improve their scientific skills and learn to think scientifically about complex dynamical systems.

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

Prerequisites: solid mathematical skills

This course discusses complex techno-socio-economic systems, their counter-intuitive behaviors, and how their theoretical understanding empowers us to solve some long-standing problems that are currently bothering the world.

Participants should learn to get an overview of the state of the art in the field, to present it in a well understandable way to an interdisciplinary scientific audience, to develop models for open problems, to analyze them, and to defend their results in response to critical questions. In essence, participants should improve their scientific skills and learn to think scientifically about complex dynamical systems.

The course starts with a discussion of the typical and often counter-intuitive features of complex dynamical systems such as self-organization, emergence, (sudden) phase transitions at “tipping points”, multi-stability, systemic instability, deterministic chaos, and turbulence. It then discusses phenomena in networked systems such as feedback, side and cascade effects, and the problem of radical uncertainty. The course progresses by demonstrating the relevance of these properties for understanding societal and, at times, global-scale problems such as traffic jams, crowd disasters, breakdowns of cooperation, crime, conflict, social unrests, political revolutions, bubbles and crashes in financial markets, epidemic spreading, and/or “tragedies of the commons” such as environmental exploitation, overfishing, or climate change. Based on this understanding, the course points to possible ways of mitigating techno-socio-economic-environmental problems, and what data science may contribute to their solution.

Mathematical skills can be helpful

Participants are exemplarily introduced to different research methods used in research on learning and instruction and learn to weigh advantages and disadvantages of these approaches.
851-0738-00L  Intellectual Property: Introduction

**Abstract**
The course provides an introduction to Swiss and European intellectual property law (trademarks, copyright, patent and design rights). Aspects of competition law are treated insofar as they are relevant for the protection of intellectual creations and source designations. The legal principles are developed based on current cases.

**Objective**
The aim of this course is to enable students at ETH Zurich to recognize which rights may protect their creations, and which rights may be infringed as a result of their activities. Students should learn to assess the risks and opportunities of intellectual property rights in the development and marketing of new products. To put them in this position, they need to know the prerequisites and scope of protection afforded by the various intellectual property rights as well as the practical difficulties involved in the enforcement of intellectual property rights. This knowledge is imparted based on current rulings and cases.

Another goal is to enable the students to participate in the current debate over the goals and desirability of protecting intellectual creations, particularly in the areas of copyright (keywords: fair use, Creative Commons, Copyleft) and patent law (software patents, patent trolls, patent thickets).

**851-0738-01L  The Role of Intellectual Property in Daily Routine: A Practical Introduction**

**Abstract**
The lecture gives an overview of the fundamental aspects of intellectual property, which plays an important role in the daily routine of engineers. The lecture aims to make participants aware of the various methods of protection and to put them in a position to use this knowledge in the workplace.

**Objective**
In recent years, knowledge about intellectual property has become increasingly important for engineers. Both in production and distribution and in research and development, engineers are increasingly being confronted with questions concerning the patenting of technical inventions and the use of patent information.

The lecture will acquaint students with practical aspects of intellectual property and enable them to use the acquired knowledge in their future professional life.

Topics covered during the lecture will include:
- The importance of innovation in industrialised countries
- An overview of the different forms of intellectual property
- The protection of technical inventions and how to safeguard their commercialisation
- Patents as a source of technical and business information
- Practical aspects of intellectual property in day-to-day research, at the workplace and for the formation of start-ups.

Case studies will illustrate and deepen the topics addressed during the lecture.

**Prerequisites / notice**
The seminar will comprise practical exercises on how to use and search patent information. Basic knowledge of how to read and evaluate patent documents as well as how to use publicly available patent databases to obtain the required patent information will also be provided.

For students of chemistry-related degree programs, the lecture 'Protecting inventions in chemistry' (851-0738-03) will be offered in the autumn semester.

851-0157-00L  Mind and Brain

**Abstract**
In the last 2500 years, the mind-brain relationship has been articulated in various ways. In these lectures, I will explore the scientific and philosophical aspects of this relationship in the context of relevant cultural, historical and technological processes, with a focus on the modern neurosciences, but I will also discuss works of art and literature.

**Objective**
By the end of this lecture, students should be familiar with essential positions in the scientific and philosophical treatment of questions relating the mind to the brain. It should also become clear that some of the most relevant problems in current neurosciences have a long history.

**Content**
According to a myth, the ancient Greek philosopher Democrit dissected animals, because he was in search of the seat of the soul. Current neuroscientists use neuroimaging techniques like functional magnetic-resonance-tomography in order to localize cognitive and emotional qualities in the brain. Between these two dates lies a history of 2500 years, in which the relationship between the mind and the brain has been debated in various ways. Starting with ancient and medieval theories, the lecture will focus on modern theories from the nineteenth century onward. I will discuss essential issues in the history of the neurosciences such as localization theories, the neuron doctrine, reflex theory, theories of emotions, neurocybernetics and the importance of visualizing the brain and its parts, but I will also include works of art and literature.

851-0125-41L  Introduction Into Philosophy of Technology

**Abstract**
Since antiquity philosophy reflects about and evaluates technology. The technical developments in the 19th and 20th century have led to an autonomous philosophy of technology, which had become important also for other philosophical disciplines (e.g. in Heidegger's philosophy).

The course gives an overview on the main schools in the philosophy of technology. Students should learn to analyse and evaluate different philosophies of technology (compensation, objectification, externalisation). For credit point a critical protokoll is to be written.

851-0252-04L  Behavioral Studies Colloquium

**Abstract**
This colloquium offers an opportunity for students to discuss their ongoing research and scientific ideas in the behavioral sciences, both at the micro- and macro-levels of cognitive, behavioral and social science. It also offers an opportunity for students from other disciplines to discuss their research ideas in relation to behavioral science. The colloquium also features invited research talks.

**Objective**
Students know and can apply autonomously up-to-date investigation methods and techniques in the behavioral sciences. They achieve the ability to develop their own ideas in the field and to communicate their ideas in oral presentations and in written papers. The credits will be obtained by a written report of approximately 10 pages.
851-0252-01L Human-Computer Interaction: Cognition and Usability

Number of participants limited to 30.

3 credits 2S  I. Barisic, C. Hölscher, S. Oganjancic

Abstract

This seminar introduces theory and methods in human-computer interaction and usability. Cognitive Science provides a theoretical framework for designing user interfaces as well as a range of methods for assessing user testing, cognitive walkthrough, GOMS. The seminar will provide an opportunity to experience some of the methods in applied group projects.

Objective

This seminar will introduce key topics, theories and methodology in human-computer interaction (HCI) and usability. Presentations will cover basics of human-computer interaction and selected topics like mobile interaction, adaptive systems, human error and attention. A focus of the seminar will be on getting to know evaluation techniques in HCI. Students form work groups that first familiarize themselves with a select usability evaluation method (e.g. user testing, GOMS, task analysis, heuristic evaluation, questionnaires or Cognitive Walkthrough). They will then apply the methods to a human-computer interaction setting (e.g. an existing software or hardware interface) and present the method as well as their procedure and results to the plenary. Active participation is vital for the success of the seminar, and students are expected to contribute to presentations of foundational themes, methods and results of their chosen group project. In order to obtain course credit a written essay / report will be required (details to be specified in the introductory session of the course).

851-0252-02L Introduction to Cognitive Science

Number of participants limited to 70.

3 credits 2V  V. Schinazi, L. Konieczny, T. Thrash

Abstract

The lectures provide an overview of the foundations of cognitive science and investigate processes of human cognition, especially with respect to knowledge acquisition, knowledge representation and usage in information processing tasks.

Objective

Cognitive Science views human cognition as information processing and provides an inter-disciplinary integration of approaches from cognitive psychology, informatics (e.g., artificial intelligence), neuroscience and anthropology among others. The lectures provide an overview of basic mechanisms of human information processing and various application domains. A focus will be on matters of knowledge acquisition, representation and usage in humans and machines. Models of human perception, reasoning, memory and learning are presented and students will learn about experimental methods of investigating and understanding human cognitive processes and representation structures.

851-0252-03L Cognition in Architecture - Designing Orientation and Navigation for Building Users

Number of participants limited to 40.

3 credits 2S  V. Schinazi, B. Emo Nax, C. Hölscher

Abstract

How can behavioral and cognitive science inform architecture? This project-oriented seminar investigates contributions of cognitive science to architectural design with an emphasis on orientation and navigation in complex buildings and urban settings. It includes theories on spatial memory and decision-making as well as hands-on observations of behavior in real and virtual reality.

Objective

Taking the perspectives of building users (occupants and visitors) is vital for a human-centered design approach. Students will learn about relevant theory and methods in cognitive science and environmental psychology that can be used to understand human behavior in built environments. The foundations of environmental psychology and human spatial cognition will be introduced. A focus of the seminar will be on how people perceive their surroundings, how they orient in a building, how they memorize the environment and how they find their way from A to B. Students will also learn about a range of methods including real-world observation, virtual reality experiments, eye-tracking and behavior simulation for design. Students will reflect on the roles of designers and other stakeholders with respect to human-centered design and an evidence-based design perspective. The seminar is geared towards a mix of students from architecture / planning, engineering, computer science and behavioral science as well as anybody interested in the relation between design and cognition.

Architecture students can obtain course credit in "Vertiefungsfach" or "Wahlfach" on any other term paper.

851-0585-04L Lecture with Computer Exercises: Modelling and Simulating Social Systems with MATLAB

Number of participants limited to 70.

3 credits 2S  D. Helbing, L. Sanders, O. Woolley

Abstract

This course introduces first the basic functionalities and features of the mathematical software package MATLAB, such as the simple operations with matrices and vectors, differential equations, statistical tools, the graphical representation of data in various forms, and video animations of spatio-temporal data. With this knowledge, students are expected to implement themselves in MATLAB, models of various social processes and systems, including agent-based models, e.g. models of interactive decision making, group dynamics, human crowds, or game-theoretical models.

Content

Part of this course will consist of supervised programming exercises in a computer pool. Credit points are finally earned for the implementation of a mathematical model from the sociological literature in MATLAB and the documentation in a seminar thesis.

Prerequisites / notice

The number of participants is limited to the size of the available computer teaching room. The MATLAB code related to the seminar thesis should be well enough documented for further use by others and must be handed over to the Chair of Sociology, in particular of Modeling and Simulation, for further free and unrestricted use.

Advanced Colloquium in Literary Studies

Colloquium is designed for advanced and graduated students.
Abstract
The colloquium addresses advanced and graduate students. First, it offers participants the opportunity to present their own research projects (work in progress); and, second, it provides a most fruitful space to discuss methodological, theoretical and systematic complex issues.

Objective
The colloquium addresses advanced and graduate students. First, it offers participants the opportunity to present their own research projects (work in progress); and, second, it provides a most fruitful space to discuss methodological, theoretical and systematic complex issues.

851-0252-05L
Research Colloquium Cognitive Science
Prerequisite: Participants should be involved in research in the cognitive science group.

Abstract
The colloquium provides a forum for researchers and graduate students in cognitive science to present/discuss their ongoing projects as well as jointly discuss current publications in cognitive science and related fields. A subset of the sessions will include invited external visitors presenting their research. Participants of this colloquium are expected to be involved in active research group.

Objective
Graduate student train and improve their presentation skills based on their own project ideas, all participants stay informed on current trends in the field and have the opportunity for networking with invited scholars.

851-0738-03L
Protecting Inventions in Chemistry
Particularly suitable for students of D-CHAB

Abstract
The lecture gives students of chemistry-related degree programs an overview of the options to protect inventions and the underlying research efforts. The lecture aims to put the participants in a position to use this know-how in the workplace.

Objective
Investments and development play an important role in chemistry-related technology sectors such as inorganic and organic chemistry or pharmacy.

Prerequisites / notice

Case studies will illustrate and deepen the topics addressed during the lecture.

The seminar will comprise practical exercises on how to use and search patent information. Basic knowledge of how to read and evaluate patent documents as well as how to use publicly available patent databases to obtain the required patent information will also be provided.

The lecture is coordinated in particular to the needs of the following degree programs: Agricultural science, biotechnology, chemical engineering, pharmacy, food science, pharmaceutical sciences.

For engineering and physics students, the lecture ‘The Role of Intellectual Property in daily routine: A Practical Introduction’ (851-0738-01) will be offered in the autumn semester.

851-0585-41L
Computational Social Science

Abstract
The seminar aims at three-fold integration: (1) bringing modeling and computer simulation of techno-socio-economic processes and phenomena together with related empirical, experimental, and data-driven work, (2) combining perspectives of different scientific disciplines (e.g. sociology, computer science, physics, complexity science, engineering), (3) bridging between fundamental and applied work. Participants of the seminar should understand how tightly connected systems lead to networked risks, and why this can imply systems we do not understand and cannot control well, thereby causing systemic risks and extreme events.

Objective
They should also be able to explain how systemic instabilities can be understood by changing the perspective from a component-oriented to an interaction- and network-oriented view, and what fundamental implications this has for the proper design and management of complex dynamical systems.

Computational Social Science and Global Systems Science serve to better understand the emerging digital society with its close co-evolution of information and communication technology (ICT) and society. They make current theories of crises and disasters applicable to the solution of global-scale problems, taking a data-based approach that builds on a serious collaboration between the natural, engineering, and social sciences, i.e. an interdisciplinary integration of knowledge.

851-0252-07L
Recent Debates in Social Networks Research

Abstract
Social Networks research is a highly interdisciplinary fields. For example, scholars in Sociology, Psychology, Political Sciences, Computer Science, Physics, Mathematics and Statistics contribute to the development of theories and methods. This course aims at understanding, comparing and structuring recent debates in the field of Social Networks.

Objective
Social Networks research is a highly interdisciplinary fields. At the end of this seminar, students will understand and be able to compare different subject-specific approaches to social networks research (e.g., from Sociology, Psychology, Political Sciences, Computer Science, Physics, Mathematics and Statistics). They will be familiar with recent publications in the field of Social Networks and be able to critically participate in a number of recent debates. Amongst others, these debates touch upon the co-evolution of selection and influence mechanisms, appropriateness of statistical models, generic mechanisms and features of social networks, models for the analysis of dynamic networks.

364-1062-00L
Experimental Methods

This course is complemented by a course on z-Tree
To gain an overview of the history of the transition of large technical systems and conceptions of fundamental epistemological concepts.

Objective
This course aims to prepare PhD students for conducting their own experiment.

Content
1. Introduction: What are economic experiments and why to use them?
4. Conducting experiments: Instructions, testing, recruiting, sessions.
5. Measuring techniques: Eliciting beliefs, risk attitudes, social preferences.

Literature
Books:

Basic Articles:

A reading list with articles for each lecture has been published in Moodle.

Prerequisites / notice
This course is complemented by a course on programming experiments with z-tree. It is not mandatory but recommended to take both courses.

851-0125-60L Introduction to Epistemology

Objective
- conceptions of fundamental epistemological concepts
- sensitivity to epistemological questions
- capacity to reflect epistemological theories
- capacity to discuss epistemological theories
- reading philosophical texts (including English texts)

851-0609-06L Governing the Energy Transition

Objective
- To gain an overview of the history of the transition of large technical systems
- To recognize current challenges in the energy system to understand the theoretical frameworks and concepts for studying transitions
- To demonstrate knowledge on the role of policy and politics in energy transitions

Content
Climate change, access to energy and other societal challenges are directly linked to the way we use and create energy. Both the recent United Nations Paris climate change agreement and the UN Sustainable Development Goals make a fast and extensive transition of the energy system necessary.

This course introduces the social and environmental challenges involved in the energy sector and discusses the implications of these challenges for the rate and direction of technical change in the energy sector. It compares the current situation with historical socio-technical transitions and derives the consequences for policy-making. It then introduces theoretical frameworks and concepts for studying innovation and transitions. It then focuses on the role of policy and policy change in governing the energy transition, considering the role of political actors, institutions and policy feedback.

The course has a highly interactive (seminar-like) character. Students are expected to actively engage in the weekly discussions and to give a presentation (15-20 minutes) on one of the weekly topics during that particular session. The presentation (30%) and participation in the discussions (20%) will form one part of the final grade, the remaining 50% of the final grade will be formed by a final exam.

Lecture notes
Slides and reading material will be made available via moodle.ethz.ch (only for registered students).

851-0253-03L The Sense of Time and its Effects on Motivation, Cognition, and Emotion

Objective
To learn and understand how our sense of time influences our motivation, cognition, and emotion and to learn that our sense of time is malleable and can be influenced for the better. The course involves participating actively and regularly, reading articles, giving an oral presentation (in groups or individually), and writing a short paper.

851-0148-04L Cyclical time

Objective
Understanding the various forms and functions of repetition on the basis of texts by Plato (anamnesis), Freud (repetition compulsion), Kierkegaard (narration), Nietzsche (eternal return as cosmological and ethical principle), Deleuze (time synthesis and repetition of the future), Poincaré's theorem of recurrence.

851-0301-04L Photography and Literature. Exchanging Practices and Poetics

Objective
Students know a wide variety of literary text (and their authors) that are related in content or form to the practice of photography. Students know how to relate texts to key critical theories as well as to the historical and social context.
In the second half of the 20th century, postal services have dramatically changed. Communication today is computer-based. The lecture

Beginnings

Philosophy of Time

Does not take place this semester.

Philosophical Aspects of Quantum Physics

Particularly suitable for students of D-CHAB, D-PHYS

Abstract

This course provides an introduction to philosophical issues surrounding quantum physics. In particular, we will examine different
interpretations of quantum mechanics (such as the many-world interpretation) and the transition between the quantum and the classical
physical realm (here phenomena such as decoherence will be highlighted).

Objective

By the end of the course students are able to describe and compare different interpretations of quantum mechanics. They are able to
identify and examine issues concerning these different interpretations and issues concerning the transition between quantum and classical
descriptions in physics. Students are in a position to critically discuss and evaluate the repercussions of these issues in broader scientific
contexts.

Philosophy of Time

Does not take place this semester.

Philosophical Aspects of Quantum Physics

Particularly suitable for students of D-CHAB, D-PHYS

Abstract

This course provides an introduction to philosophical issues surrounding the concept of time. We will treat topics such as: the existence of
past, present, and future; the possibility of time travel; the constitution of time consciousness and its possible neurophysiological
counterparts; temporal biases in the conduct of our lives; responsibility to future and past generations.

Objective

By the end of the course students are able to describe and compare different theories and concepts of time (physical time, perceptual time,
historical time ...). They are able to identify and examine issues concerning time as they occur in various philosophical subdisciplines -
especially in philosophy of science, philosophy of mind, metaphysics, and ethics. Students are in a position to critically discuss and
evaluate the repercussions of these issues in broader scientific and social contexts.

Part of the course reflects on methods and contents from physics, neuroscience/cognitive science, and logic.
"Bollywood and Beyond" - A Cultural History of Indian W 3 credits 2V H. Fischer-Tiné Cinema in the 20th Century

Abstract
The Indian film industry has been around for 100 years and is one of the richest and most varied in the world. The lecture reconstructs the cultural development of Indian cinema and uses it as a lens through which cultural, social, and political change in the subcontinent can be explored.

Objective
The objective of this course is three-fold. For one, the participants shall learn to question aesthetic canons and receive modes of perception of cinematographic art. Secondly they will be acquainted with the historical potential of films as a source to grasp processes of social and cultural change. Besides, the reconstruction of the international career of a specific variety of art and entertainment will also raise important questions of cultural globalisation and consumerism. As a side-effect, a sit was, the students will also be provided with important insights into the chequered history of the Indian subcontinent in during the course of the 20th century.

Literature

Prerequisites / notice
A detailed course description and session plan will be available from 15 Sept 2013 onwards at http://www.gmw.ethz.ch/education

Collections in Context: What Do Historians and Scientists Learn from Butterflies, Stones, and Bones? W 3 credits 2S B. Schär, M. Greeff

Abstract
Zurich holds huge scientific collections. They contain objects from around the world, some of them dating back to the 18th century. This interdisciplinary seminar combines perspectives from the history of science and from current scientific disciplines. What do these objects tell us about Zurich's place in the global history of science? What potentials do old collections hold for historians today?

Objective
- The aim of this seminar is threefold: Firstly, students will become familiarised with historiographical approaches to scientific collections. Among them are constructivist approaches that seek to understand scientific knowledges not primarily as a system of objective truths, but rather as an outcome of human 'constructions'. Other approaches deal with the problem of how scientific objects are related to systems of power and oppression, namely in the case of objects collected during the time of European colonialism overseas. Secondly, students will become familiarised with how old collections can yield new insights for current scientists working, e.g., on questions of ecology. Thirdly, the seminar shall serve as a platform to discuss ways of dialogue and possible collaboration between these different approaches.
- Students will be expected to read theoretical texts and case studies during the semester, participate in discussions with external experts (historians, curators, and scientists), and to write a summarizing essay at the end of the term.


Abstract
Bruno Latour (‘1947) is one of the most important contemporary sociologist of science. He enriched our understanding of what a scientific fact is and how we get to it, i.e. how it is made up, not only discovered. Latour defends a constructivist approach with realist elements. What that exactly means, will be clarified in this course.

Objective
- Introduction into the sociology of science of Bruno Latour, esp. the Agent/Network/Theory.
- Understanding main topics of sociology and philosophy of science.

Frontiers in Energy Research W 2 credits 2S M. Mazzotti, R. S. Abhari, J. Carmeliet, M. Filippini

Abstract
PhD students at ETH Zurich working in the broad area of energy present their research to their colleagues, to their advisors and to the scientific community. Each week there are two presentations, each structured as follows: 15 min introduction to the research topic, 15 min presentation of the results, 15 min discussion with the audience.

Creativity W 3 credits 2S M. Wulz, V. Wolff

Abstract
Being creative may appear to be the most important requirement of the present age: creative thinking, start-ups, project development all seem to promise an ongoing innovation of work and life. Instead of repeating that promise once again, this course asks for the historical conditions of discourses of creativity.

Objective
- We will deal with historical and contemporary theories of inventive imagination, fantasy, and creativity. Looking at artistic, psychological, pedagogical, economic, and entrepreneurial discourses of creativity from the 18th to the 21st century we will discuss their specific contexts in order to uncover historical differences and changes. Is it indeed possible to identify conjunctions between the economicalization, scientification and normalization of creativity? Are there any alternatives to the reigning paradigm of creativity? And if so, what are those?

Publish or Perish, 1800-2016: On the History of Scientific Publishing W 3 credits 2S N. Guettler, M. Studler

Abstract
This seminar deals with the past, present, and imaginary futures of scientific publishing. We shall discuss the origins and trajectories of specific formats, conventions, and genres as well as examine exemplary historical developments as regards scientific publishing and associated cultures of science.

Objective
- The technological upheavals wrought by the "digital age" have put the subject of scientific publishing on the map (again). Open access, copyright, or print-on-demand are just a few of the buzzwords that have defined controversies in recent years. The aim of this seminar is to assist students in developing critical perspectives on these contemporary debates - by learning about the history of scientific publishing, including the role of specific publishers and journals, the footnote, or the malleable nature of authorship.

The Mathematics of Scientific Racism W 2 credits 1S A. Teicher

Abstract
How did racial scientists determine racial affiliation? In the seminar we will examine the practical challenges and eventual works of physical anthropologists from 1850 to the present. By scrutinizing the scientific toolbox of racial scientists, we will reveal how national affiliation, anti-Semitic perceptions and Gender identity shaped scholars' choices of graphical and computational methods.

Objective
- The aim of the course is to analyze the mutual relations between scientific theories and social perceptions, and to follow the formation of the "scientific mind". The course focuses on racial scientists and on the way their practices of computation and statistical analysis influenced their world-views - and vice versa. The students will be instructed on the way historians of science analyze scientific sources. They will gain a better understanding of the complexities of disciplinary dynamics, social biases and institutional pressures shaping scientific ideas, and learn on the influences such scientific ideas may have on the society as a whole.

Prerequisites / notice
Please note that the seminar will be held in English and most texts will be in English. However, a small portion of the reading material will be in German.
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<tr>
<th>Code</th>
<th>Title</th>
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<th>Authors</th>
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<tbody>
<tr>
<td>851-0157-69L</td>
<td>History of Astronomy</td>
<td>3</td>
<td>W</td>
<td>A. Kilcher, S. Mastorakou</td>
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<td></td>
<td><em>Particularly suitable for students of D-ERDW, D-MATH, D-PHYS</em></td>
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<td><strong>Abstract</strong></td>
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<td>The course is designed to provide an overview of the astronomical developments from the ancient Greek world to the 16th century. We are going to use primary sources tackling historical, technical and philosophical questions. Special attention will be paid to the dramatic change in the way people understood the structure of the heavens and the nature of the physical world.</td>
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<td>The course aims at providing a working knowledge of astronomy and cosmology from the ancient world to the 16th century. Upon its completion the students will be able to describe how our knowledge of the heavens changed from Aristotle's system to the Copernican Revolution. In addition, they will also have acquired an appreciation of the debates about man's place in the cosmos and the philosophical principles underpinning cosmology.</td>
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<td><strong>Abstract</strong></td>
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<td>This course studies philosophical issues concerning computers and computing. Topics include: information and information content, computational complexity, the Turing Test for computer thought; the &quot;Chinese Room&quot; argument against the possibility of strong AI; connectionist AI; consciousness; the Church-Turing thesis; computational and hypercomputational models of mind; and free will.</td>
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<td></td>
<td>- Exhibit a general understanding of the philosophy and history of computing.</td>
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<td>- Explain central problems in the field and their potential solutions, independently and at a level requiring in-depth knowledge and critical understanding.</td>
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<td>- Communicate clearly in writing about topics in this field.</td>
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<td>851-0331-05L</td>
<td>The Art of Conversation</td>
<td>3</td>
<td>W</td>
<td>C. Thomas</td>
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<td></td>
<td><strong>Abstract</strong></td>
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<td>This course will offer the occasion to reflect upon the art of conversation: its codes, its pleasures of improvisation, its worldly aspects and its importance in everyday life.</td>
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<td>This will permit us to consider different figures of the writer and salon hostess, such as Mme de Lafayette, Mme du Deffand, Julie de Lespinasse, and Mme de Staël.</td>
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<td>851-0331-06L</td>
<td>The Secretaries of the Baroque Age and the &quot;Honest Dissimulation&quot;</td>
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<td>W</td>
<td>S. Nigro</td>
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<td><strong>Abstract</strong></td>
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<td>Torquato Accetto, secretary and poet, published the treatise &quot;Della simulazione onesta&quot; in 1641. It was a thin manual to survive political turmoils and moral instability of the time; it was also a guide to &quot;secret&quot; writing in a time of censorship. The course follows the reception of the treatise up to the 20th century and focuses on how it got shaped to meet various historical and political ideas.</td>
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<td>The students know the author and his coeval context; the students can relate the writing modalities of the treatise to the socio-cultural context of various historical times; the students know how to identify and interpret the metaphorical potential of the texts, as well as its literary power.</td>
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<td>Only for MAGPW students, D-GESS PHD and D-ARCH PHD students.</td>
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<td><strong>Abstract</strong></td>
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<td>The colloquium of the ZGW focuses on present developments, debates and perspectives in the field of history of knowledge. On the second and fourth date there will be public events in the Cabaret Voltaire.</td>
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<td>The colloquium deals with the general problems, questions and methods of the interdisciplinary research field &quot;The History of Knowledge&quot;. Knowledge has become one of the existential conditions of modern societies and it increasingly determines their dynamics. Therefore, it is getting more and more relevant to develop a differentiated analysis of the epistemic, social and cultural constraints of the production, circulation and the decay of knowledge. In addition, the colloquium asks after the cultural and ethical resonances of knowledge not only within science but also in relation to art, literature, technology, everyday life, and so on.</td>
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<td><strong>Prerequisites / notice</strong></td>
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<td>Short notice about program changes are possible and will be communicated through the ZGW newsletter. Please register with <a href="http://www.zgw.ethz.ch/de/newsletter.html">www.zgw.ethz.ch/de/newsletter.html</a></td>
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<td>Credit points can be gained by regular attending and by writing an essay. In addition to the five colloquia there will be a deepening seminar on offer (lecturer K. Espahangizi).</td>
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<td>Free childcare available.</td>
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<td>851-0125-63L</td>
<td>Images of Mathematics</td>
<td>3</td>
<td>W</td>
<td>M. Hampe, A. Schubbach</td>
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<td><em>Particularly suitable for students of D-MATH</em></td>
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<td><strong>Abstract</strong></td>
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<td>The lecture series “Images of Mathematics” deals with the formalization of the objects and the logical language of mathematics from Hilbert to Gödel and considers its consequences in view of our conception of mathematical practice and knowledge, the limits of calculability and computability in mathematics, and the relation between the logical proof procedures and the involved intuitive aspects.</td>
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<td>The lecture series will present philosophical problems of theoretical mathematics in the 20th century and will discuss the consequences of formalization and axiomatization. It aims at a critical reflection on the modern images of mathematics.</td>
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How we understand Mathematics is probably strongly influenced by the Mathematics lessons we participated in during our school days. The common image of mathematics is therefore often characterized by the impression of a very stable form of knowledge with clear-cut problems and suitable recipes for finding the solution. It is a very static image which is very much in conflict with the rapid series of innovations that the discipline has experienced especially since the 19th century: Mathematics as a field of research has been highly innovative and even revolutionary as few other scientific disciplines in the last 200 hundred years.

These mathematical innovations did not only contribute to a progress amassing more and more knowledge. They very often changed how mathematicians conceived of their discipline. Even a contribution to a specific research question that appears at first sight to be minor can sometimes establish new connections to other fields, found a whole research field of its own or introduce new methods thereby changing the whole image of mathematics in the same way that a small addition to a picture can alter radically what we take it to represent.

The lecture series "Images of Mathematics" deals with a few moments in the history of the scientific discipline since the middle of the 19th century when the image of mathematics changed. In particular, it focuses on the consequences of the fact that in the 19th century mathematics started to not only reflect on their own conceptual and methodological foundations in a general manner (which had been done since the dawn of mathematics and was especially a philosophical task), but to formalize them in a strict, mathematical way: the objects of mathematics, its logical language and its proof procedures. Through Cantor's set theory, the mathematical treatment of logic since Boole and especially through Frege and the formalization of its axioms in a wide ranging discussion involving Zermelo, Fraenkel and others, this self-reflexive stance came to the fore.

Yet, the deeper mathematics dug into its foundations, the more radical the problems became. Finally, the optimistic Hilbert program of laying the foundation of mathematics within mathematics and of proving its own consistency as well as its completeness contributed to clarifying of the foundation of mathematics primarily as if it was doomed to failure. Gödel proved his famous incompleteness theorems and thereby dismissed at the same time the formalist attempt to reduce mathematical truth to logical provability. His work resulted in detailed insights in the precariousness of the foundation of mathematics and further numerous of productive consequences within mathematics.

Moreover, Gödel's theorems open many far-reaching and intriguing questions in view of our image of mathematics, questions concerning the conception of mathematical practice and knowledge, the limits of calculability of mathematics and the possible role of computability and machines in mathematics, the relation between the logical proof procedures and the involved intuitive aspects. In short, the image of mathematics is not as static as we sometimes expect it to be, it was radically redrawn by the mathematicians of the 20th century and has since then again been open to diverging interpretations.

Literature

For further reading (optional): Mark van Atten and Juliette Kennedy, Gödel's Logic, in: Handbook of the History of Logic, Vol 5: Logic from From Plato, Aristotle and Cicero, philosophers have tried to find the core principle of wit (or the joke, as both meanings are contained in the German term "Witz"). Even during the 20th century, the philosophy of life and psychoanalysis struggle with it. The seminar provides an overview about the various approaches and methods of literature studies and gain an overview of literary theory.

Man and Machine

Does not take place this semester.

Particularly suitable for students of D-CHAB, D-HEST, D-MAVT, D-MATL

The lecture gives an overview about the different Man-Machine-Relations since the 16th century. Different models of machines will be important here: the clockwork, the steam engine and the computer.

On the one hand modells of machines had a heuristical value in research on man, e.g. in Harvey's discovery of blood circulation in the 17th century or in brain research in the 20th century. On the other hand these modells were always criticised, sometimes polemically, because they are supposedly not adequate for man.

Students should learn about the connections between the history of anthropology and technology and be able at the end of the course to evaluate the critical philosophical arguments that are connected with the metaphor of the machine.

The Knowledge of Literature. An Introduction

This lecture provides a general introduction to literary theory and presents the important theories dealing with knowledge and its role in and as literature.

Students are introduced to the various approaches and methods of literature studies and gain an overview of literary theory.

This lecture has two aims: Firstly, it serves as a general introduction into the field of literary theory (thereby looking into "knowledge about literature"). Secondly, there will be a special emphasis on recent theoretical approaches that take seriously literature and knowledge as one of its components (thus investigating the "knowledge of literature"). Even though traditional criticism disagrees, a number of recent approaches, based on literature and culture studies, hold that literature is not to be conceived of as standing in opposition to the world and the explanatory system of the academic disciplines, particularly the sciences (e.g. Foucauldian discourse analysis and New Historicism).

Instead, these approaches understand literature in terms of its epistemological forms and functions. Thus, the main thesis is that literature actively participates in the constitution and formation of knowledge. Literature itself generates models of knowledge, sometimes with critical or even utopian intentions. Moreover, it draws attention to the fundamental role of order and representation (systematization, narrative ordering, linguistic and pictorial representation) in both humanities and sciences.

Philosophy of Mathematics


851-0125-51L

851-0300-85L

851-0300-79L

862-0078-02L

364-1078-00L

For PhD students and postdoctoral. Masterstudents are welcome.

The forntightly colloquium provides a forum for PhD students and postdoctoral researchers to present and discuss their current work. Half of the slots are reserved for presentations by invited external scholars.

PhD students will have an opportunity to improve their presentation skills and obtain an important chance to receive feedback both from peers and more advanced scholars.

For further reading (optional): Mark van Atten and Juliette Kennedy, Gödel's Logic, in: Handbook of the History of Logic, Vol 5: Logic from
Learn the basic features of the software z-Tree. Learn how to program an experiment that can be implemented.

How can Behavioral and Cognitive Science inform architecture? In this project-oriented course, students are introduced to cognitive and analytical methods to evaluate their design projects. Existing theories are introduced and complemented with hands-on sessions, in which students learn how to implement a range of methods. The course is tailored for students from relevant design studios.

This course explores selected topics of cognitive neuroscience. The course begins with a basic introduction to the field covering neural anatomy and brain physiology. Contemporary methods used in neuroscientific research (e.g., IMRI, EEG) will also be introduced and their benefits and limits critically reviewed. Using this knowledge, we will discuss some of the classic works in neuroscience in visual perception, memory and emotion. This will be accompanied by some famous cases of patients demonstrating problems in these domains (e.g., people with agnosia or amnesia). Further topics will include the cognitive and neural processes involved in pain processing, the placebo effect, as well as spatial representation and navigation.

This course targets students at the Bachelor level with no previous experience. The main requirement for this course is an open and critical mind. By the end of the course, the student will be able to identify the major brain structures and to explain the basic functioning of neurons as well as some of the fundamental principles of how our brain works. Students should have an understanding of the methods used to evaluate these findings, and what can and cannot be answered with neuroscience techniques. For each of the topics, students should be able to identify the phenomenon, give examples, and discuss one or two of the main theories explaining it.

The class is open to all Ph.D. (and Master students) who are interested in conducting (behavioral) economic experiments.

Special Topics in Cognitive Neuroscience

- 851-0597-01L
  - **Objective**
    - This lecture will deal with the manifestations of the "selfish gene" principle in human social behavior. Cooperation and competition, selfishness and altruism, gender relations and parent-child conflicts are issues, the evolutionary backgrounds of which will be discussed. Special attention will be paid to the costly signaling theory.
  - **Literature**
  - **Prerequisites / notice**

Doctoral Department of Humanities, Social and Political Sciences - Key for Type

<table>
<thead>
<tr>
<th>Key for Hours</th>
<th>W+ ELIGIBLE FOR CREDITS AND RECOMMENDED</th>
<th>W ELIGIBLE FOR CREDITS</th>
<th>E- RECOMMENDED, NOT ELIGIBLE FOR CREDITS</th>
<th>Z COURSES OUTSIDE THE CURRICULUM</th>
<th>D SUITABLE FOR DOCTORATE</th>
<th>O COMPULSORY</th>
</tr>
</thead>
<tbody>
<tr>
<td>V lecture</td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>G lecture with exercise</td>
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<tr>
<td>U exercise</td>
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<tr>
<td>S seminar</td>
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<tr>
<td>K colloquium</td>
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<tr>
<td>ECTS</td>
<td>European Credit Transfer and Accumulation System</td>
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</tr>
<tr>
<td>Notice</td>
<td>Special students and auditors need special permission from the lecturers.</td>
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</tbody>
</table>
### Doctoral and Post-Doctoral Courses

#### Health Sciences and Technology

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
<th>Prerequisites / notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-1791-00L</td>
<td>Introductory Course in Neuroscience I (University of Zurich)</td>
<td>W</td>
<td>2 credits</td>
<td>2V</td>
<td>J.M. Fritschy, W. Knecht</td>
<td>No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: SPV0Y005</td>
</tr>
</tbody>
</table>

Abstract
The course gives an introduction to human and comparative neuroanatomy, molecular, cellular and systems neuroscience.

Objective
The course gives an introduction to human and comparative neuroanatomy, molecular, cellular and systems neuroscience.

Content
1) Human Neuroanatomy I&II
2) Comparative Neuroanatomy
3) Development I&II
4) Membran and Action Potential
5) Synaptic Transmission & Plasticity I&II
6) Glia and Blood-Brain-Barrier
7) Somatosensory and Motor System
8) Visual System
9) Auditory System
10) Circuits underlying Emotion
11) Modeling of Neural Circuits

Prerequisites / notice
For doctoral students of the Neuroscience Center Zurich (ZNZ).

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
<th>Prerequisites / notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-1795-00L</td>
<td>Advanced Course in Neurobiology I (Functional Anatomy of the Rodent Brain) (University of Zurich)</td>
<td>W</td>
<td>2 credits</td>
<td>2V</td>
<td>J.M. Fritschy, H. U. Zeilhofer</td>
<td>No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: SPV0Y009</td>
</tr>
</tbody>
</table>

Abstract
The goal of this Advanced Course in Neurobiology is to provide students with a broader knowledge in several important areas of neurobiology. The course consists of four parts: Part I deals with various topics in developmental neurobiology. Part II is devoted to aspects of signal transduction. Part III focuses on synaptic transmission. Part IV gives deeper insights into systems neuroscience.

Objective
This credit point course is designed for doctoral students who have successfully completed the Introductory Course in Neuroscience at the Neuroscience Center Zürich. The goal is to provide students with a broader and deeper knowledge in several important areas of neurobiology.

Prerequisites / notice

#### Food Science

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
<th>Prerequisites / notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>752-0005-00L</td>
<td>Public Colloquium in Food Science</td>
<td>E-</td>
<td>1 credit</td>
<td>2K</td>
<td>S. J. Sturla</td>
<td>Participation in weekly seminars on a variety of topics including Food Microbiology, Food Toxicology, Food Biochemistry, Food Processing, Consumer Behavior, Food Technology, and Food Materials and Technology, and oral presentation of a selected published study in one of these areas inspired by participation in the seminars.</td>
</tr>
</tbody>
</table>

Objective
The objectives are to become familiar with and stimulate interest in leading-edge science related to the research topics of the Institute of Food, Nutrition and Health. Participants attend weekly seminars given by external and internal speakers, and are also required to deliver a presentation on a recent research article inspired by a topic from the seminar presentations.

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**Doctoral Department of Health Sciences and Technology - Key for Type**

<table>
<thead>
<tr>
<th>W+</th>
<th>Eligible for credits and recommended</th>
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</thead>
<tbody>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
</tbody>
</table>

**Key for Hours**

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
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<tbody>
<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
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</tbody>
</table>

| ECTS | European Credit Transfer and Accumulation System |

Special students and auditors need special permission from the lecturers.

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### Doctoral and Post-Doctoral Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>252-0912-00L</td>
<td>Experimental Computer Systems</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>T. Gross</td>
</tr>
<tr>
<td></td>
<td>Only for Ph.D. students at the Institute of Computer Systems. All other students need the approval by the lecturer.</td>
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</tr>
<tr>
<td>Abstract</td>
<td>This graduate seminar provides doctoral students in computer science a chance to discuss their research. Enrolment requires permission of the instructor. Credit units are granted only to active participants.</td>
<td></td>
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<tr>
<td>Objective</td>
<td>Learn how to formulate a research project, how to conduct research and how to improve presentation skills in an academic setting.</td>
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</tr>
<tr>
<td>Content</td>
<td>The seminar will explore different topics from a research perspective. The seminar is open to assistants of the Department of Computer Science (Informatik), Computer Systems Institute. Others should contact the instructor.</td>
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<tr>
<td>Lecture notes</td>
<td>Supporting material will be distributed during the seminar.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Credit will be given only to those who present a paper/project. No credit for &quot;attendance&quot;.</td>
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</tbody>
</table>

#### Course Catalogue of ETH Zurich

<table>
<thead>
<tr>
<th>Number</th>
<th>OMS Case Study I</th>
<th>W</th>
<th>2</th>
<th>2S</th>
<th>M. Norrie</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>This doctoral seminar consists of a series of talks and discussions covering the history and foundations of OMS, related work and on-going OMS developments and applications.</td>
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<tr>
<td>Objective</td>
<td>The seminar will explore different topics from a research perspective.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Number</th>
<th>Seminar on Cryptography</th>
<th>W</th>
<th>2</th>
<th>1S</th>
<th>U. Maurer, M. Hirt</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Latest Topics in Cryptography will be discussed.</td>
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<tr>
<td>Objective</td>
<td>The seminar will explore different topics from a research perspective.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Number</th>
<th>Algorithms and Complexity (HS)</th>
<th>W</th>
<th>1</th>
<th>1S</th>
<th>J. Hromkovic, P. Widmayer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>The seminar treats selected problems of current interest in the area of algorithms and complexity.</td>
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<tr>
<td>Objective</td>
<td>Develop an understanding of selected problems of current interest in the area of algorithms and complexity.</td>
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<tr>
<td>Content</td>
<td>This seminar treats selected problems of current interest in the area of algorithms and complexity.</td>
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</tr>
<tr>
<td>Literature</td>
<td>Research papers, to be chosen in the seminar.</td>
<td></td>
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<tr>
<td>Prerequisites / notice</td>
<td>Prerequisites: Basic understanding of algorithms and complexity.</td>
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<tbody>
<tr>
<td></td>
<td>Only for Computer Science Ph.D. students.</td>
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</tr>
<tr>
<td>Abstract</td>
<td>An essential aspect of any research project is dissemination of the findings arising from the study. Here we focus on oral communication, which includes: appropriate selection of material, preparation of the visual aids (slides and/or posters), and presentation skills.</td>
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<tr>
<td>Objective</td>
<td>The seminar participants should learn how to prepare and deliver scientific talks as well as to deal with technical questions. Participants are also expected to actively contribute to discussions during presentations by others, thus learning and practicing critical thinking skills.</td>
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</tr>
<tr>
<td>Prerequisites / notice</td>
<td>This doctoral seminar of the Machine Learning Laboratory of ETH is intended for PhD students who work on a machine learning project, i.e., for the PhD students of the ML lab.</td>
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<table>
<thead>
<tr>
<th>Number</th>
<th>Seminar in Theoretical Computer Science</th>
<th>W</th>
<th>2</th>
<th>2S</th>
<th>E. Welzl, B. Gärtner, M. Hoffmann, J. Lengler, A. Steger, B. Sudakov</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Presentation of recent publications in theoretical computer science, including results by diploma, masters and doctoral candidates.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Number</th>
<th>Geometry: Combinatorics and Algorithms</th>
<th>W</th>
<th>6</th>
<th>2V+2U+1A</th>
<th>B. Gärtner, E. Welzl, M. Hoffmann, A. Pilz</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Geometric structures are useful in many areas, and there is a need to understand their structural properties, and to work with them algorithmically. The lecture addresses theoretical foundations concerning geometric structures. Central objects of interest are triangulations. We study combinatorial (Does a certain object exist?) and algorithmic questions (Can we find a certain object efficiently?).</td>
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<tr>
<td>Objective</td>
<td>The goal is to make students familiar with fundamental concepts, techniques and results in combinatorial and computational geometry, so as to enable them to model, analyze, and solve theoretical and practical problems in the area and in various application domains. In particular, we want to prepare students for conducting independent research, for instance, within the scope of a thesis project.</td>
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<tr>
<td>Content</td>
<td>Planar and geometric graphs, embeddings and their representation (Whitney's Theorem, canonical orderings, DCEL), polygon triangulations and the art gallery theorem, convexity in Rd, planar convex hull algorithms (Jarvis Wrap, Graham Scan, Chan's Algorithm), point set triangulations, Delaunay triangulations (Lawson flips, lifting map, randomized incremental construction), Voronoi diagrams, the Crossing Lemma and incidence bounds, line arrangements (duality, Zone Theorem, ham-sandwich cuts), 3-SUM hardness, counting planar triangulations.</td>
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</tr>
<tr>
<td>Lecture notes</td>
<td>yes</td>
<td></td>
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<tr>
<td>Prerequisites / notice</td>
<td>Prerequisites: The course assumes basic knowledge of discrete mathematics and algorithms, as supplied in the first semesters of Bachelor Studies at ETH. Outbook: In the following spring semester there is a seminar &quot;Geometry: Combinatorics and Algorithms&quot; that builds on this course. There are ample possibilities for Semester-, Bachelor- and Master Thesis projects in the area.</td>
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</table>

<table>
<thead>
<tr>
<th>Number</th>
<th>Research Topics in Software Engineering</th>
<th>W</th>
<th>2</th>
<th>2S</th>
<th>P. Müller, M. Püschel</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number of participants limited to 22.</td>
<td></td>
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</tr>
<tr>
<td>Abstract</td>
<td>This seminar is an opportunity to become familiar with current research in software engineering and more generally with the methods and challenges of scientific research.</td>
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<tr>
<td>Objective</td>
<td>Each student will be asked to study some papers from the recent software engineering literature and review them. This is an exercise in critical review and analysis. Active participation is required (a presentation of a paper as well as participation in discussions).</td>
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</tbody>
</table>
The aim of this seminar is to introduce students to recent research results in the area of programming languages and software engineering.

To accomplish that, students will study and present research papers in the area as well as participate in paper discussions. The papers will span topics in both theory and practice, including papers on program verification, program analysis, testing, programming language design, and development tools. A particular focus will be on domain-specific languages.

Organizational note: the seminar will meet only when there is a scheduled presentation. Please consult the seminar's home page for information.

264-5800-00L Doctoral Seminar in Visual Computing (HS16)
- **W+** Eligible for credits and recommended
- **W** Eligible for credits
- **E-** Recommended, not eligible for credits

Objectives:
- Learn about current research results in the area of Visual Computing, practice of scientific presentations.

Content:
- This graduate seminar provides doctoral students in computer science a chance to read and discuss current research papers.

Programming Languages Seminar
- **W** 2 credits
- **E-** Recommended, not eligible for credits

Objectives:
- Learn about current research results in the area of programming languages, static program analysis, program verification, and related areas; practice of scientific presentations.

Content:
- The seminar will explore different topics from a research perspective.

Prerequisites / notice
- Supporting material will be distributed during the seminar.

Frontiers in Energy Research
- **W** 2 credits
- **E-** Recommended, not eligible for credits

Objectives:
- Knowledge of advanced research in the area of energy.

Content:
- PhD students at ETH Zurich working in the broad area of energy present their research to their colleagues, to their advisors and to the scientific community.

Writing for Publication in Computer Science (WPCS)
- **Z** 0 credits
- **E-** Recommended, not eligible for credits

Objectives:
- Writing for Publication in Computer Science is a short course (5 x 4-lesson workshops) designed to help doctoral students develop the skills needed to write their first research articles. The course deals with topics such as:
  - understanding the needs of different target readerships,
  - managing the writing process efficiently,
  - structuring texts effectively,
  - producing logical flow in sentences and paragraphs,
  - editing texts before submission, and
  - revising texts in response to colleagues' feedback and reviewers' comments.

Content:
- Participants will be expected to produce a number of short texts (e.g., draft of a conference abstract) as homework assignments; they will receive individual feedback on these texts during the course. Wherever feasible, elements of participants' future conference/journal articles can be developed as assignments within the course, so it is likely to be particularly useful for those who have i) their data and are about to begin the writing process, or ii) an MSc thesis they would like to convert for publication.

Doctoral Department of Computer Science - Key for Type

| W+ | Eligible for credits and recommended |
| W  | Eligible for credits |
| E- | Recommended, not eligible for credits |
| Z  | Courses outside the curriculum |
| Dr | Suitable for doctorate |
| O  | Compulsory |

Key for Hours

- **V** lecture
- **G** lecture with exercise
- **U** exercise
- **S** seminar
- **K** colloquium
- **P** practical/laboratory course
- **A** independent project
- **D** diploma thesis
- **R** revision course / private study

Special students and auditors need special permission from the lecturers.

European Credit Transfer and Accumulation System (ECTS)

<table>
<thead>
<tr>
<th>ECTS</th>
<th>European Credit Transfer and Accumulation System</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Special students and auditors need special permission from the lecturers.</td>
</tr>
</tbody>
</table>
Doctoral Dep. of Information Technology and Electrical Engineering


Doctoral and Post-Doctoral Courses

A minimum of 12 ECTS credit points must be obtained during doctoral studies.

The courses on offer below are but a small selection out of a much larger available number of courses. Please discuss your course selection with your PhD supervisor.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0906-00L</td>
<td>Frontiers in Energy Research</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>M. Mazzotti, R. S. Abhari, J. Carmeli, M. Filippini</td>
</tr>
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<td>PhD students at ETH Zurich working in the broad area of energy present their research to their colleagues, to their advisors and to the scientific community.</td>
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<tr>
<td>227-0225-00L</td>
<td>Linear System Theory</td>
<td>W</td>
<td>6</td>
<td>5G</td>
<td>M. Kamgarpour</td>
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<td>The class is intended to provide a comprehensive overview of the theory of linear dynamical systems, their use in control, filtering, and estimation and their applications to areas ranging from avionics to systems biology.</td>
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<tr>
<td>227-0389-00L</td>
<td>Advanced Topics in Magnetic Resonance Imaging</td>
<td>Z</td>
<td>0</td>
<td>1V</td>
<td>K. P. Prüssmann</td>
</tr>
<tr>
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<td>This course is geared towards master and PhD students with a focus on bioimaging. It covers advanced topics in magnetic resonance imaging in biennial rotation, including the electrodynamics of MR signal detection, noise mechanisms, image reconstruction, radiofrequency pulse design, RF pulse trains, as well as advanced contrast mechanisms.</td>
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<tr>
<td>227-0417-00L</td>
<td>Information Theory I</td>
<td>W</td>
<td>6</td>
<td>4G</td>
<td>A. Lapidoth</td>
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<tr>
<td></td>
<td>This course covers the basic concepts of information theory and of communication theory. Topics covered include the entropy rate of a source, mutual information, typical sequences, the asymptotic equi-partition property, Huffman coding, channel capacity, the channel coding theorem, the source-channel separation theorem, and feedback capacity.</td>
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<tr>
<td>227-0427-00L</td>
<td>Signal and Information Processing: Modeling, Filtering, Learning</td>
<td>W</td>
<td>6</td>
<td>4G</td>
<td>H.A. Loeliger</td>
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<td></td>
<td>Fundamentals in signal processing, detection/estimation, and machine learning.</td>
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<tr>
<td>227-0455-00L</td>
<td>Terahertz: Technology &amp; Applications</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>K. Sankaran</td>
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<td></td>
<td>This course will provide a solid foundation for understanding physical principles of THz applications. We will discuss various building blocks of THz technology - components dealing with generation, manipulation, and detection of THz electromagnetic radiation. We will introduce THz applications in the domain of imaging, communications, and energy harvesting.</td>
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</table>

Lecture notes:

Slides will be distributed.

Prerequisites / notice:

- local bachelors: course "Discrete-Time and Statistical Signal Processing" (5. Sem.)
- others: solid basics in linear algebra and probability theory

Course topics:

- Stability and stabilization, observers, state and output feedback, separation principle.
- Controllability and observability, canonical forms, Kalman decomposition. Time invariant systems treated as a special case.
- Continuous and discrete time, time varying linear systems. Time domain solutions. Time invariant systems treated as a special case.

Machine learning algorithms provide analytical methods to search data sets for characteristic patterns. Typical tasks include the

**Applications**
- Chapter 6: THz Imaging
- Chapter 7: THz Communication
- Chapter 8: THz Energy Harvesting

**Literature**
- Yun-Shik Lee, Principles of Terahertz Science and Technology, Springer 2009

Whenever we deviate from the main material discussed in these books, softcopy of lectures notes will be provided.

**Prerequisites / notice**
Good foundation in electromagnetics & knowledge of microwave or optical communication is helpful.

**227-0689-00L**  System Identification  
**Abstract** Theory and techniques for the identification of dynamic models from experimentally obtained system input-output data.  
**Objective** To provide a series of practical techniques for the development of dynamical models from experimental data, with the emphasis being on the development of models suitable for feedback control design purposes. To provide sufficient theory to enable the practitioner to understand the trade-offs between model accuracy, data quality and data quantity.

**Content** Introduction to modeling: Black-box and grey-box models; Parametric and non-parametric models; ARX, ARMAX (etc.) models.

Optimal experimental design, Cramer-Rao bounds, input signal design.

Parametric identification methods. On-line and batch approaches.

Closed-loop identification strategies. Trade-off between controller performance and information available for identification.


When ever we deviate from the main material discussed in these books, softcopy of lectures notes will be provided.

**Prerequisites / notice** Control systems (227-0216-00L) or equivalent.

**227-0955-00L** Seminar in Electromagnetics, Photonics and Terahertz  
**Abstract** Selected topics of the current research activities at the IEF and closely related institutions are discussed. Have an overview on the research activities of the IEF institute.

**Prerequisites / notice** Good foundation in electromagnetics & knowledge of microwave or optical communication is helpful.

**227-0974-00L** TNU Colloquium  
**Abstract** This colloquium for MSc and PhD students at D-ITET discusses current research topics in Translational Neuromodeling, a new discipline concerned with the development of mathematical models for diagnostics of brain diseases. The range of topics is broad, incl. statistics and computational modeling, experimental paradigms (fMRI, EEG, behaviour), and clinical questions.

**Objective** After this course students will know fundamental techniques from probabilistic combinatorics for designing randomized algorithms and will be able to apply them to solve typical problems in these areas.

**Content** Randomized Algorithms are algorithms that "flip coins" to take certain decisions. This concept extends the classical model of deterministic algorithms and has become very popular and useful within the last twenty years. In many cases, randomized algorithms are faster, simpler or just more elegant than deterministic ones. In the course, we will discuss basic principles and techniques and derive from them a number of randomized methods for problems in different areas.


**252-0417-00L** Randomized Algorithms and Probabilistic Methods  
**Abstract** Las Vegas & Monte Carlo algorithms; inequalities of Markov, Chebyshev, Chernoff; negative correlation; Markov chains: convergence, rapidly mixing; generating functions; Examples include: min cut, median, balls and bins, routing in hypercubes, 3SAT, card shuffling, random walks

**Objective** After this course students will know fundamental techniques from probabilistic combinatorics for designing randomized algorithms and will be able to apply them to solve typical problems in these areas.

**Content** Randomized Algorithms are algorithms that "flip coins" to take certain decisions. This concept extends the classical model of deterministic algorithms and has become very popular and useful within the last twenty years. In many cases, randomized algorithms are faster, simpler or just more elegant than deterministic ones. In the course, we will discuss basic principles and techniques and derive from them a number of randomized methods for problems in different areas.

**Lecture notes** Yes


**252-0535-00L** Machine Learning  
**Abstract** Machine learning algorithms provide analytical methods to search data sets for characteristic patterns. Typical tasks include the classification of data, function fitting and clustering, with applications in image and speech analysis, bioinformatics and exploratory data analysis. This course is accompanied by practical machine learning projects.

**Objective** Students will be familiarized with the most important concepts and algorithms for supervised and unsupervised learning; reinforce the statistics knowledge which is indispensable to solve modeling problems under uncertainty. Key concepts are the generalization ability of algorithms and systematic approaches to modeling and regularization. A machine learning project will provide an opportunity to test the machine learning algorithms on real world data.

**Content** The theory of fundamental machine learning concepts is presented in the lecture, and illustrated with relevant applications. Students can deepen their understanding by solving both pen-and-paper and programming exercises, where they implement and apply famous algorithms to real-world data.

**Topics covered in the lecture include:**  - Bayesian theory of optimal decisions  - Maximum likelihood and Bayesian parameter inference  - Classification with discriminant functions: Perceptrons, Fisher's LDA and support vector machines (SVM)  - Ensemble methods: Bagging and Boosting  - Regression: least squares, ridge and LASSO penalization, non-linear regression and the bias-variance trade-off  - Non parametric density estimation: Parzen windows, nearest neighbour  - Dimension reduction: principal component analysis (PCA) and beyond
Lecture notes
No lecture notes, but slides will be made available on the course webpage.

Literature

Prerequisites / notice
The course requires solid basic knowledge in analysis, statistics and numerical methods for CSE as well as practical programming experience for solving assignments.
Students should at least have followed one previous course offered by the Machine Learning Institute (e.g., CIL or LIS) or an equivalent course offered by another institution.

227-0559-00L Seminar in Distributed Computing W 2 credits 2S R. Wattenhofer

Abstract
In this seminar participating students present and discuss recent research papers in the area of distributed computing. The seminar consists of algorithmic as well as systems papers in distributed computing theory, peer-to-peer computing, ad hoc and sensor networking, or multi-core computing.

Objective
In the last two decades, we have experienced an unprecedented growth in the area of distributed systems and networks; distributed computing now encompasses many of the activities occurring in today’s computer and communications world. This course introduces the basics of distributed computing, highlighting common themes and techniques. We study the fundamental issues underlying the design of distributed systems: communication, coordination, synchronization, uncertainty. We explore essential algorithmic ideas and lower bound techniques.
In this seminar, students present the latest work in this domain.

Content
Seminar language: English
Different each year. For details see: www.disco.ethz.ch/courses.html

Lecture notes
Slides of presentations will be made available.

Literature
Papers.
The actual paper selection can be found on www.disco.ethz.ch/courses.html.
Doctoral Department of Management, Technology, and Economics


Doctoral and Post-Doctoral Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>363-1036-00L</td>
<td>Empirical Innovation Economics</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>M. Wörter</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course focuses on important factors that drive the innovation performance of firms, like innovation capabilities, science-industry relationships, environmental policy and it shows how innovation activities relate to firm performance and to the technological dynamic of industries. Hence, the course provides an understanding of the relationship between technical change and industrial dynamics.</td>
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<tr>
<td>Objective</td>
<td>The course provides students with the basic skills to understand and assess empirically the technological activities of firms and the technological dynamics of industries.</td>
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<tr>
<td>Content</td>
<td>The course consists of two parts. Part I provides an introduction into important topics in the field of the economics of innovation. Part II consists of empirical exercises based on the KOF Innovation Data. In part I we will learn about ...a) market conditions that encourage firms to invest in R&amp;D (Research and Development) and develop new products. ...b) the role of universities for the technological activities of a firm (technology transfer). ...c) how technologies diffuse among firms. ...d) how the R&amp;D activities of firms are affected by economic crises and how firms finance their R&amp;D activities. ...e) how we can measure the returns to R&amp;D activities. ...f) how (environmental) policies affect the technological activities of a firm. In part II we will use the KOF Innovation Survey Data in order to assess empirically the technological activities of firms referring to the topics introduced in part I.</td>
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<tr>
<td>Lecture notes</td>
<td>Will be provided in the course</td>
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<tr>
<td>Literature</td>
<td>Literature will be presented in the course. For an introduction into the economics of innovation see G.M. Peter Swann, The Economics of Innovation - an Introduction, Edward Elgar, 2009. For an overview of empirical innovation studies see W.M. Cohen (2010): Fifty Years of Empirical Studies of Innovation Activities and Performance, in: B.H Hall, N. Rosenberg (eds.), Handbook of Economics of Innovation, volume 1, Elsevier, pp. 129-213.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Course is directed to advanced Master-Students and PhD Students with an interest in empirical work.</td>
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<tr>
<td>364-0531-00L</td>
<td>CER-ETH Research Seminar</td>
<td>E-</td>
<td>0</td>
<td>2S</td>
<td>H. Gersbach, A. Bommier, L. Bretschger, W. Mimra</td>
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<tr>
<td>Abstract</td>
<td>Research Seminar of Center of Economic Research CER-ETH</td>
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<tr>
<td>Objective</td>
<td>Understanding cutting-edge results of current research in the fields of the CER-ETH Professors.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Bitte spezielle Ankündigungen beachten.</td>
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<tr>
<td>364-0553-00L</td>
<td>Innovation in the Digital Space</td>
<td>E</td>
<td>1</td>
<td>1G</td>
<td>G. von Krogh</td>
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<tr>
<td>Abstract</td>
<td>The purpose of this course is to review and discuss issues in current theory and research relevant to innovation in the digital space.</td>
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<td>Objective</td>
<td>Through in-depth analysis of published work, doctoral candidates will identify and appraise theoretical and empirical studies, formulate research questions, and improve the positioning of their own research within the academic debate.</td>
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<td>Content</td>
<td>The Internet has a twofold impact on the way individuals and firms innovate. First, firms increasingly draw on digital technology to access and capture innovation-relevant knowledge in their environment. Second, individuals, firms, and other organizations extensively utilize the Internet to create, diffuse, and commercialize new digital products and services. During the past decade, theory and research on innovation in the digital space has flourished and generated extensive insights of relevance to both academia and management practice. This has brought us better understanding of working models, and some fundamental reasons for innovation success or failure. A host of new models and research designs have been created to explore the innovation in the digital space, but these have also brought out many open research questions. We will review some of the existing streams of work, and in the process explore a new research agenda.</td>
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<td>Format</td>
<td>The course is organized in one block of 2 days. The course is a combination of pre-readings, presentations by faculty and students, and discussions. The students prepare presentations of papers in order to facilitate analysis and discussion.</td>
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</tbody>
</table>
Innovation, openness and search:


Open source and innovation models:


Motivation to Innovate:


Leadership and Governance:


Motivation to Innovate:


Leadership and Governance:


Lecture notes
For panel data analysis, I will rely on the book:

For sample selection and endogenous treatment effect analysis, I will rely on the book:

For spatial econometrics:
I will mostly use papers.

I will prepare a script (based on slides), covering all topics.

364-0517-00L Urban and Spatial Economics W 3 credits 2V R. H. van Nieuwkoop

Abstract
This course explores the economic factors which influence location decisions of households and firms, and it explores theories of how these decisions induce the formation of cities. The course will cover the neoclassical models of land use, concepts from the new economic geography, zoning, and transportation and traffic congestion.

Prerequisite: one semester in microeconomics.

Objective
The objective of the course is to provide graduate students with an understanding of the economic factors which give rise to urban spatial structure and the models which have been employed to study these processes. The course aims to help students develop an appreciation for the use of economic models in both positive and normative frameworks. We will assess both the history of thought regarding the role of markets in creating urban development, and we will read about modern theories of externalities and economic factors which induce agglomeration. The final section of the course will focus on transportation problems in urban areas and the use of economic models to assess public policy measures to deal with congestion and associated externalities.

Content
Outline of Lectures
Topic 1: Why do cities exist?
Topic 2: The Basic Muth-Mills model
Topic 3: The New Economic Geography
Topic 4: Business demand for land and Von Thünen's model
Topic 5: Urban spatial structure
Topic 6: Land use control
Topic 7: City size and city growth
Topic 8: Traffic externalities and congestion
Topic 9: Public transport

Lecture notes
o Urban Economics by Arthur O'Sullivan, McGraw-Hill.

Ancillary Texts

o Cities, agglomeration and spatial equilibrium by E. L. Glaeser, 2008, Oxford University Press.


o The new introduction to geographical economics, Steven Brakman, Harry Garretsen and Charles van Marrewijk, Cambridge.


364-0581-00L Microeconomics Seminar (ETH/UZH) E- 0 credits 2S H. Gersbach

Abstract
Research Seminar research papers of leading researchers in Microeconomics are presented and discussed

Objective
Research Seminar research papers of leading researchers in Microeconomics are presented and discussed

Content
Invited Speakers present current research in Microeconomics

364-1013-00L Managerial Cognition W 1 credit 1G S. Brusoni

Does not take place this semester.

Abstract
The primary objective of this module is to introduce some of the major theoretical threads and controversies in the field of managerial cognition. A secondary objective is to help understand the process of empirical research that has the potential to make an impact on research and management practice.

Objective
The module will seek to provide:
1) Exposure to key theoretical streams in the area.
2) Familiarity with the issues, methods, findings and gaps in the area.
3) Skills in finding insight in the literature.
4) Skills in critiquing the literature, defining research problems and proposing empirical research in this area.

Content
Session 1 - Introduction to the field of managerial cognition
Session 2 - Methods to study managerial cognition
Session 3 - Sensemaking, Mindfulness and Attention
Session 1: Introduction


Session 2: Some methods to study managerial cognition


Session 3: Sensemaking, Mindfulness and Attention

Bonus: http://www.wired.com/wired/archive/4.04/weick_pr.html


Assignments: At the beginning of each session, students must distribute copies of their critique of the assigned reading (please see your names at the end of each reference). The critique should be brief, extending to a maximum of one printed page. The critique is meant to serve as a starting point for the student to lead the class in a discussion of the strengths and weaknesses of the paper. For each session, students should emphasize the following topics in their critique:

Session 1:
- summarize the research problem or question
- summarize the central framework/ theory that is proposed
- list the strengths of the paper (you can use bulletpoints)
- list the weaknesses of the paper (you can use bulletpoints)

Session 2:
- Same as for session 1 with particular emphasis on the pros and cons of the method used
- Propose at least one alternative methodology and explain why you think the alternative method(s) would have been better suited

Session 3:
- three bullet points summarizing the paper strengths
- three bullet points summarizing the paper weaknesses
- prepare a one-page research idea: what would be a new research question? how would you extend the paper? what could be counterintuitive results?

Please contact Dr Daniella Laureiro Martinez for more information on this course.
Abstract

This module aims to introduce major theoretical perspectives on organizational knowledge and to improve the competence of doctoral students to publish in relevant research areas. How knowledge is conceptualized and what aspects of knowledge are being studied depends on the epistemological and ontological assumptions accepted by researchers.

Objective

This module aims:
1. To provide a basic understanding of key theoretical perspectives on organizational knowledge.
2. To provide insights on the research questions, methods, findings and implications of the selected papers.
3. To build skills in critically analyzing the literature.
4. To identify future directions in the area.

Content

Given its prominence in the history of organization science, an impressive variety of theories have evolved that deals with organizational epistemology, the way of knowing in the organization (e.g., Brown & Duguid, 1991; Grant, 1996; Kogut & Zander, 1992; Lave & Wenger, 1991; Nonaka, 1994; Spender, 1996; Tsoukas, 1996; von Krogh et al., 1994). In this module, students will learn about various seminal contributions in the area of organizational knowledge and make connections between theory and empirical research, and identify the ongoing trends and future research directions.

Session 1: Knowledge based view of the firm.
Session 2: Knowledge sharing and transfer
Session 3: Social practice view on knowledge and knowing

Literature

Remark: The list might change. Students will be informed about the changes before the first session.

Prerequisites / notice

In each session, students will have three assignments:
1) prepare for in-depth discussion of all papers. The students are supposed to read in advance all the papers that will be presented in the sessions.
2) critically review and discuss the assigned papers. Assignments will be done after participants confirm their presence.
3) submit in advance a short critique of the assigned papers - max 2 pages.

364-1013-01L Organizations and Technical Change

Abstract

W 1 credit 1G S. Brusoni

This 1-credit module is designed to introduce students to selected topics focused on the relationship between technical change and organizational dynamics.

Objective

The objectives of this module are:
1) to provide students with a relatively detailed understanding of some of the major theoretical perspectives and their developments in the field of innovation and technical change
2) to illustrate how these perspectives have evolved
3) to discuss how they can be operationalised
4) and, on these bases, develop the ability of constructively criticising them in order to learn how ‘to build upon and extend’ extant research in the field

Content

Session 1: Technology rules. Once upon a time, people believed that technology determines organization. What techniques we use explain how we organize around them. If there is no fit to the technique, then there is failure. Powerful, simple, predictive, engineer-friendly, Occasionally correct, too.

Session 2: Never Mind the Bollocks ... Once upon a time, people believed that technologies were fully malleable to social dynamics. Marxists, social constructivists and management gurus (still) share great optimism in the human ability of solving technical problems, once the right organizational processes are in place. Revolutionary, ambitious, path-breaking. Occasionally bungling, though.

Session 3: It takes two to tango: Technological and organizational dynamics. And last, the big compromise, or the balance finally found? It is not white. It is not black. But it is not grey either. Pragmatic, practical, progressive. Relevant? Actionable?
The course will be based on some chapters of the books “Advanced Microeconomic Theory” by Jehle and Reny (2011) and W. D. Basin, A. Bommier, Risk Center Seminar Series. The objectives of this course are:

1. The objective of the course is to provide students with advanced knowledge in some areas of micro economic theory. The course will focus on 1) Individual behavior 2) Collective behavior 3) Choice under uncertainty 4) Intertemporal choice.

2. Advanced Microeconomics

3. Prerequisites / notice

On each session, students will have two assignments: 1) prepare a summary and critique of at least one of the readings for the day; 2) come prepared to critically discuss all the readings for the day. For the critique, readings will be preassigned in advance of each sessions.

Further info on assignments will be circulated by email before the start of the course.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Instructor</th>
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</thead>
<tbody>
<tr>
<td>364-1013-05L</td>
<td>Organizational Behavior</td>
<td>1</td>
<td>E. L. Paddock, G. Grote</td>
</tr>
<tr>
<td>364-1013-06L</td>
<td>Marketing Theory</td>
<td>1</td>
<td>F. von Wangenheim</td>
</tr>
<tr>
<td>364-1025-00L</td>
<td>Advanced Microeconomics</td>
<td>3</td>
<td>A. Bommier</td>
</tr>
<tr>
<td>364-1058-00L</td>
<td>Risk Center Seminar Series</td>
<td>0</td>
<td>H. Gersbach, D. Basin, A. Bommier</td>
</tr>
</tbody>
</table>

Abstract

Organizational behavior concerns the study of individual and group-level processes in organizations like creativity, motivation, decision-making, and leadership. In this module an overview of major research streams and empirical paradigms in organizational behavior is provided.

The objectives of this course are:

- to provide an overview of OB research
- to discuss major research streams in OB
- to enable students to relate their own research to concepts and methods used in OB

The course is taught Florian Wangenheim (ETHZ)

It focuses on the theoretical foundations of marketing and marketing research.

The purpose of the course is to confront students with current theoretical thinking in marketing, and currently used theories for understanding and explaining buyer and customer behavior in response to marketing action.

In the first class, current understanding of the marketing literature and marketing thought is discussed.

In the following classes, various theories are discussed, particularly in light of their importance for marketing. Economic, psychological and sociological theory will be related to current marketing thought.

The following topics will be addressed:

2) Collective models. Cooperative and non cooperative models of household behavior.
3) Choice under uncertainty. The foundations of expected utility theory. Some insights on other approaches to choice under uncertainty.
4) Intertemporal choice. Dynamic model. Life cycle theory.

The course will be based on some chapters of the books “Advanced Microeconomic Theory” by Jehle and Reny (2011) and “Microeconomic Theory”, by Mas-Colell, Whinston and Green (1995), as well as research articles for the most advanced parts.

This course is a mixture between a seminar primarily for PhD and postdoc students and a colloquium involving invited speakers. It consists of presentations and subsequent discussions in the area of modeling complex socio-economic systems and crises. Students and other guests are welcome.

Participants should learn to get an overview of the state of the art in the field, to present it in a well understandable way to an interdisciplinary scientific audience, to develop novel mathematical models for open problems, to analyze them with computers, and to defend their results in response to critical questions. In essence, participants should improve their scientific skills and learn to work scientifically on an internationally competitive level.

This course is a mixture between a seminar primarily for PhD and postdoc students and a colloquium involving invited speakers. It consists of presentations and subsequent discussions in the area of modeling complex socio-economic systems and crises. For details of the program see the webpage of the colloquium. Students and other guests are welcome.
### 364-1064-00L Inaugural Seminar - PhD Retreat

**Objective**
This course is geared towards first and second-year Ph.D. students of MTEC. It is held as a workshop style. Students attending this seminar will benefit from interdisciplinary discussions and insights into current and future work in business and economics research.

**Abstract**
This course is held jointly with Prof. Dr. Woitek and Prof. Dr. Hoffman from the University of Zurich, distinguished international researchers present their current research related to international economic policy. The participating doctoral students are expected to attend the presentations (bi-weekly). Moreover, a critical review has to be prepared for 1 of the papers presented.

**Prerequisites / notice**
Participating students are exposed to research at the frontier of international economic policy research. On the other hand, skills such as critical thinking and preparing reviews are learned.

**Literature**
Books:

Basic Articles:

A reading list with articles for each lecture has been published in Moodle.

### 364-1062-00L Experimental Methods

**Objective**
This course aims to prepare PhD students into the principles of experimental methods and outlines how to prepare, conduct and evaluate an experiment.

**Abstract**
This course introduces PhD students into the principles of experimental methods and outlines how to prepare, conduct and evaluate an experiment.

**Content**
1. Introduction: What are economic experiments and why to use them?
4. Conducting experiments: Instructions, testing, recruiting, sessions.
5. Measuring techniques: Eliciting beliefs, risk attitudes, social preferences.

**Literature**
Books:

Basic Articles:

A reading list with articles for each lecture has been published in Moodle.

### 364-1015-00L KOF-ETH-UZH International Economic Policy Seminar (University of Zurich)

**Objective**
This course is complemented by a course on programming experiments with z-tree. It is not mandatory but recommended to take both courses.

**Abstract**
No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: DOEC0584

Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

In this seminar series, which is held jointly with Prof. Dr. Woltek and Prof. Dr. Hoffman from the University of Zurich, distinguished international researchers present their current research related to international economic policy. The participating doctoral students are expected to attend the presentations (bi-weekly). Moreover, a critical review has to be prepared for 1 of the papers presented.

**Prerequisites / notice**
This course is complemented by a course on programming experiments with z-tree. It is not mandatory but recommended to take both courses.

**Literature**
Books:

Basic Articles:

A reading list with articles for each lecture has been published in Moodle.

### 364-1078-00L z-Tree: Programming Experiments in Economics and the Social Sciences

**Objective**
This course is complemented by a course on experimental methods (364-1062-00L Experimental Methods). It is not mandatory but recommended to take both courses.

**Abstract**
Learn the basic features of the software z-Tree. Learn how to program an experiment that can be implemented.

**Prerequisites / notice**
The class is open to all Ph.D. (and Master students) who are interested in conducting (behavioral) economic experiments.

**Course Catalogue of ETH Zurich**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
<th>Offered By</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>364-1064-00L</td>
<td>Inaugural Seminar - PhD Retreat</td>
<td>1</td>
<td>C. Waibel</td>
<td>This course is geared towards first and second-year Ph.D. students of MTEC. It is held as a workshop style. Students attending this seminar benefit from interdisciplinary discussions and insights into current and future work in business and economics research.</td>
</tr>
<tr>
<td>364-1062-00L</td>
<td>Experimental Methods</td>
<td>1</td>
<td>C. Waibel</td>
<td>This course introduces PhD students into the principles of experimental methods and outlines how to prepare, conduct and evaluate an experiment.</td>
</tr>
<tr>
<td>364-1015-00L</td>
<td>KOF-ETH-UZH International Economic Policy Seminar (University of Zurich)</td>
<td>2</td>
<td>P. Egger, J.E. Sturm</td>
<td>This course is complemented by a course on programming experiments with z-tree. It is not mandatory but recommended to take both courses.</td>
</tr>
<tr>
<td>364-1078-00L</td>
<td>z-Tree: Programming Experiments in Economics and the Social Sciences</td>
<td>1</td>
<td>J. Schmitz</td>
<td>Learn the basic features of the software z-Tree. Learn how to program an experiment that can be implemented.</td>
</tr>
</tbody>
</table>

**Prerequisites / notice**
Participants should have relatively good mathematical skills and some experience of how scientific work is performed.
<table>
<thead>
<tr>
<th>Key for Hours</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

**ECTS**
- European Credit Transfer and Accumulation System
- Special students and auditors need special permission from the lecturers.
<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0111-00L</td>
<td>Research Seminar in Fluid Dynamics</td>
<td>E-</td>
<td>0</td>
<td>2S</td>
<td>P. Jenny, T. Rösgen</td>
</tr>
<tr>
<td>Abstract</td>
<td>Current research projects at the Institute of Fluid Dynamics are presented and discussed.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>Exchange on current internal research projects. Training of presentation skills.</td>
<td></td>
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</tr>
<tr>
<td>151-0115-00L</td>
<td>Academia Industry Modeling Week (University of Zurich)</td>
<td>W</td>
<td>2</td>
<td>3S</td>
<td>University lecturers</td>
</tr>
<tr>
<td>Abstract</td>
<td>Enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.</td>
<td></td>
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<tr>
<td>Objective</td>
<td>Focused research by teams of Master and PhD students as well as post-doctoral fellows on applied problems proposed by industrial partners.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Team work on industrial problems. Interfacing academia and industry.</td>
<td></td>
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<tr>
<td>151-0906-00L</td>
<td>Frontiers in Energy Research</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>M. Mazzotti, R. S. Abhari, J. Carmelet, M. Filippini</td>
</tr>
<tr>
<td>Abstract</td>
<td>PhD students at ETH Zurich working in the broad area of energy present their research to their colleagues, to their advisors and to the scientific community.</td>
<td></td>
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<tr>
<td>Objective</td>
<td>Knowledge of advanced research in the area of energy.</td>
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<tr>
<td>Content</td>
<td>PhD students at ETH Zurich working in the broad area of energy present their research to their colleagues, to their advisors and to the scientific community.</td>
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</tr>
<tr>
<td>Lecture notes</td>
<td>Slides will be distributed.</td>
<td></td>
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</tr>
<tr>
<td>151-1049-00L</td>
<td>Seminar in Fundamentals of Process Engineering</td>
<td>W</td>
<td>1</td>
<td>1S</td>
<td>P. Rudolf von Rohr</td>
</tr>
<tr>
<td>Abstract</td>
<td>This seminar covers actual subjects from the specific research areas of the laboratory of transport processes and reactions.</td>
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<tr>
<td>Objective</td>
<td>Scientific discussion on actual research topics</td>
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<tr>
<td>Content</td>
<td>The contents are announced through the group's webpage.</td>
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</tr>
<tr>
<td>Lecture notes</td>
<td>No textbook</td>
<td></td>
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</tr>
<tr>
<td>Abstract</td>
<td>Current advanced research activities in the areas of thermo- and fluid dynamics are presented and discussed, mostly by external speakers.</td>
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<tr>
<td>Objective</td>
<td>Knowledge of advanced research in the areas of thermo- and fluid dynamics.</td>
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</tr>
<tr>
<td>151-1014-00L</td>
<td>Uncertainty Quantification for Engineering &amp; Life Sciences</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>P. Koumoutsakos</td>
</tr>
<tr>
<td>Abstract</td>
<td>Quantification of uncertainties in computational models pertaining to applications in engineering and life sciences. Exploitation of massively available data to develop computational models with quantifiable predictive capabilities. Applications of Uncertainty Quantification and Propagation to problems in mechanics, control, systems and cell biology.</td>
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<tr>
<td>Objective</td>
<td>The course will teach fundamental concept of Uncertainty Quantification and Propagation (UQ+P) for computational models of systems in Engineering and Life Sciences. Emphasis will be placed on practical and computational aspects of UQ+P including the implementation of relevant algorithms in multicore architectures.</td>
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<tr>
<td>Content</td>
<td>Topics that will be covered include: Uncertainty quantification under parametric and non-parametric modelling uncertainty, Bayesian inference with model class assessment, Markov Chain Monte Carlo simulation, prior and posterior reliability analysis.</td>
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</tr>
<tr>
<td>Literature</td>
<td>The class will be largely based on the book: Data Analysis: A Bayesian Tutorial by Devinderjit Sivia as well as on class notes and related literature that will be distributed in class.</td>
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</tr>
<tr>
<td>Literature</td>
<td>1. Data Analysis: A Bayesian Tutorial by Devinderjit Sivia</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Literature</td>
<td>2. Probability Theory: The Logic of Science by E. T. Jaynes</td>
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</tr>
<tr>
<td>Literature</td>
<td>3. Class Notes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prerequisites / notice</td>
<td>Fundamentals of Probability, Fundamentals of Computational Modeling</td>
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</tbody>
</table>

| 151-0107-20L | High Performance Computing for Science and Engineering (HPCSE) I         | W    | 4    | 4G    | M. Troyer, P. Chatzidoukas              |
| Abstract     | This course gives an introduction into algorithms and numerical methods for parallel computing for multi and many-core architectures and for applications from problems in science and engineering. |      |      |       |                                         |
The course is based mostly on notes developed by the instructor. The course presents an overview of measurement tasks in engineering environments. Different concepts for the acquisition and processing of typical measurement quantities are introduced. Following an initial in-class introduction, laboratory exercises from different application areas (especially in thermofluidics and process engineering) are attended by students in small groups.

**Objective**

Introduction to various aspects of measurement techniques, with particular emphasis on thermo-fluidic applications. Understanding of various sensing technologies and analysis procedures. Exposure to typical experiments, diagnostics hardware, data acquisition and processing. Study of applications in the laboratory.

**Content**

In-class introduction to representative measurement techniques in the research areas of the participating institutes (fluid dynamics, energy technology, process engineering)

Student participation in 8-10 laboratory experiments (study groups of 3-5 students, dependent on the number of course participants and available experiments)

Lab reports for all attended experiments have to be submitted by the study groups.

A final exam evaluates the acquired knowledge individually.

**Prerequisites**

- fluid mechanics, thermodynamics, heat and mass transfer
- electrical engineering / electronics
- numerical data analysis and processing (e.g. using MATLAB)

**Literature**


**Prerequisites / notice**

Basic understanding in the following areas:

- programming models and languages:
  - C++ threading (2 weeks)
  - OpenMP (4 weeks)
  - MPI (5 weeks)
- Computers and methods:
  - Hardware and architectures
  - Libraries
  - Particles: N-body solvers
  - Fields: PDEs
  - Stochastics: Monte Carlo

**Lecture notes**

http://www.cse-lab.ethz.ch/index.php/teaching/42-teaching/classes/615-hpcse1

**Class notes, handouts**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Semester</th>
<th>Credits</th>
<th>Prerequisites</th>
<th>Literature</th>
<th>Prerequisites / notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0123-00L</td>
<td>Experimental Methods for Engineers</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>A. Haselbacher</td>
<td></td>
</tr>
<tr>
<td>151-0182-00L</td>
<td>Fundamentals of CFD Methods</td>
<td>W</td>
<td>4 credits</td>
<td>2V+2U</td>
<td>T. Rösgen, R. S. Abhari, K. Boulouchos, D. J. Norris, H.M. Prasser, A. Steinfield</td>
<td></td>
</tr>
<tr>
<td>151-0517-00L</td>
<td>Scientific Visualization for Engineering Applications</td>
<td>W</td>
<td>4 credits</td>
<td>2V+2P</td>
<td>X. Tricoche</td>
<td></td>
</tr>
</tbody>
</table>

**Objective**

1. Students know and understand basic numerical methods used in CFD in terms of accuracy and stability.
2. Students have a basic understanding of a typical simple CFD code.
3. Students understand how to assess the numerical and physical accuracy of CFD results.

**Content**

1. Governing and model equations. Brief review of equations and properties
2. Overview of basic concepts: Overview of discretization process and its consequences
3. Overview of numerical methods: Finite-difference and finite-volume methods
4. Analysis of spatially discrete equations: Consistency, accuracy, stability, convergence of semi-discrete methods
5. Time-integration methods: LMS and RK methods, consistency, accuracy, stability, convergence
6. Analysis of fully discrete equations: Consistency, accuracy, stability, convergence of fully discrete methods
7. Solution of one-dimensional advection equation: Motivation for and consequences of upwinding, Godunov's theorem, TVD methods, DRP methods
8. Solution of two-dimensional advection equation: Dimension-by-dimension methods, dimensional splitting, multidimensional methods
9. Solution of one- and two-dimensional diffusion equations: Implicit methods, ADI methods
10. Solution of one-dimensional advection-diffusion equation: Numerical vs physical viscosity, boundary layers, non-uniform grids
11. Solution of incompressible Navier-Stokes equations: Incompressibility constraint and consequences, fractional-step and pressure-correction methods
12. Solution of incompressible Navier-Stokes equations on unstructured grids

**Prerequisites**

- Prior knowledge of fluid dynamics, applied mathematics, basic numerical methods, and programming in Fortran and/or C++ (knowledge of MATLAB is "not" sufficient).
This course consists of a series of seven lectures given by researchers who have distinguished themselves in the area of Robotics, Systems, and Controls. Please see http://www.msrl.ethz.ch/education/distinguished-seminar-in-robotics--systems---controls--151-0623-0.html for a list of upcoming lectures.

Content
- Graphics primer
- Data structures and spatial queries
- Smooth data reconstruction
- Color perception
- Color mapping
- Isosurfaces (level sets)
- Ridges
- Direct volume rendering and transfer function design
- Integral curves and surfaces
- Texture-based flow representations
- Tensor glyphs and curves
- Topological methods for scalar, vector, and tensor fields
- Multifield techniques
- Visualization software

Lecture notes
Course slides and relevant papers

Literature
Prerequisites / notice
Basic programming knowledge

151-0563-01L  Dynamic Programming and Optimal Control  W  4 credits  2V+1U  R. D’Andrea
Abstract Introduction to Dynamic Programming and Optimal Control.
Objective Covers the fundamental concepts of Dynamic Programming & Optimal Control.
Content Dynamic Programming Algorithm; Deterministic Systems and Shortest Path Problems; Infinite Horizon Problems, Bellman Equation; Deterministic Continuous-Time Optimal Control.
Prerequisites / notice Requirements: Knowledge of advanced calculus, introductory probability theory, and matrix-vector algebra.

Abstract This course provides a comprehensive overview of embedded control systems. The concepts introduced are implemented and verified on a microprocessor-controlled haptic device.
Objective Familiarize students with main architectural principles and concepts of embedded control systems.
Content An embedded system is a microprocessor used as a component in another piece of technology, such as cell phones or automobiles. In this intensive two-week block course the students are presented the principles of embedded digital control systems using a haptic device as an example for a mechatronic system. A haptic interface allows for a human to interact with a computer through the sense of touch.
Subjects covered in lectures and practical lab exercises include:
- The application of C-programming on a microprocessor
- Digital I/O and serial communication
- Quadrate decoding for wheel position sensing
- Queued analog-to-digital conversion to interface with the analog world
- Pulse width modulation
- Timer interrupts to create sampling time intervals
- System dynamics and virtual worlds with haptic feedback
- Introduction to rapid prototyping

Lecture notes
Lecture notes, lab instructions, supplemental material

Prerequisites / notice
Prerequisite courses are Control Systems I and Informatics I.

This course is restricted to 33 students due to limited lab infrastructure. Interested students please contact Marianne Schmid (E-Mail: marischm@ethz.ch)
After your reservation has been confirmed please register online at www.mystudies.ethz.ch.

Detailed information can be found on the course website http://www.idsc.ethz.ch/education/lectures/embedded-control-systems.html

151-0623-00L  ETH Zurich Distinguished Seminar in Robotics, Systems and Controls  W  1 credit  1S  B. Nelson, J. Buchli, M. Chli, R. Gassert, M. Hutter, W. Karlen, R. Riener, R. Siegwart
Abstract This course consists of a series of seven lectures given by researchers who have distinguished themselves in the area of Robotics, Systems, and Controls.
Objective Obtain an overview of various topics in Robotics, Systems, and Controls from leaders in the field. Please see http://www.msr1.ethz.ch/education/distinguished-seminar-in-robotics--systems---controls--151-0623-0.html for a list of upcoming lectures.
Content This course consists of a series of seven lectures given by researchers who have distinguished themselves in the area of Robotics, Systems, and Controls. MSc students in Robotics, Systems, and Controls are required to attend every lecture. Attendance will be monitored. If for some reason a student cannot attend one of the lectures, the student must select another ETH or University of Zurich seminar related to the field and submit a one page description of the seminar topic. Please see http://www.msr1.ethz.ch/education/distinguished-seminar-in-robotics--systems---controls--151-0623-0.html for a suggestion of other lectures.

Prerequisites / notice
Students are required to attend all seven lectures to obtain credit. If a student must miss a lecture then attendance at a related special lecture will be accepted that is reported in a one page summary of the attended lecture. No exceptions to this rule are allowed.

151-0765-00L  Leading and Coaching Focus Project Teams (Basic Course)  W  0 credits  2G+0.5A  R. P. Haas, I. Goller
Abstract This course is the first part of a two-semester course.
The course "Leading and Coaching Focus Project Teams (Basic Course)" for Autumn Semester is examined together with the course "Leading and Coaching Focus Project Teams (Advanced Course)" for Spring Semester with 4 ECTS.
Aim is enhancement of knowledge and competency regarding coaching skills. Participants should be coaches of focus projects. Topics:
Overview of the role and mind set of a coach, introduction into coaching methodology, building competencies by doing and exchanging good practices from former focus projects.

Basic knowledge about role and mindset of a coach;
Knowledge and reflection about the classical problems in coaching of a focus project;
Development of personal coaching skills;
Knowledge and know-how about coaching methods;
Reflection and exchange of experiences about personal coaching situations;
Inspiration and learning from good cases regarding organizational and team management aspects.

Knowledge and know-how about coaching methods:
- Knowledge about basic coaching methods for technical projects/innovations projects
- Know-how about usage of methods in the coaching process
- Facilitating decisions
- Using and applying coaches opinions and knowledge
- Reflection and exchange of experiences about personal coaching situations
- Self-reflection
- Exchange of experiences in the lecture group
- Good practice on organizational and management aspects
- How to do system and concurrent engineering
- Project planning and replanning
- Facilitating conflict situations
- Discussing sample cases from former teams and actual cases of participants.

Participants (Students, PhD Students, Postdocs) should be part of the coaching team of focus project teams.

The course "Leading and Coaching Focus Project Teams (Basic Course)" (HS) is examined together with "Leading and Coaching Focus Project Teams (Advanced Course)" (FS) in FS with 4 ECTS.

Most problems in engineering are of nonlinear nature. The nonlinearities are caused basically due to the nonlinear material behavior, contact conditions and instability of structures. The principles of the nonlinear Finite-Element-Method (FEM) will be introduced in the scope of this lecture for treating such problems.

The goal of the lecture is to provide the students with the fundamentals of the non linear Finite Element Method (FEM). The lecture focuses on the principles of the nonlinear Finite-Element-Method based on explicit and implicit formulations. Typical applications of the nonlinear Finite-Element-Methods are simulations of:
- Crash
- Collapse of structures
- Materials in Biomechanics (soft materials)
- General forming processes

Special attention will be paid to the modeling of the nonlinear material behavior, thermo-mechanical processes and processes with large plastic deformations. The ability to independently create a virtual model which describes the complex non linear systems will be acquired through accompanying exercises. These will include the Matlab programming of important model components such as constitutive equations.

Fundamentals of continuum mechanics to characterize large plastic deformations
- Elasto-plastic material models
- Updated-Lagrange (UL), Euler and combined Euler-Lagrange (ALE) approaches
- FEM implementation of constitutive equations
- Element formulations
- Implicit and explicit FEM methods
- FEM formulations of coupled thermo-mechanical problems
- Modeling of tool contact and the influence of friction
- Solvers and convergence
- Modeling of crack propagation
- Introduction of advanced FE-Methods

If we will have a large number of students, two dates for the exercises will be offered.

Discovering Management offers an introduction to the field of business management and entrepreneurship for engineers and natural scientists. The module provides an overview of the principles of management, teaches knowledge about management that is highly complementary to the students' technical knowledge, and provides a basis for advancing the knowledge of the various subjects offered at D-MTEC.
Discovering Management combines in an innovate format a set of lectures and an advanced business game. The learning model for 
Discovering Management involves 'learning by doing'. The objective is to introduce the students to the relevant topics of the management 
literature and give them a good introduction in entrepreneurship topics too. The course is a series of lectures on the topics of strategy, 
innovation, corporate finance, leadership, design thinking and corporate social responsibility. While the 14 different lectures provide the 
theoretical and conceptual foundations, the experiential learning outcomes result from the interactive business game. The purpose of the 
business game is to analyse the innovative needs of a large multinational company and develop a business case for the company to grow. 
This business case is as relevant to someone exploring innovation within an organisation as it is if you are planning to start your own 
business. By discovering the key aspects of entrepreneurial management, the purpose of the course is to advance students’ understanding 
of factors driving innovation, entrepreneurship, and company success.

This course intends to enable all students to:

Slides will be available on the TIMGROUP website.

F. von Wangenheim

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

F. von Wangenheim

We develop a ‘systemic’ view of organizations.

Further information is available on the Tim Group Chair's website:

http://www.timgroup.ethz.ch/en/courses

and on the Moodle of the course:

https://moodle-app2.ielt.ethz.ch/course/view.php?id=2209

(The Enrollment Key to Moodle will be provided during the course)


Selected readings from the book and additional learning materials will be available on the course Moodle:

https://moodle-app2.ielt.ethz.ch/course/view.php?id=2209

All the materials uploaded on Moodle must be considered as required readings.

The final exam of the present course is in written form.

The final exam is requested for all types of students (BSc, MSc, MAs, PhD, and Exchange students).

It is not possible to retake the exam within the same term or academic year.

We strongly recommend Exchange students to take it into consideration when selecting the courses to attend.

We consider how managerial decisions are made in any one of these domains affect decisions in each of the others.

No prior knowledge of business or economics is required to successfully complete this course.

No prior knowledge of business or economics is required to successfully complete this course.

363-0341-00L

Introduction to Management

W 3 credits 2G  S. Brusoni, P. Baschera

Objective

We develop a ‘systemic’ view of organizations.

Content

Further information is available on the Tim Group Chair’s website:

http://www.timgroup.ethz.ch/en/courses

and on the Moodle of the course:

https://moodle-app2.ielt.ethz.ch/course/view.php?id=2209

(The Enrollment Key to Moodle will be provided during the course)


Selected readings from the book and additional learning materials will be available on the course Moodle:

https://moodle-app2.ielt.ethz.ch/course/view.php?id=2209

All the materials uploaded on Moodle must be considered as required readings.

The final exam of the present course is in written form.

The final exam is requested for all types of students (BSc, MSc, MAs, PhD, and Exchange students).

It is not possible to retake the exam within the same term or academic year.

We strongly recommend Exchange students to take it into consideration when selecting the courses to attend.

Technology and Innovation Management

W 3 credits 2G  S. Brusoni

Objective

This course intends to enable all students to:

- understand the core concepts necessary to analyze how innovation happens
- master the most common methods and tools organizations deploy to innovate
- develop the ability to critically evaluate the innovation process, and act upon the main obstacles to innovation

Content

This course looks at technology and innovation management as a process. Continuously, organizations are faced with a fundamental 
decision: they have to allocate resources between well-known tasks that reliably generate positive results; or explore new ways of doing 
things, new technologies, products and services. The latter is a high risk choice. Its rewards can be high, but the chances of success are small.

How do firms organize to take these decisions? What kind of management skills are necessary to take them? What kind of tools and 
methods are deployed to sustain managerial decision-making in highly volatile environments? These are the central questions on which 
this course focuses, relying on a combination of lectures, case-based discussion, guest speakers, simulations and group work.

Lecture notes

Slides will be available on the TIMGROUP website.

Literature

Readings will be available on the TIMGROUP website.

Prerequisites /

notice

No specific background in economics or management is required.

363-0403-00L

Abstract

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

F. von Wangenheim

Autumn Semester 2016
The learning objectives of the course are:

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

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

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


Weekly readings, distributed in class (via Moodle)

363-0503-00L Principles of Microeconomics W 3 credits 2G M. Filippini

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

Content
The course introduces basic principles, problems and approaches of microeconomics.

(1) Students must be able to discuss basic principles, problems and approaches in microeconomics. (2) Students can analyse and explain simple economic principles in a market using supply and demand graphs. (3) Students can contrast different market structures and describe firm and consumer behaviour. (4) Students can identify market failures such as externalities related to market activities and illustrate how these affect the economy as a whole. (5) Students can apply simple mathematical treatment of some basic concepts and can solve utility maximization and cost minimization problems.

Lecture notes
Lecture notes, exercises and reference material can be downloaded from Moodle.

Literature

The book can also be used for the course 'Principles of Macroeconomics' (Sturm)

For students taking only the course 'Principles of Microeconomics' there is a shorter version of the same book:

Complementary:

363-0511-00L Managerial Economics W 4 credits 3V S. Rausch, V. Hoffmann

Objective
Managerial Economics applies economic theory and methods to business and economic decision-making. Economic ideas related to optimization, the theory of consumer demand, the theory of the firm, industrial organization and decision making under uncertainty are studied using methods of numerical analysis, statistical estimation, game theory and constrained optimization.

Abstract
The objective of the course is to provide undergraduate and graduate students in MAVT with an understanding of the use of economic concepts for firm-level management decisions. The course covers a number of models and methods of analysis which are commonly employed in business decisions. The course covers the economic theory of choice, models of oligopoly and industrial organization, applications of game theory to contract design and agency theory, and the theory of decision making under uncertainty focusing specifically on long-term investment decisions. The course will include three lectures by Professor Volker Hoffman focusing on related case-studies in management.

Literature
Mikróökonomie (Pearson Studium - Economic VWL) Gebundene Ausgabe, August 2013, Robert S. Pindyck, Dr. Daniel L. Rubinfeld.

Prerequisites / notice
The course acquaints students who have previous not studied economics to economic concepts and quantitative methods which can be used to solve management decision problems.

363-0565-00L Principles of Macroeconomics W 3 credits 2V J.E. Sturm

Abstract
This course examines the behaviour of macroeconomic variables, such as gross domestic product, unemployment and inflation rates. It tries to answer questions like: How can we explain fluctuations of national economic activity? What can economic policy do against unemployment and inflation? What significance do international economic relations have for Switzerland?

Objective
This course helps you understand the world in which you live. There are many questions about the macroeconomy that might spark your curiosity. Why are living standards so meagre in many African countries? Why do some countries have high rates of inflation while others have stable prices? Why have some European countries adopted a common currency? These are just a few of the questions that this course will help you answer.

Furthermore, this course will give you a better understanding of the potential and limits of economic policy. As a voter, you help choose the policies that guide the allocation of society's resources. When deciding which policies to support, you may find yourself asking various questions about economics. What are the burdens associated with alternative forms of taxation? What are the effects of free trade with other countries? What is the best way to protect the environment? How does the government budget deficit affect the economy? These and similar questions are always on the minds of policy makers.

Literature
The course webpage (to be found at https://moodle-app2.let.ethz.ch/course/view.php?id=2467) contains announcements, course information and lecture slides.

363-0711-00L Accounting for Managers W 3 credits 2V M. Passardi

This course helps you understand the world in which you live. There are many questions about the macroeconomy that might spark your curiosity.

We advise you to also buy access to Aplia. This internet platform will support you in learning for this course. To save money, you should buy the book together with Aplia. This is sold as a bundle (ISBN: 9781473715998).

Besides this textbook, the slides and lecture notes will cover the content of the lecture and the exam questions.
### 363-0790-00L Technology Entrepreneurship

**W**

2 credits

2V

U. Claesson, B. Clarysse

#### Abstract

Technology ventures are significantly changing the global economic picture. Technological skills increasingly need to be complemented by entrepreneurial understanding. This course aims to introduce students to the fundamentals of theory and practice of entrepreneurship in new technology ventures. Main topics covered are success factors in the creation of new firms, including founding, financing and growing a venture.

#### Objective

- Understand the different procedures involved in the accounting system
- Record change in balance sheet
- Measure business income
- Prepare final accounts
- Understand the principles of cost accounting
- Calculate the different product costs
- Make decisions about the acceptance or rejection of a particular product

#### Content

- Managerial Accounting: Full costing, variable costing, cost-volume profit, break-even analysis, activity-based costing

#### Prerequisites / notice

This course is a prerequisite for the course Financial Management.

<table>
<thead>
<tr>
<th>Literature</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecture slides and case material</td>
<td>See course website: <a href="http://www.entrepreneurship.ethz.ch/sresources/courses/tech-entrepreneurship.html">http://www.entrepreneurship.ethz.ch/sresources/courses/tech-entrepreneurship.html</a></td>
</tr>
</tbody>
</table>

### 363-1201-00L Monetary Policy

**W**

3 credits

2V

J.E. Sturm, D. Kaufmann

#### Abstract

The main aim of this course is to analyse the goals of monetary policy and to review the instruments available to central banks in order to pursue these goals. It will focus on the transmission mechanisms of monetary policy and the differences between monetary policy rules and discretionary policy. It will also make connections between theoretical economic concepts and current real world issues.

#### Objective

This lecture will introduce the fundamentals of monetary economics and explain the working and impact of monetary policy.

#### Literature

The course will be based on chapters of:


#### Prerequisites / notice

- Basic knowledge in international economics and a good background in macroeconomics.
- The course website can be found at: [https://moodle-app2.let.ethz.ch/course/view.php?id=2457](https://moodle-app2.let.ethz.ch/course/view.php?id=2457)

### 401-0625-01L Applied Analysis of Variance and Experimental Design

**W**

5 credits

2V+1U

L. Meier

#### Abstract


#### Objective

- Participants will be able to plan and analyze efficient experiments in the fields of natural sciences. They will gain practical experience by using the software R.

#### Content

- Principles of experimental design.
- One-way analysis of variance.
- Multi-factor experiments and analysis of variance.
- Block designs.
- Latin square designs.
- Split-plot and strip-plot designs.
- Random effects and mixed effects models.
- Full factorials and fractional designs.

#### Literature


#### Prerequisites / notice

- The exercises, but also the classes will be based on procedures from the freely available, open-source statistical software R, for which an introduction will be held.

### 535-0546-00L Patents

**W**

1 credit

1V

A. Koept, P. Pliska

#### Abstract

Knowledge in the field of intellectual property, especially of patents and trademarks, with particular emphasis on pharmacoeconomics. Introduction into intellectual property; prosecution of patent applications; patent information; exploitation and enforcement of patents; peculiarities in pharmacoeconomics and medicine; social, political and ethical aspects; Trademarks.

#### Objective

- Basic knowledge in the field of industrial property, especially of patents and trademarks, with particular emphasis on the chemical, pharmaceutical and biotech field.

#### Content

1. Introduction into industrial property (patents, trademarks, industrial designs);
2. Prosecution of patent applications (patentability);
3. Patent information (patent publications, databases, searches);
4. Exploitation and enforcement of patents (possibilities of exploitation, licenses, parallel imports, scope of protection, patent infringement);
5. Peculiarities in pharmacoeconomics and medicine (supplementary protection certificates, experimental use exemption, therapy and diagnosis, medical indication);
6. Social, political and ethical aspects (patents and prices for medicinal products, traditional knowledge and ethnomedicine, bioprospecting and biopiracy, human DNA inventions);
7. Trademarks, types of trademarks, grounds for refusal, peculiarities of pharma-trademarks.

#### Lecture notes

- A script is available in electronic form during the lecture.

#### Literature

Objective
The students are supposed to acquire a deep understanding of the process of biological design including model representation of a biological system, its thorough analysis, and the subsequent experimental implementation of the system and the related problems.

Content
Presentations on advanced synthetic biology topics (e.g., genetic circuit design, adaptation of systems dynamics, analytical concepts, large scale de novo DNA synthesis), project selection, modeling of selected biological system, design space exploration, sensitivity analysis, conversion into DNA sequence, (DNA synthesis external) implementation and analysis of design, summary of results in form of scientific presentation and poster, presentation of results at the iGEM international student competition (www.igem.org).

Lecture notes
Handouts during course

Prerequisites / notice
The final presentation of the project is typically at the MIT (Cambridge, US). Other competing schools include regularly Imperial College, Cambridge University, Harvard University, UC Berkeley, Princeton University, CalTech, etc.

This project takes place between end of Spring Semester and beginning of Autumn Semester. Registration in April.

Please note that the number of ECTS credits and the actual work load are disconnected.

851-0180-00L Research Ethics 2 credits 2G G. Achermann
Particularly suitable for students of D-BIOL, D-CHAB, D-HEST

Abstract
This course has its focus on the responsible conduct of research (RCR) and the ethical dimensions of the biological and biomedical sciences.

Objective
The main goal of this course is to enhance the student's ability to:
- recognize and identify ethical issues and conflicts,
- analyze and develop well-reasoned responses to the kinds of ethical problems a scientist is likely to encounter.

Additionally, students will become familiar with regulations and ethical guidelines relevant for their research field on the international, governmental, institutional and professional level.

To achieve these objectives, teaching methods will include lectures, discussions, case study work (alone and in groups), moral games, paper work and exercises.
I. Ethics & the Process of Ethical Inquiry

Introduction in Ethics and Research Ethics
- What is ethics? What ethics is not...;
- Awareness: what constitutes an ethical question? Distinguishing ethical questions from other kinds of questions; Science & ethics: a comparison;
- The ethics movement in the biological and health sciences;
- What is research ethics and why is it important?
- Values (personal, cultural & ethical) in science & principles for ethical conduct in research;
- Professional codes of conduct: functions and limitations

Ethical approaches in the conduct of research (Normative Ethics)
- Overview over important theories for research ethics: virtue theories, duty-based theories (rights theory, categorical imperative, prima facie duties), consequentialist theories, other theories);
- The plurality of ethical theories and its consequences;
- The concept of dignity

Moral reasoning I: Arguments
- Why arguments? What is a good argument? The structure of (moral) arguments;
- Deductive and inductive arguments; Validity and soundness;
- Assessing moral arguments

Moral reasoning II: Decision-making
- How (not) to approach ethical issues...; Is there a correct method for answering moral questions?
- Models of method in Applied Ethics: a) Top-down approaches; b) the reflective equilibrium; c) a bottom-up approach: casuistry (or reasoning-by-analogy);
- Is there a right answer?

II. Research Ethics / Responsible Conduct of Research (RCR)

Integrity in Research & Research Misconduct
- What is "integrity" in scientific research? What is research misconduct (falsification, fabrication, plagiarism - FFP) and questionable research practices (QRP)?
- Factors leading to misconduct; Procedure for responding to allegations of research misconduct;
- The confidant of ETH Zurich

Data Management
- Data collection and recordkeeping; Analysis and selection of data;
- Ownership of data; retention and sharing of data;
- Falsification and fabrication of data

Research involving animals
- The moral status of animals; Ethical approaches to animal experimentation: Animal welfare (Peter Singer) and Animal rights (Tom Regan);
- The 3 Rs (replacement, reduction, refinement);
- Ethical assessment of conflicting issues in animal experimentation;
- The dignity of animals in the Swiss constitution;

Research involving human subjects
- History & guidelines (Nuremberg Code; Declaration of Helsinki; Belmont Report; International Ethical Guidelines for Biomedical Research Involving Human Subjects (CIOMS Guidelines); Convention on Human Rights and Biomedicine (Oviedo Convention);
- Informed consent; confidentiality and anonymity; research risks and benefits; vulnerable subjects;
- Clinical trials;
- Biobanks
- Ethics Committees / Institutional Review Boards (IRB)

Authorship & Peer review
- Criteria for authorship;
- Plagiarism;
- Challenges to openness and freedom in scientific publication;
- Open access
- Peer review

Social responsibility
- What is social responsibility? Social responsibility: whose obligation?
- Public advocacy by researchers

Lecture notes
Course material (handouts, case studies, exercises, surveys and papers) will be available during the lectures and on the course homepage.

Literature
Recommended literature:
- "Introduction to the Responsible Conduct of Research" (http://ori.dhhs.gov/education/products/RCRintro/)

Detailed literature lists for the different topics of the course will be provided in the script/handout or on the course work space.

Course Catalogue of ETH Zurich
**Doctoral Department of Mechanical and Process Engineering - Key for Type**

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
<tr>
<td>O</td>
<td>Compulsory</td>
</tr>
</tbody>
</table>

**Key for Hours**

<table>
<thead>
<tr>
<th>Key</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

**ECTS**

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Doctoral Department of Materials Science


► Doctoral and Post-Doctoral Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>327-0710-00L</td>
<td>Polymer Physics</td>
<td>E-</td>
<td>0</td>
<td>2S</td>
<td>H. C. Öttinger, M. Kröger</td>
</tr>
<tr>
<td>Abstract</td>
<td>Group seminar in polymer physics</td>
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<tr>
<td>Objective</td>
<td>Continued and deeper education in polymer physics, in particular, for Ph.D. students</td>
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<tr>
<td>Content</td>
<td>Presentation and discussion of ongoing research projects by members of the polymer physics group and external speakers</td>
<td></td>
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</tr>
<tr>
<td>Lecture notes</td>
<td>No script</td>
<td></td>
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</tr>
<tr>
<td>Prerequisites / notice</td>
<td>Irregular series of presentations (see announcements)</td>
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<tr>
<td>327-0711-00L</td>
<td>Metal Physics and Technology Seminar</td>
<td>E-</td>
<td>0</td>
<td>2S</td>
<td>J. F. Löffler</td>
</tr>
<tr>
<td>Abstract</td>
<td>Seminar for Ph.D. students and researchers in the area of metal physics and technology.</td>
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<tr>
<td>Objective</td>
<td>Detailed education of researchers in the area of metallic materials.</td>
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<tr>
<td>Content</td>
<td>Presentation and discussion of latest research results concerning basic principles of metals research and development of new metallic materials.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>- Requirements: Involvement in research activities.</td>
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<tr>
<td></td>
<td>- Lectures are generally in English.</td>
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<tr>
<td>327-0712-00L</td>
<td>Nanometallurgy</td>
<td>E-</td>
<td>0</td>
<td>2S</td>
<td>R. Spolenak</td>
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<tr>
<td>Abstract</td>
<td>Seminar for Ph.D. students and researchers in the area of nanometallurgy.</td>
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<tr>
<td>Objective</td>
<td>Detailed education of researchers in the area of nanometallurgy.</td>
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<tr>
<td>327-1300-00L</td>
<td>Joint Group Seminar</td>
<td>E-</td>
<td>0</td>
<td>1S</td>
<td>M. Fiebig, N. Spaldin</td>
</tr>
<tr>
<td>Abstract</td>
<td>Only for D-MATL doctoral students</td>
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<tr>
<td>Objective</td>
<td>Seminar for PhD students and researchers in condensed-matter physics.</td>
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<tr>
<td>Content</td>
<td>Improving the interaction of researchers in the participating groups.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Presentation and discussion of contemporary research.</td>
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<tr>
<td></td>
<td>Own scientific contributions.</td>
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<tr>
<td>327-0721-00L</td>
<td>Writing for Publication in Materials Science</td>
<td>Dr</td>
<td>2</td>
<td>1G</td>
<td>R. Mihalka</td>
</tr>
<tr>
<td>Objective</td>
<td>This short course is designed to help junior researchers in Materials Science develop the skills needed to write their first research articles.</td>
<td></td>
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<tr>
<td>Abstract</td>
<td>Writing for Publication in Materials Science is a short course (5 x 4-lesson workshops) designed to help junior researchers develop the skills needed to write their first research articles.</td>
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<tr>
<td>Content</td>
<td>- Identifying target readerships and selecting outlets,</td>
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<tr>
<td></td>
<td>- Managing the writing process efficiently,</td>
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<td></td>
<td>- Structuring the text effectively,</td>
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<td>- Producing logical flow in sentences and paragraphs,</td>
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<td>- Editing the text before submission, and</td>
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<tr>
<td></td>
<td>- Revising the text in response to reviewers’ comments.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Participants will be expected to produce a number of short texts as homework assignments and will receive individual feedback on these during the course. Wherever feasible, elements of participants’ future research articles can be developed as assignments within the course, so it is likely to be particularly useful for those who have their data and are about to begin the writing process.</td>
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<tr>
<td></td>
<td>Part 1: Introduction to the course; the writing context; identifying target readers and targeting journals; using model texts; activating vocabulary; writing clear English sentences; the English verb system in research publications - using tense, aspect, and voice</td>
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<td>Part 2: The writing process; structural decisions (IMRD and variations); from plan to draft; basics of paragraph structure; reader-friendly paragraph structure; patterns and tools for creating logical flow; the English noun phrase in research publications</td>
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<td>Part 3: The experimental narrative; process descriptions, explanation and justification; data commentaries; embedding figures, diagrams, etc.</td>
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<td>Part 4: Introductions; creating a research space (CARS); writing about the literature; reference, citation, paraphrase and quotation; discussion and conclusion sections; overview of abstracts and titles</td>
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<td>Part 5: Managing the strength of the claim - hedging and emphasis; punctuation and style; the editing process; responding to reviewers’ comments; preparing writing portfolios for assessment and research articles for submission.</td>
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<tr>
<td></td>
<td>This short course is designed to help junior researchers in Materials Science develop the skills needed to write their first research articles.</td>
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<tr>
<td>151-0906-00L</td>
<td>Frontiers in Energy Research</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>M. Mazzotti, R. S. Abhari, J. Carmeliet, M. Filippini</td>
</tr>
<tr>
<td>Abstract</td>
<td>PhD students at ETH Zurich working in the broad area of energy present their research to their colleagues, to their advisors and to the scientific community.</td>
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<tr>
<td>Objective</td>
<td>Knowledge of advanced research in the area of energy.</td>
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</tr>
<tr>
<td>Content</td>
<td>PhD students at ETH Zurich working in the broad area of energy present their research to their colleagues, to their advisors and to the scientific community. Every week there are two presentations, each structured as follows: 15 min introduction to the research topic, 15 min presentation of the results, 15 min discussion with the audience.</td>
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</tr>
<tr>
<td>Lecture notes</td>
<td>Slides will be distributed.</td>
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</tbody>
</table>
Doctoral Department of Materials Science - Key for Type

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
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<tr>
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<tr>
<td>O</td>
<td>Compulsory</td>
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</table>

Key for Hours

<table>
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<tr>
<th>Letter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
The course shall begin with the basic structure associated to hyperbolic partial differential equations, characteristic hypersurfaces and bicharacteristics, causal structure, and the domain of dependence theorem. The course then focuses on nonlinear systems of equations in two independent variables, in particular the Euler equations of compressible fluids with plane symmetry and the Einstein equations of general relativity with spherical symmetry.

Objective
The objective is to introduce students in mathematics and physics to an area of mathematical analysis involving differential geometry which is of fundamental importance for the development of classical macroscopic continuum physics.

Content
The course begins with characteristics, the definition of hyperbolicity, causal structure and the domain of dependence theorem. The course then focuses on nonlinear systems of equations in two independent variables, in particular the Euler equations of compressible fluids with plane symmetry and the Einstein equations of general relativity with spherical symmetry.

Prerequisites / notice
Basic real analysis and differential geometry.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-5001-66L</td>
<td>Stochastic Arnold Diffusion of Deterministic Systems</td>
<td>Z</td>
<td>0 credits</td>
<td>2V</td>
<td>V. Kaloshin</td>
</tr>
<tr>
<td>Abstract</td>
<td>Nachdiplom lecture</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Content</td>
<td>In 1964, V. Arnold constructed an example of a nearly integrable deterministic system exhibiting instabilities. In the 1970s, physicist B. Chirikov coined the term for this phenomenon &quot;Arnold diffusion&quot;, where diffusion refers to stochastic nature of instability. One of the most famous examples of stochastic instabilities for nearly integrable systems is dynamics of asteroids in Kirkwood gaps in the Asteroid belt. They were discovered numerically by astronomer J. Wisdom. During the course we shall discuss various aspects of this phenomenon. In particular, a class of nearly integrable deterministic systems, where stochastic diffusive behaviour was proven, namely, that distributions given by deterministic evolution of certain probability measures weakly converge to a stochastic diffusion process.</td>
<td></td>
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</tbody>
</table>

| 401-5003-66L | Some Problems of Mathematical Fluid Dynamics | Z    | 0 credits | 2V | A. Shnirelmann |
| Abstract | Nachdiplom lecture                         |      |      |       |                     |
| Content  | Ideal incompressible fluid is one of the most fundamental models in the continuum mechanics. The fluid flow is described by the Euler-Lagrange equations which, in spite of their apparent simplicity, are among the toughest in the whole mathematics. No wonder that the study of these equations involves many different mathematical structures, and requires a stereoscopical approach to capture the full picture. In these lectures I'll propose various viewpoints on the fluid. Here are the topics of the lectures. 1. Analyticity properties of the flows of the ideal incompressible fluid. Complex singularities, their persistence and propagation. 2. Singularities of solutions, their propagation and evolution. Exponential map as an elliptic paradifferential operator. Microlocal integrals and Liapunov functions. Glomorphismal structure of the group of volume preserving diffeomorphisms and the exponential map. 3. Two-point problem for the Euler-Lagrange equations. Surjectivity of the exponential map in 2-d, and pathologies in 3-d. 4. Braids and flows. Length minimizing braids and weak solutions in 2-d. Minimal folded braids and the inverse cascade solutions. 5. Generalized flows and weak solutions of the Euler equations. Models of turbulent cascade. 6. Long-time behavior of solutions of the Euler equations and the existence of a non-trivial attractor. |

| 401-5005-66L | Random Two-Dimensional Geometries | Z    | 0 credits | 2V | G. Miermont |
| Abstract | Nachdiplom lecture                         |      |      |       |                     |
| Content  | There have been some very important efforts in the recent years to understand certain canonical models of two-dimensional random geometries, whose inspiration came from theoretical physics in the years 80-90. These are defined either as continuum limits of discrete models (random maps) or purely continuum objects defined in terms of conformally invariant processes (Gaussian free field, SLE). In these lectures, we will review the perspective on scaling limits of random maps, discuss the various ways to encode them based on their combinatorics, and describe some of the (many) natural continuum random structures that arise from these models. In the third part of the course, the most important one, we will present the notion of Singular Integrals and Calderón-Zygmund theory as well as their application to the analysis of linear elliptic operators. |

| 401-4767-66L | Partial Differential Equations (Hyperbolic PDEs) | W    | 7 credits | 4V | D. Christodoulou |
| Abstract | The course begins with characteristics, the definition of hyperbolicity, causal structure and the domain of dependence theorem. The course then focuses on nonlinear systems of equations in two independent variables, in particular the Euler equations of compressible fluids with plane symmetry and the Einstein equations of general relativity with spherical symmetry. |

| 401-4463-62L | Fourier Analysis in Function Space Theory | W    | 6 credits | 3V | T. Rivière |
| Abstract | In the most important part of the course, we will present the notion of Singular Integrals and Calderón-Zygmund theory as well as its application to the analysis of linear elliptic operators. |

| Literature |
| 2) Javier Duoandikoetxea, "Fourier Analysis" AMS. |
| 3) Loukas Grafakos, "Classical Fourier Analysis" GTM 249 Springer. |
| 4) Loukas Grafakos, "Modern Fourier Analysis" GTM 250 Springer. |
401-4145-66L Reading Course: Abelian Varieties over Finite Fields

**Abstract**

In this course we try to understand Peter Scholze's seminal paper on Perfectoid Spaces. We will cover in details (as much as time permits) the preliminary background from Huber's work on adic spaces, which provides the context for the basic constructions. Time permitting, we will also see how this theory leads to applications in p-adic etale cohomology.

**Content**

In this course we try to understand Peter Scholze's seminal paper on Perfectoid Spaces. We will cover in details (as much as time permits) the preliminary background from Huber's work on adic spaces, which provides the context for the basic constructions. Time permitting, we will also see how this theory leads to applications in p-adic etale cohomology.

The theory of perfectoid spaces provides functions, called tilting, between geometric objects in characteristic 0 and in characteristic p. In the zero dimensional case (fields) this essentially recovers a construction of Fontaine and Wintenberger that underlies p-adic Hodge theory: the absolute Galois group of an infinitely ramified p-adic field and that of the perfection of the corresponding Laurent series field (the tilted field) are canonically isomorphic. Subsequent works by Scholze have shown that perfectoid spaces are a powerful new tool across many aspects of arithmetic geometry.

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**401-4322-00L Introduction to Lie Groups**

**Abstract**

Topological groups and Haar measure. Definition of Lie groups, examples of local fields and examples of discrete subgroups; basic properties; Lie subgroups. Lie algebras and relation with Lie groups: exponential map, adjoint representation. Semisimplicity, nilpotency, solvability, compactness: Killing form, Lie's and Engel's theorems. Definition of algebraic groups and relation with Lie groups.

**Objective**

The goal is to have a broad though foundational knowledge of the theory of Lie groups and their associated Lie algebras with an emphasis on the algebraic and topological aspects of it.

**Literature**

- A. Knapp: “Lie groups beyond an Introduction” (Birkhaeuser)
- F.Warner: “Foundations of differentiable manifolds and Lie groups” (Springer)
- J. Helgason: “Differential geometry, Lie groups and symmetric spaces” (Academic Press, ’78)

**Prerequisites / notice**

Topology and basic notions of measure theory. A basic understanding of the concepts of manifold, tangent space and vector field is useful, but could also be achieved throughout the semester.

**Course webpage:** http://www.math.ethz.ch/education/bachelor/lectures/hs2014/math/introlg

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**401-4531-66L Topics in Rigidity Theory**

**Abstract**

The aim of this course is to give detailed proofs of Margulis' normal subgroup theorem and his superrigidity theorem for lattices in higher rank Lie groups.

**Objective**

Understand the basic techniques of rigidity theory.

**Content**

This course gives an introduction to rigidity theory, which is a set of techniques initially invented to understand the structure of a certain class of discrete subgroups of Lie groups, called lattices, and currently used in more general contexts of groups arising as isometries of non-positively curved geometries. A prominent example of a lattice in the Lie group $SL(n, \mathbb{R})$ is the group $SL(n, \mathbb{Z})$ of integer $n \times n$ matrices with determinant 1. Prominent questions concerning this group are:

- Describe all its proper quotients.
- Classify all its finite dimensional linear representations.
- More generally, can this group act by diffeomorphisms on "small" manifolds like the circle?
- Does its Cayley graph considered as a metric space at large scale contain enough information to recover the group structure?

In this course we will give detailed treatment for the answers to the first two questions; they are respectively Margulis’ normal subgroup theorem and Margulis’ superrigidity theorem. These results, valid for all lattices in Lie groups of rank at least 2 – like $SL(n, \mathbb{R})$, with $n$ at least 3 – lead to the arithmeticity theorem, which says that all lattices are obtained by an arithmetic construction.

**Literature**

- W. Witte-Morris: “Introduction to Arithmetic groups”, available on Arxiv
- Y. Benoist: “Five lectures on lattices in simeple Lie groups”, available on his homepage.
- M. Burger: “Rigidity and Arithmeticity”, European School of Group Theory, 1996, handwritten notes, will be put online.

**Prerequisites / notice**

For this course some knowledge of elementary Lie theory would be good. We will however treat Lie groups by examples and avoid structure theory since this is not the point of the course nor of the techniques.

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**401-3001-61L Algebraic Topology I**

**Abstract**

This is an introductory course in algebraic topology. The course will cover the following main topics: introduction to homotopy theory, homology and cohomology of spaces.

**Literature**


Book can be downloaded for free at: http://www.math.cornell.edu/%7eehatcher/AT/ATpage.html

See also: http://www.math.cornell.edu/%7eehatcher/#anchor1772800

**Prerequisites / notice**

3) E. Spanier, “Algebraic topology”, Springer-Verlag

General topology, linear algebra.

Some knowledge of differential geometry and differential topology is useful but not absolutely necessary.

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**401-3536-11L Geometric Aspects of Hamiltonian Dynamics**

**Abstract**

The course will concentrate on the geometry of the group of Hamiltonian diffeomorphisms introduced by Hofer in the early 1990’s and its relations to various topics in symplectic geometry such as capacities, Lagrangian submanifolds, holomorphic curves, as well as recent algebraic structures on the group of Hamiltonian diffeomorphisms such as quasi-morphisms.

**Literature**

Books:
- L. Polterovich: “The geometry of the group of symplectic diffeomorphisms”
- H. Hofer & E. Zehnder: “Symplectic invariants and Hamiltonian dynamics”

**Prerequisites / notice**

Prerequisites. Good knowledge of undergraduate mathematics (analysis, complex functions, topology, and differential geometry). Some knowledge of elementary algebraic topology would be useful.
In this course we study the concept of a semigroup of bounded linear operators and we use this concept to investigate existence, uniqueness, and regularity properties of solutions of partial differential equations (PDEs) of the evolutionary type.

The aim of this course is to teach the students a decent knowledge (i) on semigroups of bounded linear operators, (ii) on solutions of partial differential equations (PDEs) of the evolutionary type, and (iii) on the analytic concepts used to formulate and study such semigroups and such PDEs.

The course includes content (i) on semigroups of bounded linear operators, (ii) on solutions of partial differential equations (PDEs) of the evolutionary type, and (iii) on the analytic concepts used to formulate and study such semigroups and such PDEs. Key example PDEs that are treated in this course are heat and wave equations.

Lecture Notes are available in the lecture homepage (please follow the link in the Learning materials section).

Mandatory prerequisites: Functional analysis

Start of lectures: Friday, September 23, 2016

For more details, please follow the link in the Learning materials section.
The field of photonics encompasses the fundamental science of light propagation and interactions in complex structures, and its applications in technology and healthcare. It includes the use of photonics in advanced lighting technology, improving energy efficiency and quality, and in developing new materials with unique properties.

Interactions between the field of photonics and mathematics have led to the emergence of a multitude of new and unique solutions in which mathematical tools, computational approaches, and inversion and optimal design methods are used to address challenging problems in nanophotonics. The emphasis will be on analyzing plasmon resonant nanoparticles, super-focusing & super-resolution of electromagnetic waves, photonic crystals, electromagnetic cloaking, metamaterials, and metasurfaces.

In this course we shall consider both analytical and computational matters in photonics. The issues we consider lead to the investigation of fundamental problems in various branches of mathematics. These include asymptotic analysis, spectral analysis, mathematical imaging, optimal design, stochastic modelling, and analysis of wave propagation phenomena. On the other hand, deriving mathematical foundations, and new and efficient computational frameworks and tools in photonics, requires a deep understanding of the different scales in the wave phenomenon in nanophotonics, the aim is to control, manipulate, reshape, guide, and focus electromagnetic waves at nanometer length scales, beyond the resolution limit. In particular, one wants to break the resolution limit by reducing the focal spot and confine light to length scales that are significantly smaller than half the wavelength.

The main objective in this course is to report on the use of sophisticated mathematics in diffractive optics, plasmonics, super-resolution, photonic crystals, and metamaterials for electromagnetic invisibility and cloaking. The course merges highly nontrivial multi-mathematics in order to make a breakthrough in the field of mathematical modelling, imaging, and optimal design of optical nanodevices and nanostructures capable of light enhancement, and of the focusing and guiding of light at a subwavelength scale. We demonstrate the power of layer potential techniques in solving challenging problems in photonics, when they are combined with asymptotic analysis and the elegant theory of Gohberg and Sigal on meromorphic operator-valued functions.

In this course we shall consider both analytical and computational matters in photonics. The issues we consider lead to the investigation of fundamental problems in various branches of mathematics. These include asymptotic analysis, spectral analysis, mathematical imaging, optimal design, stochastic modelling, and analysis of wave propagation phenomena. On the other hand, deriving mathematical foundations, and new and efficient computational frameworks and tools in photonics, requires a deep understanding of the different scales in the wave phenomenon in nanophotonics, the aim is to control, manipulate, reshape, guide, and focus electromagnetic waves at nanometer length scales, beyond the resolution limit. In particular, one wants to break the resolution limit by reducing the focal spot and confine light to length scales that are significantly smaller than half the wavelength.

The recent advances in nanoscience present great challenges for the applied and computational mathematics community. In nanophotonics, the aim is to control, manipulate, reshape, guide, and focus electromagnetic waves at nanometer length scales, beyond the resolution limit. In particular, one wants to break the resolution limit by reducing the focal spot and confine light to length scales that are significantly smaller than half the wavelength.

The field of photonics encompasses the fundamental science of light propagation and interactions in complex structures, and its technological applications.

The main objective in this course is to report on the use of sophisticated mathematics in diffractive optics, plasmonics, super-resolution, photonic crystals, and metamaterials for electromagnetic invisibility and cloaking. The course merges highly nontrivial multi-mathematics in order to make a breakthrough in the field of mathematical modelling, imaging, and optimal design of optical nanodevices and nanostructures capable of light enhancement, and of the focusing and guiding of light at a subwavelength scale. We demonstrate the power of layer potential techniques in solving challenging problems in photonics, when they are combined with asymptotic analysis and the elegant theory of Gohberg and Sigal on meromorphic operator-valued functions.

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Upon completion of the course, students are able to classify combinatorial problems and to apply adequate techniques to solve them.

### Objective
This course deals with modeling and analysis of variables which change randomly in time. Their essential feature is the dependence between successive observations.

### Content
Applications occur in geophysics, engineering, economics and finance. Topics covered: Stationarity, trend estimation, seasonal decomposition, autocorrelations, spectral and wavelet analysis, ARIMA-, GARCH- and state space models. The models and techniques are illustrated using the statistical software R.

### Literature
A list of references will be distributed during the course.

### Prerequisites / notice
Basic knowledge in probability and statistics

### 401-3627-00L
#### High-Dimensional Statistics

**Abstract**
"High-Dimensional Statistics" deals with modern methods and theory for statistical inference when the number of unknown parameters is of much larger order than sample size. Statistical estimation and algorithms for complex models and aspects of multiple testing will be discussed.

**Objective**
Knowledge of methods and basic theory for high-dimensional statistical inference

**Content**
Lasso and Group Lasso for high-dimensional linear and generalized linear models; Additive models and many smooth univariate functions; Non-convex loss functions and 1-regularization; Stability selection, multiple testing and construction of p-values; Undirected graphical modeling

**Literature**

**Prerequisites / notice**
Knowledge of basic concepts in probability theory, and intermediate knowledge of statistics (e.g. a course in linear models or computational statistics).

### 401-4889-00L
#### Mathematical Finance

**Abstract**
Advanced introduction to mathematical finance:
- absence of arbitrage and martingale measures
- option pricing and hedging
- optimal investment problems
- additional topics

**Objective**
Advanced level introduction to mathematical finance, presupposing knowledge in probability theory and stochastic processes

**Content**
This is an advanced level introduction to mathematical finance for students with a good background in probability. We want to give an overview of main concepts, questions and approaches, and we do this in both discrete- and continuous-time models. Topics include absence of arbitrage and martingale measures, option pricing and hedging, optimal investment problems, and probably others.

**Lecture notes**
None available

**Literature**
Details will be announced in the course.

**Prerequisites / notice**
Prerequisites are probability theory and stochastic processes (for which lecture notes are available).

### 402-0861-00L
#### Statistical Physics

**Abstract**
This course covers the concepts of classical and quantum statistical physics, and some aspects of kinetic gas theory and hydrodynamics. In a more advanced part degenerate Fermions, Bose-Einstein condensation, real Bose gases, magnetism, general mean field theory and critical phenomena will be addressed.

**Objective**
This lecture gives an introduction in the basic concepts and applications of statistical physics for the general use in physics and, in particular, as a preparation for the theoretical solid state physics education.

**Content**

**Lecture notes**
Lecture notes available in german.

**Literature**
No specific book is used for the course. Relevant literature will be given in the course.

### 401-3059-00L
#### Combinatorics II

**Abstract**
The course Combinatorics I and II is an introduction into the field of enumerative combinatorics.

**Objective**
Upon completion of the course, students are able to classify combinatorial problems and to apply adequate techniques to solve them.

**Content**
Contents of the lectures Combinatorics I and II: congruence transformation of the plane, symmetry groups of geometric figures, Euler’s function, Cayley graphs, formal power series, permutation groups, cycles, Bunsdie’s lemma, cycle index, Polya’s theorems, applications to graph theory and isomers.

### Seminars

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-3640-66L</td>
<td>Monte Carlo and Quasi-Monte Carlo Methods: Mathematical and Numerical Analysis</td>
<td>W</td>
<td>4</td>
<td>2S</td>
<td>C. Schwab</td>
</tr>
</tbody>
</table>

**Abstract**
Introduction and current research topics in the theory and implementation of Monte Carlo and quasi-Monte Carlo methods and applications.
Prerequisites / notice

**Prerequisites:**
Completed courses
Numerical Analysis of Elliptic/Parabolic PDEs,
or Numerical Analysis of Hyperbolic PDEs,
or Numerical Analysis of Stochastic ODEs,
and FAI, Probability Theory I.

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**401-4600-66L**  
**Student Seminar in Probability**  
**W**  
4 credits  
2S  
A.S. Sznitman, J. Bertoin, P. Nolin, W. Werner

**Content**

The seminar is centered around a topic in probability theory which changes each semester.

The student seminar in probability is held at times at the undergraduate level (typically during the spring term) and at times at the graduate level (typically during the autumn term). The themes vary each semester.

The number of participants to the seminar is limited. Registration to the seminar will only be effective once confirmed by email from the organizers.

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**Colloquia**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>401-5000-00L</td>
<td>Zurich Colloquium in Mathematics</td>
<td>E-</td>
<td>0 credits</td>
<td>1K</td>
<td>W. Werner, P. L. Bühlmann, M. Burger, S. Mishra, R. Pandharipande, University lecturers</td>
</tr>
<tr>
<td>401-5990-00L</td>
<td>Zurich Graduate Colloquium (University of Zurich)</td>
<td>E-</td>
<td>0 credits</td>
<td>1K</td>
<td>University lecturers</td>
</tr>
</tbody>
</table>

**Abstract**

The Graduate Colloquium is an informal seminar aimed at graduate students and postdocs whose purpose is to provide a forum for communicating one's interests and thoughts in mathematics.

<table>
<thead>
<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>401-5110-00L</td>
<td>Number Theory Seminar</td>
<td>E-</td>
<td>0 credits</td>
<td>1K</td>
<td>Ö. Imamoglu, P. S. Jossen, E. Kowalski, P. D. Nelson, R. Pink, G. Wüstholz</td>
</tr>
<tr>
<td>401-5140-11L</td>
<td>Algebraic Geometry and Moduli Seminar</td>
<td>E-</td>
<td>0 credits</td>
<td>2K</td>
<td>R. Pandharipande</td>
</tr>
<tr>
<td>401-5530-00L</td>
<td>Geometry Seminar</td>
<td>E-</td>
<td>0 credits</td>
<td>1K</td>
<td>M. Burger, M. Einsiedler, U. Lang, University lecturers</td>
</tr>
<tr>
<td>401-5350-00L</td>
<td>Analysis Seminar</td>
<td>E-</td>
<td>0 credits</td>
<td>1K</td>
<td>M. Struwe, A. Carlotto, D. Christodoulou, F. Da Lio, A. Figalli, N. Hungerbühler, T. Ilmanen, T. Kappeler, T. Rivière, D. A. Salamon</td>
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<tr>
<td>401-5580-00L</td>
<td>Symplectic Geometry Seminar</td>
<td>E-</td>
<td>0 credits</td>
<td>2K</td>
<td>D. A. Salamon, P. Biran, A. Cannas da Silva</td>
</tr>
<tr>
<td>401-5330-00L</td>
<td>Talks in Mathematical Physics</td>
<td>E-</td>
<td>0 credits</td>
<td>1K</td>
<td>A. Cattaneo, G. Felder, M. Gaberdiel, G. M. Graf, H. Knörrer, T. H. Willwacher, University lecturers</td>
</tr>
<tr>
<td>401-5600-00L</td>
<td>Seminar on Stochastic Processes</td>
<td>E-</td>
<td>0 credits</td>
<td>1K</td>
<td>J. Bertoin, A. Nikeghbali, P. Nolin, B. D. Schlein, A.S. Sznitman, W. Werner</td>
</tr>
<tr>
<td>401-5910-00L</td>
<td>Talks in Financial and Insurance Mathematics</td>
<td>E-</td>
<td>0 credits</td>
<td>1K</td>
<td>P. Cheridito, M. Schweizer, M. Soner, J. Teichmann, M. V. Wüthrich</td>
</tr>
<tr>
<td>401-5900-00L</td>
<td>Optimization Seminar</td>
<td>E-</td>
<td>0 credits</td>
<td>1K</td>
<td>R. Weismantel, R. Zenklusen</td>
</tr>
</tbody>
</table>

**Objectives**

Exposure graduate students to ongoing research activities (including applications) in the domain of optimization.

**Data:** 06.03.2019 12:57  
**Autumn Semester 2016**  
**Page 465 of 1571**
This seminar is a forum for researchers interested in optimization theory and its applications. Speakers are expected to stimulate discussions on theoretical and applied aspects of optimization and related subjects. The focus is on efficient algorithms for continuous and discrete optimization problems, complexity analysis of algorithms and associated decision problems, approximation algorithms, mathematical modeling and solution procedures for real-world optimization problems in science, engineering, industries, public sectors etc.

<table>
<thead>
<tr>
<th>Code</th>
<th>Course Description</th>
<th>Credits</th>
<th>Semester</th>
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<tbody>
<tr>
<td>252-4202-00L</td>
<td>Seminar in Theoretical Computer Science</td>
<td>2</td>
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<tr>
<td></td>
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<tr>
<td>Abstract</td>
<td>Presentation of recent publications in theoretical computer science, including results by diploma, masters and doctoral candidates.</td>
<td></td>
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<tr>
<td>Objective</td>
<td>The goal is to introduce students to current research, and to enable them to read, understand, and present scientific papers.</td>
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</table>

**Doctoral Department of Mathematics - Key for Type**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
<tr>
<td>O</td>
<td>Compulsory</td>
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</table>

**Key for Hours**

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<tr>
<th>Code</th>
<th>Description</th>
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<tbody>
<tr>
<td>V</td>
<td>lecture</td>
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<td>G</td>
<td>lecture with exercise</td>
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<td>exercise</td>
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<td>seminar</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

**ECTS**

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Modern Aspects in Surface Science Research: Semiconductor Materials: Fundamentals and Course description

Title

Basic knowledge of semiconductor physics and technology. Application of this knowledge for state-of-the-art semiconductor device fabrication

Type

ECTS

6 credits

Hours

2V+1U

Lecturers

S. Schön. W. Wegscheider

Abstract

This course gives an introduction into the fundamentals of semiconductor materials. The main focus is on state-of-the-art fabrication and characterization methods. The course will be continued in the spring term with a focus on applications.

Objective

Basic knowledge of semiconductor physics and technology. Application of this knowledge for state-of-the-art semiconductor device processing

Content

Fundamentals of Solid State Physics: Semiconductor materials, band structures, carrier statistics in intrinsic and doped semiconductors, p-n junctions, low-dimensional structures; Bulk Material growth of Semiconductors: Czochralski method, floating zone method, high pressure synthesis; Semiconductor Epitaxy: Fundamentals, MBE, MOCVD, LPE; In situ characterization: RHEED, LEED, AES, XPS, process control (temperature, thickness)

Lecture notes

https://moodle-app2.let.ethz.ch/course/view.php?id=2395

Modern Aspects in Surface Science Research: Techniques and Applications

402-0521-66L

W

6 credits

2V+1U

O. Gürtlü

Abstract

The course will be an introduction into the fundamentals of bulk crystals and a reminder on the x-ray diffraction from crystals. We will continue with the extension of the alphabet of bulk crystal structure to surfaces and the nomenclature of surface reconstructions and interesting structures like moiré patterns will be introduced. Following the two introductory weeks, we will dwell in to the realm of imaging the surfaces. We will start with electron beam based imaging and analysis techniques of surfaces. Scanning Electron Microscopy (SEM), Low Energy Electron Diffraction (LEED) and Low Energy Electron Microscopy (LEEM) will be discussed. Imaging with ion beam based techniques like Low Energy Ion Scattering (LEIS) and He-ion microscopy will be touched upon. Following these, probe microscopy techniques will be explored starting with the topografiner and continuing with Scanning Tunnelling Microscopy (STM). Basics of Atomic Force Microscopy (AFM) will follow. Imaging is a fundamental part of efforts on understanding surfaces. Yet, a thorough understanding and capability of generating and manipulating novel surface and interface systems can only be achieved by studying the electronic structure of surfaces. In order to investigate the electronic structure of surface and interface systems, a basic knowledge of the bulk electronic structure is necessary. So, introductory concepts on the electronic structure of the bulk and low dimensional systems will be discussed. Then, the basics of photoelectron emission from surfaces will be given. In the final two weeks of the course an overview of the spectroscopic modes of scanning probes and atomic scale electron spectroscopy will be introduced.

Course contents

1) Introduction and reminder of bulk crystals (week 1): Reminder of the crystal structure, x-ray diffraction and determination of the crystal structure.

2) Crystal surfaces (weeks 2 and 3): Definitions, description of surfaces, and reconstructions; Moiré patterns; quasi-crystals.

3) Imaging surfaces with electrons (week 4): SEM, LEED, LEEM

4) Imaging surfaces with ions (week 5): LEIS, He ion microscopy

5) Introduction to probe microscopy (week 6): General problems, field ion microscope, topografiner

6) Scanning Tunnelling Microscopy (weeks 6, 7 and 8): Tunnelling problem (reminder), work function derivation and measurement with STM, imaging surfaces in real space, surface reconstructions, examples from metals and semiconductors and hybrid surface systems

7) Atomic force microscopy (week 9): Technique, basics, examples.

8) Electronic structure of the bulk (week 10): Reminders; density of states, band structure, low dimensional systems

9) Electronic structure of surfaces (week 11): Bulk derived states, image states, examples from STM research

10) Photoelectric emission (week 12): Basics of spectroscopy with x-rays and electrons.

11) STM and AFM derived spectroscopy techniques (weeks 13 and 14): Comparative studies of Scanning Tunnelling spectroscopy (STS) to other integral spectroscopic methods.


6) Charles Kittel, Introduction to Solid State Physics (8th Ed.)

7) Neil W. Ashcroft and N. David Mermin, Solid State Physics

8) Harald Ibach and Hans Lüth, Solid-State Physics: An Introduction to Principles of Materials Science

9) Further reading material will be supplied.

Prerequisites / notice

At least, 4 homework will be assigned.
The course covers the foundations of semiconductor nanostructures, e.g., materials, band structures, bandgap engineering and doping, which are fundamental interest as well as relevant for modern technological applications. The dynamics of the lattice, the electron gas as well as the spin system of a solid are discussed. The focus is on time resolved experiments which provide insight into pico- and femtosecond dynamics.

After attending this course you understand the dynamics of essential excitation processes which occur in solids and you have an overview over state of the art experimental techniques used to study fast processes.

1. Experimental techniques, an overview
   2. Dynamics of the electron gas
      2.1 First experiments on electron dynamics and lattice heating
      2.2 The finite lifetime of excited states
      2.3 Detection of lifetime effects
      2.4 Dynamical properties of reactions and adsorbents
   3. Dynamics of the lattice
      3.1 Phonons
      3.2 Non-thermal melting
   4. Dynamics of the spin system
      4.1 Laser induced ultrafast demagnetization
      4.2 Ultrafast spin currents generated by lasers
      4.3 Landau-Lifschitz-Dynamics
      4.4 Laser induced switching
   5. Correlated materials

Lecture notes will be distributed

relevant publications will be cited

The lecture can also be followed by interested non-physics students as basic concepts will be introduced.

This lecture is complementary to the lecture on “ultrafast methods for solid state physics” of the spring semester. Both lectures can be attended independently. The focus of this lecture is on the physical processes whereas the focus of the “ultrafast methods for solid state physics” lecture is on the experimental techniques.

The rich physics of the optical properties of semiconductors, as well as the advanced processing available on these material, enabled numerous applications (lasers, LEDs and solar cells) as well as the realization of new physical concepts. Systems that will be covered include quantum dots, exciton-polaritons, quantum Hall fluids and graphene-like materials.

Electronic states in III-V materials and quantum structures, optical transitions, excitons and polaritons, novel two dimensional semiconductors, spin-orbit interaction and magneto-optics.

Electronic states in III-V materials and quantum structures, optical transitions, excitons and polaritons, novel two dimensional semiconductors, spin-orbit interaction and magneto-optics.

The lecture “Introduction to Magnetism” is the regular course on Magnetism for the Master curriculum of the Department of Physics of ETH Zurich. With respect to specialized courses related to Magnetism (such as the one held by R. Allenspach in FS16) this lecture addresses more fundamental aspects -- quantum and statistical physics of magnetism -- which are often not comprehensively spelled out in conventional lectures on solid state physics.

Preliminary contents for the HS16:
- Magnetism in atoms (quantum-mechanical origin of atomic magnetic moments, intra-atomic exchange interaction)
- Magnetism in solids (mechanisms producing inter-atomic exchange interaction, solid field).
- Magnetic order at finite temperatures (Ising and Heisenberg models, mean-field approximation, low-dimensional magnetism)
- Diplar interaction in ferromagnets (shape anisotropy, frustration and modulated phases of magnetic domains)
- Spin physics in the time domain (Larmor precession, resonance phenomena, Bloch equation, Landau-Lifshitz-Gilbert equation, superparamagnetism)

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The lecture can also be followed by interested non-physics students as basic concepts will be introduced.

The former title of this course unit was "Fundamental Aspects of Magnetism". This lecture insists on the fundamental aspects which are often not comprehensively spelled out in conventional lectures on solid state physics.

Preliminary contents for the HS16:
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- Magnetic order at finite temperatures (Ising and Heisenberg models, mean-field approximation, low-dimensional magnetism)
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- Spin physics in the time domain (Larmor precession, resonance phenomena, Bloch equation, Landau-Lifshitz-Gilbert equation, superparamagnetism)

Applications to nanoscale magnetism will be considered from the perspective of basic underlying principles.

The course covers the foundations of semiconductor nanostructures, e.g., materials, band structures, bandgap engineering and doping, field-effect transistors. The physics of the quantum Hall effect and of common nanostructures based on two-dimensional electron gases will be discussed, i.e., quantum point contacts, Aharonov-Bohm rings and quantum dots.
In addition to the lecture notes, the following supplementary books can be recommended:


The course will focus predominantly on understanding research conducted over the last 4-5 years at the forefront of this developing field, with a strong emphasis on nonlinear THz science which has only recently become possible. This in particular has generated excitement as it offers potential new ways to control chemical reactions and/or phase transitions in materials.

Topics to be discussed in the class include:

1) Overview of THz & interactions with matter
2) THz generation and detection
3) Linear THz spectroscopies
4) Imaging
5) Nonlinear THz interactions

The readings for the course will draw mostly on current journal articles that will be distributed in class/via moodle. There is also a general textbook listed below available electronically via the ETH library system. You can also order a black-and-white paperback via an "on-demand" system for a pretty reasonable price.

Prerequisites: Principles of Terahertz Science and Technology, Yun-Shick Lee (Springer, 2008).

The former course title of this course is "Terahertz Technology and Applications".

The course is taught in English.

Recommended Literature:


More advanced reading:

- Golub, Richardson & Lamoreaux: "Ultra-Cold Neutrons"
- Rauch & Werner: "Neutron Interferometry"
- Carlile & Willis: "Experimental Neutron Scattering"
- Byrne: "Neutrons, Nuclei and Matter"
- Klappdor-Kleingrothaus: "Non Accelerator Particle Physics"

Prerequisites: Very ambitioned students in the third year may be able to follow. The lecture can be chosen as part of the PhD-program.

The lecture is suitable for all physics students beyond the bachelor of science degree. Basic knowledge of solid state physics is recommended. Very ambitioned students in the third year may be able to follow. The lecture can be chosen as part of the PhD-program. The course is taught in English.

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### Low Energy Particle Physics

**W 6 credits 2V+1U A. S. Antognini, P. A. Schmidt-Wellenburg**

**Abstract**

Low energy particle physics provides complementary information to high energy physics with colliders. In this lecture, we will concentrate on selected experiments, using mainly neutrons and muons, which have significantly improved our understanding of particle physics today.

The course aims to provide an introduction to selected advanced topics in low energy particle physics with neutrons and muons.

**Objective**

The course aims to provide an introduction to selected advanced topics in low energy particle physics with neutrons and muons.

**Content**

- Production and characteristics of muon and neutron beams
- Ultracold neutron production
- Measurement of the neutron lifetime and electric dipole moment
- The neutron in the gravitational field and its electric charge
- Muon and neutron decay correlations
- Lepton flavour violations with muons to search for new physics
- What atomic physics can do for particle physics and vice versa
- Laser experiments at accelerators
- From myonic hydrogen to the proton structure and bound-state QED
- From piconic hydrogen to the strong interaction and effective field theories
- etc.

**Literature**

- Golub, Richardson & Lamoreaux: "Ultra-Cold Neutrons"
- Rauch & Werner: "Neutron Interferometry"
- Carlile & Willis: "Experimental Neutron Scattering"
- Byrne: "Neutrons, Nuclei and Matter"
- Klappdor-Kleingrothaus: "Non Accelerator Particle Physics"

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### Neutrino Physics

**W 6 credits 2V+1U A. Rubbia**

**Abstract**

Theoretical basis and selected experiments to determine the properties of neutrinos and their interactions (mass, spin, helicity, chirality, oscillations, interactions with leptons and quarks).

**Objective**

Introduction to the physics of neutrinos with special consideration of phenomena connected with neutrino masses.

**Lecture notes**

Script
Literature


D.O. Caldwell, Current Aspects of Neutrino Physics, Springer.


<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Lectures</th>
<th>Laboratories</th>
<th>Literature Details</th>
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</thead>
<tbody>
<tr>
<td>402-0883-63L</td>
<td>Symmetries in Physics</td>
<td>W</td>
<td>6</td>
<td>2V+1U</td>
<td>B. Gaberdiel</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract</strong></td>
<td></td>
<td></td>
<td></td>
<td>The course gives an introduction to symmetry groups in physics. It explains the relevant mathematical background (finite groups, Lie groups and algebras as well as their representations), and illustrates their important role in modern physics. Abstract mathematical constructions will be illustrated with examples from physics.</td>
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<tr>
<td></td>
<td><strong>Objective</strong></td>
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<td></td>
<td>The aim of the course is to give a self-contained introduction into finite group theory as well as Lie theory from a physicists point of view.</td>
</tr>
<tr>
<td>402-0898-00L</td>
<td>The Physics of Electroweak Symmetry Breaking</td>
<td>W</td>
<td>6</td>
<td>2V+1U</td>
<td>Not available</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract</strong></td>
<td></td>
<td></td>
<td></td>
<td>Does not take place this semester. The aim is to understand the need of physics beyond the Standard Model, the basic techniques of model building in theories BSM and the elements of collider physics required to analyze their phenomenological implications. After an introduction to the SM and alternative theories of electroweak symmetry breaking, we will investigate these issues in the context of models with warped extra dimensions.</td>
</tr>
<tr>
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<td><strong>Objective</strong></td>
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<td></td>
<td>After the course the student should have a good knowledge of some of the most relevant theories beyond the Standard Model and have the techniques to understand those theories that have not been surveyed in the course. He or she should be able to compute the constraints on any model of new physics, its successes explaining current experimental data and its main phenomenological implications at colliders.</td>
</tr>
<tr>
<td></td>
<td><strong>Prerequisites / notice</strong></td>
<td></td>
<td></td>
<td></td>
<td>The former title of this course unit was &quot;The Physics Beyond the Standard Model&quot;. If you already got credits for &quot;The Physics Beyond the Standard Model&quot; (402-0898-00L), you cannot get credits for &quot;The Physics of Electroweak Symmetry Breaking&quot; (402-0898-00L).</td>
</tr>
<tr>
<td>402-0845-60L</td>
<td>Quantum Field Theory III: EFT and SUSY</td>
<td>W</td>
<td>6</td>
<td>2V+1U</td>
<td>G. Isidori</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract</strong></td>
<td></td>
<td></td>
<td></td>
<td>This course provides a comprehensive introduction to two advanced topics in Quantum Field Theory: Effective Field Theories (EFTs) and Supersymmetry (SUSY). In the first part we will discuss the basic concepts of EFTs, with particular attention to the concepts of decoupling of heavy degrees of freedom, matching and renormalization, chiral Lagrangians. The Standard Model viewed as an EFT will also be discussed as a specific application. The second part of the course is devoted to Supersymmetry, starting from the discussion of the SUSY algebra and its representations, to arrive, after the presentation of the superfield formalism, to the construction of the supersymmetric version of gauge field theories. A phenomenological discussion of the mechanisms of SUSY breaking and the construction of viable supersymmetric extensions of the Standard Model will also be presented.</td>
</tr>
</tbody>
</table>
|             | **Topics**                           |         |          |             | - Introduction to Effective Field Theories 
- The Appelquist-Carrazone theorem 
- The matching procedure 
- Chiral Lagrangians 
- The SM as an EFTs 
- The SUSY algebra 
- Superspace and superfields 
- Supersymmetric field theories 
- Supersymmetric gauge theories 
- Supersymmetry breaking 
- The Minimal supersymmetric Standard Model |
|             | **Prerequisites / notice**            |         |          |             | Quantum Field Theory-I (mandatory) and Quantum Field Theory-II (highly recommended). |
| 402-0899-65L | Higgs Physics                        | W       | 6        | 2V+1U       | M. Grazzini       |
|             | **Abstract**                         |         |          |             | Does not take place this semester. The course introduces the theory and phenomenology of the recently discovered Higgs boson. With this course the students will receive a detailed introduction to the physics of the Higgs boson in the Standard Model. They will acquire the necessary theoretical background to understand the main production and decay channels of the Higgs boson at high-energy colliders, and the corresponding experimental signatures. |
|             | **Objective**                        |         |          |             | With this course the students will receive a detailed introduction to the physics of the Higgs boson in the Standard Model. They will acquire the necessary theoretical background to understand the main production and decay channels of the Higgs boson at high-energy colliders, and the corresponding experimental signatures. |
|             | **Prerequisites / notice**            |         |          |             | None. |

Data: 06.03.2019 12:57  Autumn Semester 2016  Page 470 of 1571
PhD students at ETH Zurich working in the broad area of energy present their research to their colleagues, to their advisors and to the scientific community.

**Observational Techniques in Astrophysics**

The course introduces analysis techniques, the basics of astronomical instruments, real-world observational tools, data reduction strategy and software packages used in astrophysics research. The course will also include discussions of current topics in astrophysics with a focus on active galaxies. The course will include the reduction and analysis of real data from a variety of observatories.

The goal of this course is to understand some of the phenomena that stand in the forefront of current research in astrophysics, the physical processes behind them, and how these phenomena are observed by state-of-the-art astronomical facilities. These goals will be achieved by communal discussions, led by the students and chaired by the teachers.

**Statistical Methods in Cosmology and Astrophysics**

Statistical methods play a vital role in modern cosmology and astrophysics studies. This course will give an overview of the statistical principles and tools that are used in these fields. Topics covered will include basic probability theory, Bayesian inference, hypothesis testing, sampling and estimators.

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**Molecular Quantum Dynamics**

An understanding of basic probability and statistical theory. Gain practical knowledge of statistical methods commonly used in cosmology and astrophysics.

**Hot Topics in Astrophysics**

The themes we will discuss this year are:

- How do baryons and dark matter interact?
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**Molecular Quantum Dynamics**

Developing an understanding of basic probability and statistical theory. Gain practical knowledge of statistical methods commonly used in cosmology and astrophysics.
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<th>Credits</th>
<th>Prerequisites</th>
<th>Objective</th>
<th>Literature</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0620-00L</td>
<td>Current Topics in Accelerator Mass Spectrometry and Their Applications</td>
<td>0</td>
<td>1S</td>
<td>M. Christl, S. Willett</td>
<td>The seminar is aimed at all students who, during their studies, are confronted with age determination methods based on long-living radionuclides found in nature. Basic methodology, the latest developments, and special examples from a wide range of applications will be discussed.</td>
</tr>
<tr>
<td>402-0846-66L</td>
<td>The BFKL Equation Reloaded and the Multi-Regge Kinematics in QCD and in N=4 SYM</td>
<td>1</td>
<td></td>
<td>V. Del Duca</td>
<td>The goal of the course is to help the audience to keep abreast of the strong advances there have been in the study of the high energy limit of scattering amplitudes in the last decade. The goal of the course is to help the audience to keep abreast of the strong advances there have been in the study of N=4 SYM amplitudes in multi-Regge kinematics.</td>
</tr>
</tbody>
</table>
## Doctoral Department of Physics - Key for Type

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
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<tr>
<td>W</td>
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</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
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## Key for Hours

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<thead>
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<tr>
<td>V</td>
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<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<tr>
<td>K</td>
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<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
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</table>

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Wildlife Biology, Ecology and Conservation

Doctoral Department of Environmental Sciences


Agricultural Sciences

Graduate Programme in Plant Sciences

<table>
<thead>
<tr>
<th>Number</th>
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<th>Type</th>
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<tr>
<td>751-4003-01L</td>
<td>Current Topics in Grassland Sciences (HS)</td>
<td>W</td>
<td>2 credits</td>
<td>2S</td>
<td>N. Buchmann</td>
</tr>
</tbody>
</table>

Abstract

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

Objective

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

Content

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

Lecture notes

None

Prerequisites / notice

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

751-5123-00L Rhizosphere Ecology

W 4 credits 4G H. A. Gamper, T. I. McLaren

Number of participants limited to 18.

Abstract

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

Objective

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

Content

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

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

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

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

Lecture notes

For documentation, lecture slides and laboratory protocols will continuously be uploaded to the directory '751-5123-00L Rhizosphere Ecology' on the electronic document exchange platform ILIAS, LDA-ELBA: https://ilias-app2.let.ethz.ch/ilias.php?ref_id=109651&cmd=view&cmdClass=ilobjcoursegui&cmdNode=el:fv&baseClass=ilRepositoryGUI

Data: 06.03.2019 12:57  Autumn Semester 2016  Page 474 of 1571
Major objectives of the colloquium are:

- Increased interaction among students and professors
- Promotion of presentation and discussion skills
- Promotion of active participation and independent work of students
- Ecosystems and from basic research to applications, making use of the synergies between the different research groups of the PSC.

Number of participants limited to 40.

2017.

The course will result in posters and reports in the format of a conference and scientific paper. Reports will be due on Friday January 6, 2017.

Marking will consider the efforts and outcome of work by the individual participant as well as results of work in small groups. Activities for students of D-USYS will be reimbursed via bank transfer for train and bus tickets of the zones 121 and 122.

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

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

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

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


Challenges in Plant Sciences will cover the following topics:
Chemical communication among plants, insect and pathogens.
Genetic networks.
Plant-plant interactions.
Resilience of tropical ecosystems.
Regulatory factors controlling cell wall formation.
Chlorophyll breakdown.
Innate immunity.
Disease resistance genes.
Sustainable agroecosystems.

### Environmental Sciences
#### Atmosphere and Climate

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>402-0572-00L</td>
<td>Aerosols I: Physical and Chemical Principles</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>M. Gysel, U. Baltensperger, H. Burtscher</td>
</tr>
</tbody>
</table>

Abstract: Aerosols I deals with basic physical and chemical properties of aerosol particles. The importance of aerosols in the atmosphere and in other fields is discussed.

Objective: Knowledge of basic physical and chemical properties of aerosol particles and their importance in the atmosphere and in other fields.

Content: physical and chemical properties of aerosols, aerosol dynamics (diffusion, coagulation...), optical properties (light scattering, absorption, extinction), aerosol production, physical and chemical characterization.

Lecture notes: Material is distributed during the lecture.

Literature:

Prerequisites:
- Knowledge of basic physical and chemical properties of aerosol particles and their importance in the atmosphere and in other fields.

#### Analysis of Climate and Weather Data 701-1250-00L

Abstract: Observation networks and numerical climate and forecasting models deliver large primary datasets. The use of this data in practice and in research requires specific techniques of statistical data analysis. This lecture introduces a range of frequently used techniques, and enables students to apply them to and to properly interpret their results.

Objective: Observation networks and numerical climate and forecasting models deliver large primary datasets. The use of this data in practice and in research requires specific techniques of statistical data analysis. This lecture introduces a range of frequently used techniques, and enables students to apply them to and to properly interpret their results.

Content: Introduction into the theoretical background and the practical application of methods of data analysis in meteorology and climatology.

Topics: exploratory methods, hypothesis tests, analysis of climate trends, measuring the skill of climate and forecasting models, analysis of extreme events, principal component analysis and maximum covariance analysis.

Lecture notes: Documentation and supporting material include:
- documented view graphs used during the lecture
- exercise sets and solutions
- R-packages with software and example datasets for exercise sessions

All material is made available via the lecture web-page.

Literature:

Prerequisites:
- Prerequisites: Atmosphäre, Mathematik IV: Statistik, Anwendungsnahe Programmieren.

#### Cloud Microphysics 701-1235-00L

Abstract: Clouds are a fascinating atmospheric phenomenon central to the hydrological cycle and the Earth’s climate. Interactions between cloud particles can result in precipitation, glaciation or evaporation of the cloud depending on its microstructure and microphysical processes.

Objective: The learning objective of this course is that students understand the formation of clouds and precipitation and can apply learned principles to interpret atmospheric observations of clouds and precipitation.

Content:
- see: http://www.iac.ethz.ch/edu/courses/master/modules/cloud-microphysics.html

Lecture notes: This course will be designed as a reading course in 1-2 small groups of 8 students maximum. It will be based on the textbook below. The students are expected to read chapters of this textbook prior to the class so that open issues, fascinating and/or difficult aspects can be discussed in depth.

Literature:

Prerequisites:
- Target group: Master students in Atmosphere and Climate

#### Dynamics of Large-Scale Atmospheric Flow 701-1221-00L

Abstract: Dynamic, synoptic Meteorology
Objective: Understanding the dynamics of large-scale atmospheric flow
Content: Dynamical Meteorology is concerned with the dynamical processes of the earth's atmosphere. The fundamental equations of motion in the atmosphere will be discussed along with the dynamics and interactions of synoptic system - i.e. the low and high pressure systems that determine our weather. The motion of such systems can be understood in terms of quasi-geostrophic theory. The lecture course provides a derivation of the mathematical basis along with some interpretations and applications of the concept.

Lecture notes: Dynamics of large-scale atmospheric flow

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<table>
<thead>
<tr>
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<td>701-1251-00L</td>
<td>Land-Climate Dynamics</td>
<td>3</td>
<td>W</td>
<td>S. I. Seneviratne, E. L. Davin</td>
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<tr>
<td>701-1237-00L</td>
<td>Solar Ultraviolet Radiation</td>
<td>1</td>
<td>W</td>
<td>J. Gröbner</td>
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</table>

**Abstract**

The purpose of this course is to provide fundamental background on the role of land surface processes (vegetation, soil moisture dynamics, land energy and water balances) for the climate system. The course consists of 2 contact hours per week, including 2 computer exercises.

**Objective**
The students can understand the role of land processes and associated feedbacks for the climate system.

**Lecture notes**

Powerpoint slides will be made available

**Prerequisites / notice**

Prerequisites: Introductory lectures in atmospheric and climate science


The lecture will introduce the student to the thematics of solar ultraviolet radiation and its effects on the atmosphere and the biosphere. The lecture will cover the modeling and the measurement of solar ultraviolet radiation. The instruments used for solar radiation measurements will also be introduced.

The lecture should enable the student to understand the specific problematics related to solar ultraviolet radiation and its interaction with the atmosphere and the biosphere.
1) Einführung in die Problematik  Motivation
   Begriffe (UV-C, UV-B, UV-A,...)
   Einfluss der UV Strahlung auf Biosphäre (Mensch, Tier, Pflanzen)
   Positive und schädliche Effekte
   Wirkungsspektrum, Konzept, Beispiele
   UVIndex:

2) Geschichtlicher Rückblick
   Rayleigh - Himmelsblau
   1907: Dorno, PMOD
   1970: Bener, PMOD
   1980: Berger, Erythemal sunburn meter
   1990: - State of the Art

3) Extraterrestrische UV Strahlung
   Spektrum
   Energieverteilung
   Variabilität (Spektral, zeitlich, relativ zu Totalstrahlung)
   Satellitenmessungen, Übersicht

4) Einfluss der Atmosphäre auf die solare UV Strahlung
   Atmosphärenaufbau
   Energieverteilung der UV Strahlung
   Variabilität (spektral, zeitlich, relativ zu Totalstrahlung)
   Spektrum und Wirkungsspektrum
   Beispiele

5-6) Strahlungstransfer
   Strahlungstransfergleichung
   Modellierung, DISORT
   Parameter
   Sensitivitätsstudien
   Vergleiche mit Messungen
   3-D Modellierung (MYSTIC)

7) Strahlungsmessungen
   Instrumente zur Strahlungsmessung
   Messgrößen: Irradiance (global, direct, diffus), radiance, aktinischer Fluss
   Horizontale und geneigte Flächen
   Generelle Problematik: Freiluftmessungen...
   Qualitätssicherung

8) Solare UV Strahlungsmessungen
   Problem: Dynamik, Spektrale Variabilität, Alterung
   Stabilität
   Spezifische Instrumente: Filterradiometer, Spektroradiometer, Dosimetrie
   Übersicht: Aufbau und Verwendung

9-10) Solare UV Strahlungsmessgeräte
   Spektroradiometer, Filterradiometer (Breit und schmalbandig)
   Charakterisierung
   Kalibriermethoden (Im Labor, im Feld)
   Qualitätssicherung, Messkampagnen

11-12) Auswerteverfahren
   Atmosphärische Parameter aus Strahlungsmessungen
   Albedo, SO2
   Aerosol Parameter (AOD, SSA, g, Teilchenverteilungen)
   Zusammenspiel Messungen - Modellierung
   Aktinische UV-Strahlungsflüsse und Bestimmung von atmosphärischen Photolysefrequenzen

13) UV Klimatologie
   Trends
   UV Klimatologie durch Messnetze
   UV Klimatologie durch Satellitenmessungen am Beispiel von TOMS
   Modellierung am Beispiel Meteosat-JRC
   UV Rekonstruktionen

14) Aktuelle Forschungen
   Internationale Projekte, Stand der Forschung

701-1233-00L Stratospheric Chemistry W 4 credits 2V+1U T. Peter, A. Stenke

Abstract

Objective
The lecture gives an overview on the manifold reactions which occur in the gas phase, in stratospheric aerosol droplets and in polar cloud particles. The focus is on the chemistry of stratospheric ozone and its influence through natural and anthropogenic effects. Especially the intercontinental air traffic and the ozone depletion caused by FCKW CFC in the mid-latitude and the polar regions as well as coupling with the greenhouse effect.
Content
Short presentation of thermodynamical and kinetic basics of chemical reactions: bi- and terthermo molecular reactions, photo-dissociation. Introduction to the chemical family concept: active species, their source gases and reservoir gases. Detailed treatment of the pure oxygen family (odd oxygen) according to the Chapman chemistry. Radical reactions of the oxygen species with nitric oxide, active halogens (chlorine and bromine) and odd hydrogen. Ozone depletion cycles. Methane depletion and ozone production in the lower stratosphere (photo-smog reactions). Heterogeneous chemistry on the background aerosol and its significance for heavy air traffic. Chemistry and dynamics of the ozone hole: Formation of polar stratospheric clouds and chloride activation.

Lecture notes
Documents are provided in the contact hours.

Literature

Prerequisites / notice
Prerequisites: Basics in physical chemistry are required and an overview equivalent to the bachelor course in atmospheric chemistry (lecture 701-0471-01) is expected.

701-1211-01L Master’s Seminar: Atmosphere and Climate 1 W 3 credits 2S H. Joos, O. Stebler, F. Tummon, M. A. Wüst

Abstract
In this seminar, the process of writing a scientific proposal will be introduced. The essential elements of a proposal, including the peer review process, will be outlined and class exercises will train scientific writing skills. Knowledge exchange between class participants is promoted through the preparation of a master thesis proposal and evaluation of each other’s work.

Objective
Training scientific writing skills.

Content
In this seminar, the process of writing a scientific proposal will be introduced. The essential elements of a proposal, including the peer review process, will be outlined and class exercises will train scientific writing skills. Knowledge exchange between class participants is promoted through the preparation of a master thesis proposal and evaluation of each other’s work.

Prerequisites / notice
Attendance is mandatory.

651-4095-01L Colloquium Atmosphere and Climate 1 W 1 credit 1K H. Joos, C. Schär, D. N. Bresch, N. Gruber, R. Knutti, U. Lohmann, T. Peter, S. I. Seneviratne, H. Wernli, M. Wild

Abstract
The colloquium is a series of scientific talks by prominent invited speakers assembling interested students and researchers from around Zürich. Students take part of the scientific discussions.

Objective
The students are exposed to different atmospheric science topics and learn how to take part in scientific discussions.

Biogeochemistry and Pollutant Dynamics

Number Title Type ECTS Hours Lecturers
701-1341-00L Water Resources and Drinking Water W 3 credits 2G S. Hug, M. Berg, F. Hammes, U. von Gunten

Abstract
The course covers qualitative (chemistry and microbiology) and quantitative aspects of drinking water from the resource to the tap. Natural processes, anthropogenic pollution, legislation of groundwater and surface water and of drinking water as well as water treatment will be discussed for industrialized and developing countries.

Objective
The goal of this lecture is to give an overview over the whole path of drinking water from the source to the tap and understand the involved physical, chemical and biological processes which determine the drinking water quality.

Content
The course covers qualitative (chemistry and microbiology) and quantitative aspects of drinking water from the resource to the tap. The various water resources, particularly groundwater and surface water, are discussed as part of the natural water cycle influenced by anthropogenic activities such as agriculture, industry, urban water systems. Furthermore legislation related to water resources and drinking water will be discussed. The lecture is focused on industrialized countries, but also addresses global water issues and problems in the developing world. Finally unit processes for drinking water treatment (filtration, adsorption, oxidation, disinfection etc.) will be presented and discussed.

Lecture notes
Handouts will be distributed

Literature
A list of relevant books and papers will be provided

Prerequisites / notice
Students should have a basic knowledge of biogeochemical processes (BSc course on Biogeochemical processes in aquatic systems or equivalent).

701-1315-00L Biogeochemistry of Trace Elements W 3 credits 2G A. Voegelin, M. Etique, L. Winkel

Abstract
The course addresses the biogeochemical classification and behavior of trace elements, including key processes driving the cycling of important trace elements in aquatic and terrestrial environments and the coupling of abiotic and biotic transformation processes of trace elements. Examples of the role of trace elements in natural or engineered systems will be presented and discussed. The essential elements of a proposal, including the peer review process, will be outlined and class exercises will train scientific writing skills. Knowledge exchange between class participants is promoted through the preparation of a master thesis proposal and evaluation of each other’s work.

Objective
The students are familiar with the chemical characteristics, the environmental behavior and fate, and the biogeochemical reactivity of different groups of trace elements. They are able to apply their knowledge on the interaction of trace elements with geosphere components and on abiotic and biotic transformation processes of trace elements to discuss and evaluate the behaviour and impact of trace elements in aquatic and terrestrial systems.
Students of this course will discuss current topics from the field of infectious disease biology. From a list of publications, each student will identify a topic that he/she is going to explain and discuss with all other participants and under supervision. The actual topics will change from year to year corresponding to the progress and new results occurring in the field.

**Abstract**

Future climate change can only kept within reasonable bounds when CO2 emissions are drastically reduced. In this course, we will discuss a portfolio of options involving the alteration of natural carbon sinks and carbon sequestration. The course includes introductory lectures, presentations from guest speakers from industry and the public sector, and final presentations by the students.

**Objective**

The goal of this course is to investigate, as a group, a particular set of carbon mitigation/sequestration options and to evaluate their potential, their cost, and their consequences.

**Content**

From the large number of carbon sequestration/mitigation options, a few options will be selected and then investigated in detail by the students. The results of this research will then be presented to the other students, the involved faculty, and discussed in detail by the whole group.

**Prerequisites / notice**

Exam: No final exam. Pass/No-Pass is assigned based on the quality of the presentation and ensuing discussion.

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### Ecology and Evolution

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<td>701-0263-01L</td>
<td>Seminar in Evolutionary Ecology of Infectious Diseases</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>D. Croll, S. Bonhoeffer, R. R. Regös</td>
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<tr>
<td>701-1453-00L</td>
<td>Ecological Assessment and Evaluation</td>
<td>W</td>
<td>3</td>
<td>3G</td>
<td>F. Knaus, U. Bollens Hunziker</td>
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<td>701-1409-00L</td>
<td>Research Seminar: Ecological Genetics</td>
<td>W</td>
<td>2</td>
<td>1S</td>
<td>A. Widmer, S. Fior</td>
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<tr>
<td>701-1425-01L</td>
<td>Genetic Diversity: Techniques</td>
<td>W</td>
<td>2</td>
<td>2P</td>
<td>A. M. Minder Pfly</td>
</tr>
</tbody>
</table>

**Abstract**

The course provides methods and tools for ecological evaluations dealing with nature conservation or landscape planning. It covers census methods, ecological criteria, indicators, indices and critically appraises objectivity and accuracy of the available methods, tools and procedures. Birds and plants are used as main example guiding through different case studies.

**Objective**

Students will be able to:
1) critically consider biological data books and local, regional, and national inventories;
2) evaluate the validity of ecological criteria used in decision making processes;
3) critically appraise the handling of ecological data and criteria used in the process of evaluation;
4) perform an ecological evaluation project from the field survey up to the decision making and planning.

**Lecture notes / Literature**

Powerpoint slides are available on the webpage. Additional documents are handed out as copies. Basic literature and references are listed on the webpage.

**Prerequisites / notice**

The course structure changes between lecture parts, seminars and discussions. The didactic atmosphere is intended as working group. Prerequisites for attending this course are skills and knowledge equivalent to those taught in the following ETH courses:
- Pflanzen- und Vegetationsökologie
- Systematische Botanik
- Raum- und Regionalentwicklung
- Naturschutz und Stadtbioökologie

**Abstract**

In this research seminar we will critically discuss current topics in Ecological Genetics using publications from the leading scientific journals in this field.

**Objective**

It is our aim that participants gain insight into the current research topics and knowledge available in Ecological Genetics and learn to critically assess and appreciate scientific publications in this field.

**Lecture notes / Literature**

Active participation in the discussions is a prerequisite for this course.

**Prerequisites / notice**

Active participation in the discussions is a prerequisite for this course.

**Registration until 17.10.2016.**

This course provides training for advanced students (master, doctoral or post-doctoral level) in how to measure and collect genetic diversity data from populations, experiments, field and laboratory. Different DNA/RNA extraction, genotyping and gene expression techniques will be addressed. Choice of topic by demand and/or availability of data.

**Objective**

To learn and improve on standard and modern methods of genetic data collection. Examples are: use of pyrosequencing, expression analysis, SNP-typing, next-generation sequencing, etc.

**Content**

A course for practicioners.

Next steps after attending this course are skills and knowledge equivalent to those taught in the following ETH courses:
- Pflanzen- und Vegetationsökologie
- Systematische Botanik
- Raum- und Regionalentwicklung
- Naturschutz und Stadtbioökologie

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Environmental Governance

Number of participants limited to 30.

Abstract
The course addresses environmental policies, focusing on new steering approaches, which are generally summarized as environmental governance. The course also provides students with tools to analyze environmental policy processes and assesses the key features of environmental governance by examining various practical environmental policy examples.

Objective
To understand how an environmental problem may (not) become a policy and explain political processes, using basic concepts and techniques from political science.

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

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

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

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

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

Lecture notes
We will mostly work with readings from the following books:
Prerequisites / notice

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

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

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
<th>Lectures</th>
<th>Professor</th>
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<tbody>
<tr>
<td>851-0589-00L</td>
<td>Technology and Innovation for Development</td>
<td>3</td>
<td>2V</td>
<td>P. Aerni</td>
</tr>
</tbody>
</table>

Abstract

Technological change plays a crucial role in efforts to create a more sustainable future. In this context, policy decision makers must design rules that minimize its risks and maximize its benefits for society at large. The course discusses this challenge from an interdisciplinary perspective taking into account legal, economic, historical, development and environmental aspects.

Objective

- to recognize the challenges and opportunities of technological change in terms of sustainable development
- to become familiar with policy instruments to promote innovation
- to improve understanding of political decision-making processes in the regulation of science & technology
- improved understanding of the role of science and technology in the context of human and societal development

Content

Science and Technology Policy is normally associated with the improvement of national competitiveness; yet, it is also an integral part of effective environmental and development policies.

The course will discuss the challenges and opportunities of technological change in terms of sustainable development and show how public policy on the national and the international level is responding to this change.

In this context, students are to become familiar with the basic principles of political economy and New Growth Theory and how such theories help explain political decisions as well as political outcomes in the area of Science, Technology and Innovation. State interventions are either designed to regulate (e.g. environmental regulations, anti-trust law) or facilitate (e.g. intellectual property rights protection, public investment in R&D and technical education, technology transfer) technological change. This will be illustrated by looking at different industries and different national systems of innovation. Subsequently the positive and negative consequences for society and the natural environment will be discussed from a short-term and a long-term perspective.

Lecture notes

Reader with issue-specific articles. E-version is partly available under https://www.ethz.ch/content/specialinterest/gess/cis/international-relations/en/teaching/materials/tech.html
Literature


The 2-hour course (5-7 p.m.) will be held as a series of lectures. The course materials will be available in form of an electronic Reader at the beginning of the semester.

Students will be asked to give a (a) presentation (15 Minutes) or write a review paper based on a article selected from the electronic script, and (b) they will have to pass a written test at the end of the course in order to obtain 3 credit points in the ECTS System. In the final mark (a) will have a weight of 40% and (b) 60%.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
<th>Semester</th>
<th>Instructor(s)</th>
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<tbody>
<tr>
<td>701-1543-00L</td>
<td>Transdisciplinary Methods and Applications</td>
<td>3</td>
<td>W</td>
<td>P. Krüttli, M. Stauffacher</td>
</tr>
</tbody>
</table>

The course deals with transdisciplinary (td) methods, concepts and their applications in the context of case studies and other problem oriented research projects. Td methods are used in research at the science-society interface and when collaborating across scientific disciplines. Students learn to apply methods within a functional framework. The format of the course is seminar-like, interactive.
Objective
At the end of the course students should:

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

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

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

Be prepared for:
- Transdisciplinary Case Study 2017

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

Lecture notes
Handouts are provided by the lecturers

Literature
Selected scientific articles and book-chapters

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

701-1551-00L Sustainability Assessment

Abstract
The course deals with the concepts and methodologies for the analysis and assessment of sustainable development. A special focus is given to the social dimension and to social justice as a guiding principle of sustainability as well as to trade-offs between the three dimensions of sustainability.

Objective
At the end of the course students should

Know:
- core concepts of sustainable development, and;
- the concept of social justice - normatively and empirically - as a core element of social sustainability;
- important empirical methods for the analysis and assessment of local / regional sustainability issues.

Understand and reflect on:
- the challenges of trade-offs between the different goals of sustainable development;
- and the respective impacts on individual and societal decision-making.

Content
The course is structured as follows:
- Overview of rationale, objectives, concepts and origins of sustainable development;
- Importance and application of sustainability in science, politics, society, and economy;
- Sustainable (local / regional) development in different national / international contexts;
- Analysis and evaluation methods of sustainable development with a focus on social justice;
- Trade-offs in selected examples.

Lecture notes
Handouts.

Literature
Selected scientific articles & book chapters

Forest and Landscape Management

Number Title Type ECTS Hours Lecturers
701-1615-00L Advanced Forest Pathology W 3 credits 2G T. N. Sieber

Abstract
In-depth understanding of concepts, insight into current research and experience with methods of Forest Pathology based on selected pathosystems.

Objective
To know current biological and ecological research on selected diseases, to be able to comment on it and to understand the methods.
To understand the dynamics of selected pathosystems and disturbance processes.
To be able to diagnose tree diseases and injuries.
To know forest protection strategies and to be able to comment on them.

Content
Stress and disease, virulence and resistance, disease diagnosis and damage assessment, tree disease epidemiology, disease management, ecosystem pathology.
Systems (examples): Air pollution and trees, endophytic fungi, mycorrhiza, wood decay, conifer- root rot, Phytophthora diseases, chestnut canker and its hypoviruses, urban trees, complex diseases, emerging diseases

Lecture notes
no script, the ppt-presentations and specific articles will be made available among others:

Prerequisites / notice
The course is composed of introductory lectures, practical work, discussions and reading. The participants should have basic knowledge in forest pathology (corresponding to the course 701-0563-00 "Wald- und Baumkrankheiten, see teaching book of H. Butin: Tree diseases and disorders, Oxford University Press 1995, 252 pp.").

701-1631-00L Foundations of Ecosystem Management

Abstract
This course introduces the broad variety of conflicts that arise in projects focusing on sustainable management of natural resources. It explores case studies of ecosystem management approaches and considers their practicability, their achievements and possible barriers to their uptake.

Objective
Students should be able to
a) propose appropriate and realistic solutions to ecosystem management problems that integrate ecological, economic and social dimensions across relevant temporal and spatial scales.

b) identify important stakeholders, their needs and interests, and the main conflicts that exist among them in the context of land and resource management.
Content

Traditional management systems focus on extraction of natural resources, and their manipulation and governance. However, traditional management has frequently resulted in catastrophic failures such as, for example, the collapse of fish stocks and biodiversity loss. These failures have stimulated the development of alternative ecosystem management approaches that emphasise the functionality of human-dominated systems. Inherent to such approaches are system-wide perspectives and a focus on ecological processes and services, multiple spatial and temporal scales, as well as the need to incorporate diverse stakeholder interests in decision making. Thus, ecosystem management is the science and practice of managing natural resources, biodiversity and ecological processes, to meet multiple demands of society. It can be local, regional or global in scope, and addresses critical issues in developed and developing countries relating to economic and environmental security and sustainability.

This course provides an introduction to ecosystem management, and in particular the importance of integrating ecology into management systems to meet multiple societal demands. The course explores the extent to which human-managed terrestrial systems depend on underlying ecological processes, and the consequences of degradation of these processes for human welfare and environmental well-being. Building upon a theoretical foundation, the course will tackle issues in resource ecology and management, notably forests, agriculture and wild resources within the broader context of sustainability, biodiversity conservation and poverty alleviation or economic development. Case studies from tropical and temperate regions will be used to explore these issues. Dealing with ecological and economic uncertainty, and how this affects decision making, will be discussed. Strategies for conservation and management of terrestrial ecosystems will give consideration to landscape ecology, protected area systems, and community management, paying particular attention to alternative livelihood options and marketing strategies of common pool resources.

Lecture notes

No Script

Literature


701-1651-00L

Environmental Governance

Number of participants limited to 30.

Abstract

The course addresses environmental policies, focusing on new steering approaches, which are generally summarized as environmental governance. The course also provides students with tools to analyze environmental policy processes and assesses the key features of environmental governance by examining various practical environmental policy examples.

Objective

To understand how an environmental problem may (not) become a policy and explain political processes, using basic concepts and techniques from political science.

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

Content

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

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

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

Literature

Sampling Techniques for Forest Inventories. Daniel Mandallaz, Chapman and Hall. A free electronic copy of the book will be mailed to the participants.

We will mostly work with readings from the following books:

Prerequisites / notice

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

701-1671-00L

Sampling Techniques for Forest Inventories

W 3 credits 2V D. Mandallaz

Abstract

Introduction to design and model assisted sampling theory for finite populations as well as to the infinite population model for forest inventory. Two-phase two-stage forest inventories with simple or cluster sampling. Small area estimation. Presentation of the Swiss National Inventory. Short introduction to Kriging techniques.

Objective

Students should have a good understanding of the concepts of general sampling theory in a modern framework. They should also master the specific problems arising in forest inventory and be able, if necessary, to read more specialized books or research papers.

Content


Literature

Sampling techniques for forest inventories. Daniel Mandallaz, Chapman and Hall. A free electronic copy of the book is also available. A PDF file containing parts of the book will be mailed to the participants.

Sampling methods, remote sensing and GIS multiresource forest inventory M. Köhl, S. Magnussen, M. Marchetti, 2006, Springer.
Sampling techniques, Daniel Mandallaz, 2007, Chapman and Hall.

Prerequisites / notice

A simulation software will be used throughout the lectures to illustrate the theoretical developments. Upon request a half day field demonstration can be organized at the WSL outside the lecture time. A repetitorium for the exam is also offered.
751-5125-00L Stable Isotope Ecology of Terrestrial Ecosystems □ W 2 credits 2G R. A. Werner, N. Buchmann, A. Gessler

| Abstract | This course provides an overview about the applicability of stable isotopes (carbon 13C, nitrogen 15N, oxygen 18O and water 2H) to process-oriented ecological research. Topics focus on stable isotopes as indicators for the origin of pools and fluxes, partitioning of composite fluxes as well as to trace and integrate processes. In addition, students carry out a small project during lab sessions. Students will be familiar with basic and advanced applications of stable isotopes and familiar on plants, soils, water and trace gases, know the relevant approaches, concepts and recent results in stable isotope ecology, know how to combine classical and modern techniques to solve ecophysiological or ecological problems, learn to design, carry out and interpret a small IsoProject, practice to search and analyze literature as well as to give an oral presentation. |
| Objective | The aim of the course is to provide the fundamental knowledge about earth observation sensors, techniques and methods for process-oriented ecological research. Students should know how to combine classical and modern techniques to solve ecophysiological or ecological problems, learn to design, carry out and interpret a small IsoProject, practice to search and analyze literature as well as to give an oral presentation. |
| Content | The analyses of stable isotopes often provide insights into ecophysiological and ecological processes that otherwise would not be available with classical methods only. Stable isotopes proved useful to determine origin of pools and fluxes in ecosystems, to partition composite fluxes and to integrate processes spatially and temporally. |
| Lecture notes | Handouts will be available on the webpage of the course. |
| Literature | Will be discussed in class. |
| Prerequisites / notice | This course is based on fundamental knowledge about plant ecophysiology, soil science, and ecology in general. Course will be taught in English. |

102-0675-00L Earth Observation □ W 4 credits 3G I. Hajnsek, E. Baltsavias

| Abstract | The aim of the course is to provide the fundamental knowledge about earth observation sensors, techniques and methods for bio/geophysical environmental parameter estimation. Students should know how to combine classical and modern techniques to solve ecophysiological or ecological problems, learn to design, carry out and interpret a small IsoProject, practice to search and analyze literature as well as to give an oral presentation. |
| Objective | The aim of the course is to provide the fundamental knowledge about earth observation sensors, techniques and methods for bio/geophysical environmental parameter estimation. Students should know how to combine classical and modern techniques to solve ecophysiological or ecological problems, learn to design, carry out and interpret a small IsoProject, practice to search and analyze literature as well as to give an oral presentation. |
| Content | This course will provide an introduction to the applicability of stable isotopes to ecological research questions. Topics will focus on carbon (13C), nitrogen (15N), oxygen (18O) and hydrogen (2H) in natural isotope abundance and tracer levels. Lectures will be supplemented by intensive laboratory sessions, short presentations by students and computer exercises. |
| Lecture notes | Handouts will be available on the course webpage. |
| Literature | Will be discussed in class. |
| Prerequisites / notice | This course is based on fundamental knowledge about plant ecophysiology, soil science, and ecology in general. Course will be taught in English. |

701-1681-00L Element Balancing and Soil Functions in Managed Ecosystems □ W 3 credits 2G A. Keller

| Abstract | Applying element balances of agricultural soils and the assessment of soil functions for real applications in computer exercises to design preventive strategies against soil pollution and to support sustainable management of regional agroecosystems also in the context of spatial planning procedures. The students apply a regional balance model for Swiss regions in computer exercises and assess major soil functions of agricultural soils. You design solutions for chemical problems in soil protection at the regional scale and learn to assess soil functions using different methods. |
| Objective | The students learn to critical assess changes in land use management on element cycles in agro-ecosystems and to assess soil services (soil functions). You design solutions for chemical problems in soil protection at the regional scale and learn to assess soil functions using different methods. |
| Content | The students apply a regional balance model for Swiss regions in computer exercises and assess major soil functions of agricultural soils. You design solutions for chemical problems in soil protection at the regional scale and learn to assess soil functions using different methods. The students will have the opportunity to calculate specific scenarios regarding land use management and environmental changes. Special focus will be paid on the soil services such as regulation-, production function and soil as habitat, and the assessment of these functions based on soil mapping data. |
| Lecture notes | Literature and Exercises for a case study |
| Literature | Literature will be provided. |
| Prerequisites / notice | The course consists of lectures and computer exercises. The course take place every 2 weeks à 4 hours. recommended prerequisites for attending this course: |
- Bodenschutz und Landnutzung
- Biochemistry of Trace Elements
- Angewandte Bodenkunde

701-1776-00L Geographic Data Processing with Python and ArcGIS □ W 1 credit 2U A. Baltensweiler

| Abstract | The course communicates the basics of the programming language Python and gives a general introduction into the geoprocessing framework of ArcGIS. In addition various Python libraries (numyp, Scipy, GDAL, statsmodels, pandas) will be introduced which increase the functional range of the geoprocessing framework substantially. |
| Objective | The students learn the basics of geographic data processing based on the programming language Python and ArcGIS (arcpy). They get the ability to implement their own processing sequences and models for geoprocessing. The students are able to integrate open source libraries in their python scripts and know how the libraries are applied to spatial datasets. |
| Content | The course communicates a deepened understanding of the geoprocessing frameworks arcpy and covers basic language concepts of Python such as datatypes, control structures and functions. In addition the application of popular Python libraries in combination with spatial datasets will be shown. |
| Lecture notes | Lecture notes, exercises and worked out solutions to them will be provided. |
| Prerequisites / notice | The course will be taught in German. All material will be provided in English. Knowledge of ArcGIS is assumed. |

701-1682-00L Dendroecology □ W 3 credits 3G C. Bigler, A. Rigling, K. Treydte

| Abstract | The course dendroecology offers theoretical and practical aspects of dendrochronology. The impact of different environmental influences on tree-ring characteristics will be shown. The students learn various methods to date tree rings and they understand how ecological and environmental processes and patterns can be reconstructed using tree rings. |
The students...
- understand, how wood is configured and how tree-ring structures are formed.
- are able to identify and describe different tree-ring structures.
- understand the theoretical and practical aspects of the dating of tree rings.
- know the effects of different abiotic and biotic environmental influences (climate, site, competition, insects, fire, physical-mechanical influences) on trees and tree rings.
- discover a tool for understanding and reconstructing global change processes.
- learn software to date, standardize and analyze tree rings.
- get hands-on experience based on the demonstration of wood (increment cores, stem discs, wedges), sampling in the field, and measuring and dating of tree rings in the tree-ring lab.
- solve R-based exercises (R tutorial will be provided) and answer questions in Moodle.
- work out an independent research question related to a dendroecological topic and write a short literature review based on scientific papers.

- Overview and history of dendrochronology
- Principles of dendrochronology
- Evolution of tree rings
- Formation and structure of wood and tree rings
- Intra-seasonal tree-ring growth
- Continuous and discontinuous tree-ring characteristics
- Sampling and measuring
- Crossdating methods (visual, skeleton plots, quantitative)
- Standardization of tree-ring series
- Development of tree-ring chronologies
- Dendrogeomorphology, dendrohydrology, dendroglaciology
- Stable isotopes
- Climate, climate-growth relationships, climate reconstructions
- Age and size structures, forest dynamics (regeneration, growth, competition, mortality)
- Disturbance ecology (fire, insects, blowdown)
- Application of tree-ring research in practice and in interdisciplinary research projects
- Field and lab day (date for one entire day or two half days will be searched together with the students in the beginning of the semester): discussion of different dendroecological questions in the forest; sampling of trees; insight into different tree-ring projects in the lab (Swiss Federal Institute for Forest, Snow and Landscape Research WSL)

Lecture notes
Lecture notes (in English) will be handed out in the class.
The lecture notes and further documents (papers, software) can also be downloaded from Moodle (https://moodle-app2.let.ethz.ch) following registration for the course.

Literature
Literature lists will be handed out in the class.

Prerequisites / notice
Time schedule (total of 90 hours): There will be 12 lectures with each two hours (total of 24 hours presence) as well as a field and lab day (8 hours presence). In addition, the students are expected to put 18 hours into the preparation of the lectures as well as 18 hours for the exercises. 4 hours are reserved for the lab work and 18 hours for the project.
The class language is German and English, on request English only.
Requirements:
Basics of biology, ecology and forest ecology

701-1695-00L Soil Science Seminar
Z 0 credits 1S R. Schulin
Invited external speakers present their research on current issues in the field of soil science and discuss their results with the participants.
The program will be announced through various channels and also be made available through the teaching materials.

Objective
Master and PhD students are introduced to current areas of research in soil sciences and get first-hand experience in scientific discussion.

Inter- and Transdisciplinary Courses

Number Title Type ECTS Hours Lecturers
701-0015-00L Seminar on Transdisciplinary Research for Sustainable Development W 2 credits 2S C. E. Pohl, M. Stauffacher
The seminar is designed for students and researchers (MA, PhD, PostDoc) who use inter- and transdisciplinary elements in their projects.
It addresses the challenges of this research: How to integrate disciplines? How (and in what role) to include societal actors? How to bring results to fruition? We discuss these questions based on case studies and theories and on the participant's projects.
The participants understand the specific challenges of inter- and transdisciplinary research in general and in the context of sustainable development in particular. They know methods and concepts to address these challenges and apply them to their research projects.
The seminar covers the following topics:
(1) Theories and concepts of inter- and transdisciplinary research
(2) The specific challenges of inter- and transdisciplinary research
(3) Involving stakeholders
(4) Collaborating disciplines
(5) Exploration of tools and methods
(6) Analysing participants’ projects to improve inter- and transdisciplinary elements

Literature
Literature will be made available to the participants

Prerequisites / notice
The seminar is specifically suitable for PhD or PostDoc researchers. It is open to master students (minor "global change and sustainability") and further interested people, who preferably are preparing, or working on, a project/thesis.

701-1503-00L CCES Winter School "Science Meets Practice"
W 4 credits 9A C. Adler, P. Fry, P. Krüttli, C. E. Pohl
Increasingly, scientists need to interact more with people and institutions outside the scientific community. This requires the capability to understand and critically reflect about scientific activities and consequences for society and environment and to communicate with confidence. The CCES Winter School builds capacity to create and manage interactions between science and society.
1. To acquire knowledge of key aspects of the interplay between science and practice
2. To reflect on and understand the role and consequences of scientific activity in relation to society and environment
3. To acquire skills and learn about a systematic application of methods to create and manage interactions between science and society

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The CCES Winter School provides insights into theoretical and methodological foundations on the challenges of knowledge exchange and dialogue between science and practice. It offers media and knowledge management training for enhancing stakeholder involvement. Selected case examples support group work discussions and analysis. Real stakeholder meetings are organized for testing techniques in view of identifying diverse expectations and needs and working towards solutions. Together the Winter School participants and stakeholders experience and develop ways for better linking environmental science and practice.

The course is structured by an intimate interconnection between theoretical inputs, reflection and translation into own topics and projects. The course offers insights into a wide spectrum of crossing boundaries between science and practice (e.g. information, consultation, co-production of knowledge) and provides test fields for and room for reflection of own experiences.

The first block with inputs, individual and group work, and reflection is a preparation for the second block, which focuses on implementation of stakeholder interactions. Between the two blocks coached project work is offered.

The CCES Winter School takes place at Propstei Wislikofen in January and February 2017. Accommodation is provided. Course materials (e.g. slides, articles, toolboxes) are provided for preparatory reading and during the course (in Moodle).

The CCES Winter School addresses PhD students and postdocs from environmental and natural sciences, engineering, and social sciences related to sustainable development. Participants are required to apply online providing key information about their interest and PhD project - details and application form can be found here: http://www.cces.ethz.ch/winterschool/
## EAWAG PhD Skills Seminar

**Does not take place this semester.**

### Abstract

Purpose is to discuss and teach the professional skills that are needed in science (or future career in science). Course consists of lectures and practical sessions. Course is organized by Eawag scientists.

### Objective

Purpose is to discuss and teach the professional skills that are needed in science (or future career in science). Course consists of lectures and practical sessions.

### Content

Lectures and exercises in:
- Project management
- Application of research grants
- Scientific publishing
- Reviewing
- Writing papers
- Applying jobs
- Job interviews

## Basic Concepts of Management

**W 2 credits 2S**

J. Jokela, J. Hering

### Abstract

This course deals with fundamental and proven management concepts. The lecturers emphasize the practical applicability of concepts. The course was designed in close cooperation with practitioners; e.g. will Mr. S. Baldenweg, mechanical engineer ETH, MBA Insead, share his experience in several guest lectures.

### Objective

- Students will be familiar with basic general management concepts.
- Learn about the fundamental concepts of strategy development with practical examples.
- Get a rough overview on the concepts of financial management.
- Will learn about the strategic positioning of small departments within larger organisations.
- Will learn about the fundamental mechanisms for handling change, and will be able to recognise these situations.
- Will learn the basic principles of project management and of successful self-management.
- Will reflect on customer oriented information representation.

### Content

Management is an extensive profession ran by clear tasks and corresponding tools. The positioning of a company, or a sector within an environment and the consideration of future challenges. To this end different approaches are shown and the fundamental patterns are imparted. For the implementation of a strategy, the cooperation of people must be appropriately organized. To this end, the main organizational models and the dynamics of organizations are imparted.

The financial depiction of organizations and projects will be consistently presented, and the multi-level structure of information will be discussed with real examples.

The contents are consistently illustrated with practical examples.

### Lecture notes

Skripten werden elektronisch zur Verfügung gestellt.


### Literature


### Prerequisites / notice

Deutsch

## Research Ethics

**W 2 credits 2G**

G. Achermann

### Abstract

This course has its focus on the responsible conduct of research (RCR) and the ethical dimensions of the biological and biomedical sciences.

### Objective

The main goal of this course is to enhance the student's ability to:
- recognize and identify ethical issues and conflicts,
- analyze and develop well-reasoned responses to the kinds of ethical problems a scientist is likely to encounter.

Additionally, students will become familiar with regulations and ethical guidelines relevant for their research field on the international, governmental, institutional and professional level.

To achieve these objectives, teaching methods will include lectures, discussions, case study work (alone and in groups), moral games, paper work and exercises.
I. Ethics & the Process of Ethical Inquiry

Introduction in Ethics and Research Ethics
- What is ethics? What ethics is not...;
- Awareness: what constitutes an ethical question? Distinguishing ethical questions from other kinds of questions; Science & ethics: a comparison;
- The ethics movement in the biological and health sciences;
- What is research ethics and why is it important?
- Values (personal, cultural & ethical) in science & principles for ethical conduct in research;
- Professional codes of conduct: functions and limitations

Ethical approaches in the conduct of research (Normative Ethics)
- Overview over important theories for research ethics: virtue theories, duty-based theories (rights theory, categorical imperative, prima facie duties), consequentialist theories, other theories);
- The plurality of ethical theories and its consequences;
- The concept of dignity

Moral reasoning I: Arguments
- Why arguments? What is a good argument? The structure of (moral) arguments;
- Deductive and inductive arguments; Validity and soundness;
- Assessing moral arguments

Moral reasoning II: Decision-making
- How (not) to approach ethical issues...; Is there a correct method for answering moral questions?
- Models of method in Applied Ethics: a) Top-down approaches; b) the reflective equilibrium; c) a bottom-up approach: casuistry (or reasoning-by-analogy);
- Is there a right answer?

II. Research Ethics / Responsible Conduct of Research (RCR)

Integrity in Research & Research Misconduct
- What is "integrity" in scientific research? What is research misconduct (falsification, fabrication, plagiarism - FFP) and questionable research practices (QRP)?
- Factors leading to misconduct; Procedure for responding to allegations of research misconduct;
- The confidant of ETH Zurich

Data Management
- Data collection and recordkeeping; Analysis and selection of data;
- Ownership of data; retention and sharing of data;
- Falsification and fabrication of data

Research involving animals
- The moral status of animals; Ethical approaches to animal experimentation: Animal welfare (Peter Singer) and Animal rights (Tom Regan);
- The 3 R's (replacement, reduction, refinement);
- Ethical assessment of conflicting issues in animal experimentation;
- The dignity of animals in the Swiss constitution;

Research involving human subjects
- History & guidelines (Nuremberg Code; Declaration of Helsinki; Belmont Report; International Ethical Guidelines for Biomedical Research Involving Human Subjects (CIOMS Guidelines); Convention on Human Rights and Biomedicine (Oviedo Convention);
- Informed consent; confidentiality and anonymity; research risks and benefits; vulnerable subjects;
- Clinical trials;
- Biobanks
- Ethics Committees / Institutional Review Boards (IRB)

Authorship & Peer review
- Criteria for authorship;
- Plagiarism;
- Challenges to openness and freedom in scientific publication;
- Open access
- Peer review

Social responsibility
- What is social responsibility? Social responsibility: whose obligation?
- Public advocacy by researchers

Lecture notes
Course material (handouts, case studies, exercises, surveys and papers) will be available during the lectures and on the course homepage.

Literature
Recommended literature:
- "Introduction to the Responsible Conduct of Research" (http://ori.dhhs.gov/education/products/RCRintro/)

Detailed literature lists for the different topics of the course will be provided in the script/handout or on the course work space.
# Doctoral Department of Environmental Sciences - Key for Type

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

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<th>Description</th>
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<tr>
<td>V</td>
<td>lecture</td>
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<td>G</td>
<td>lecture with exercise</td>
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<td>U</td>
<td>exercise</td>
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<td>colloquium</td>
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<td>practical/laboratory course</td>
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<td>A</td>
<td>independent project</td>
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<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
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</table>

### ECTS

- European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
Electrical Engineering and Information Technology Bachelor

1. Semester

First Year Examinations

First Year Examination Block A

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0003-00L</td>
<td>Digital Circuits</td>
<td>O</td>
<td>4 credits</td>
<td>2V+2U</td>
<td>G. Tröster</td>
</tr>
<tr>
<td>Abstract</td>
<td>Digital and analogue signals and their representation. Combinational and sequential circuits and systems, boolean algebra, K-maps. Finite state machines. Memory and computing building blocks in CMOS technology, programmable logic circuits. Provide basic knowledge and methods to understand and to design digital circuits and systems.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>Provide basic knowledge and methods to understand and to design digital circuits and systems.</td>
<td></td>
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</tr>
<tr>
<td>Content</td>
<td>Digital and analogue signals and their representation. Boolean Algebra, circuit analysis and synthesis, the MOS transistor, CMOS logic, static and dynamic behaviour, tristate logic, Karnough-Maps, hazards, binary nuber systems, coding. Combinational and sequential circuits and systems (boolean algebra, K-maps, etc.). Memory building blocks and memory structures, programmable logic circuits. Finite state machines, architecture of microprocessors.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Literature</td>
<td>Lecture notes for all lessons, assignments and solutions. Textbook: <a href="http://www.ife.ee.ethz.ch/education/Digitaltechnik">http://www.ife.ee.ethz.ch/education/Digitaltechnik</a></td>
<td></td>
<td></td>
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</tbody>
</table>

401-0151-00L  | Linear Algebra                     | O    | 4 credits | 3G+2U  | V. C. Gradinaru, R. Käppeli |
| Abstract     | Contents: Linear systems - the Gaussian algorithm, matrices - LU decomposition, determinants, vector spaces, least squares - QR decomposition, linear maps, eigenvalue problem, normal forms - singular value decomposition; numerical aspects; introduction to MATLAB. |      |        |         |                            |
| Objective    | Einführung in die Lineare Algebra für Ingenieure unter Berücksichtigung numerischer Aspekte |      |        |         |                            |
| Lecture notes| K. Nipp / D. Stoffer, Lineare Algebra, vdf Hochschulverlag, S. Auflage 2002 |      |        |         |                            |
| Literature   | Grundlagen der Elektrotechnik, Bd. 1 und 2, M. Albach, and Textbook |      |        |         |                            |

227-0001-00L  | Networks and Circuits I            | O    | 4 credits | 2V+2U  | J. W. Kolar                 |
| Abstract     | Electrostatic field; Stationary electric current flow; Basic electric circuits; current conduction mechanisms; time variant electromagnetic field; alternating voltages and currents. |      |        |         |                            |
| Objective    | Voltage, current and properties of basic elements of electric circuits, i.e. capacitors, resistors and inductors should be understood in relation to electric and magnetic fields. Furthermore, the students should be able to mathematically describe, analyze and finally design technical realizations of circuit elements. Students should also be familiar with the calculation of voltage and current distributions of DC circuits. The effect and the mathematical formulation of magnetic induction should be known for technical applications. The fundamentals of complex AC current calculus for description of periodic sinusoidal quantities should be known and students should be able to apply the concept to basic AC circuits. |      |        |         |                            |
| Content      | Electrostatic field; Stationary electric current flow; Basic electric circuits; current conduction mechanisms; time variant electromagnetic field; alternating voltages and currents. |      |        |         |                            |
| Lecture notes| Grundlagen der Elektrotechnik, Bd. 1 und 2, M. Albach, and Textbook |      |        |         |                            |

151-0223-10L  | Engineering Mechanics              | O    | 4 credits | 2V+2U+1K | S. P. Kaufmann, J. Dual |
| Abstract     | Introduction to engineering mechanics: kinematics, statics and dynamics of rigid bodies and systems of rigid bodies. Students can solve problems of elementary engineering mechanics. |      |        |         |                            |
| Objective    | Students can solve problems of elementary engineering mechanics. Statics: static equivalence, force-couple system, center of forces, centroid, principle of virtual power, equilibrium, constraints, statics, friction. Dynamics: acceleration, inertial forces, d'Alembert's Principle, Newton's Second Law, principles of linear and angular momentum, equations of planar motion of rigid bodies. |      |        |         |                            |
| Content      | Students can solve problems of elementary engineering mechanics. Statics: static equivalence, force-couple system, center of forces, centroid, principle of virtual power, equilibrium, constraints, statics, friction. Dynamics: acceleration, inertial forces, d'Alembert's Principle, Newton's Second Law, principles of linear and angular momentum, equations of planar motion of rigid bodies. |      |        |         |                            |

First Year Examination Block B

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-0231-10L</td>
<td>Analysis I</td>
<td>O</td>
<td>8 credits</td>
<td>4V+3U</td>
<td>D. A. Salamon</td>
</tr>
<tr>
<td>Abstract</td>
<td>Calculus of one variable: Real and complex numbers, vectors, limits, sequences, series, power series, continuous maps, differentiation and integration in one variable, introduction to ordinary differential equations.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Objective</td>
<td>Einfuehrung in die Grundlagen der Analysis</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lecture notes</td>
<td>Konrad Koenigsberger, Analysis I. Christian Blatter: Ingenieur-Analyse (Kapitel 1-3)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

252-0835-00L  | Computer Science I                 | O    | 4 credits | 2V+2U  | F. O. Friedrich           |
| Abstract     |                              |      |        |         |                            |
| Objective    |                              |      |        |         |                            |
| Lecture notes|                              |      |        |         |                            |

Literature will be announced during the lessons.

No special prerequisites

Objective

Abstract

Literature

Lecture notes

Prerequisites / notice

ECTS

Number

151-0223-10L

227-0001-00L

227-0003-00L

1. Semester

Bachelor Studies (Programme Regulations 2016)

Data: 06.03.2019 12:57        Autumn Semester 2016

Page 492 of 1571
Abstract
The course covers the fundamental concepts of computer programming with a focus on systematic algorithmic problem solving. Taught language is C++. No programming experience is required.

Objective
Primary educational objective is to learn programming with C++. When successfully attended the course, students have a good command of the mechanisms to construct a program. They know the fundamental control and data structures and understand how an algorithmic problem is mapped to a computer program. They have an idea of what happens "behind the scenes" when a program is translated and executed.

Secondary goals are an algorithmic computational thinking, understanding the possibilities and limits of programming and to impart the way of thinking of a computer scientist.

Content
The course covers fundamental data types, expressions and statements, (Limits of) computer arithmetic, control statements, functions, arrays, structural types and pointers. The part on object orientation deals with classes, inheritance and polymorphy, simple dynamic data types are introduced as examples.

In general, the concepts provided in the course are motivated and illustrated with algorithms and applications.

Lecture notes
A script written in English will be provided during the semester. The script and slides will be made available for download on the course web page.

Literature
Bjarne Stroustrup: Einführung in die Programmierung mit C++, Pearson Studium, 2010

Prerequisites / notice
From AS 2013, an admission to the exam does not any more formally require an attending of the recitation sessions. Handing in solutions to the weekly exercise sheets is thus not mandatory, but we strongly recommend it.

Examination is a one hour-long written test.

First Year Compulsory Laboratory Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0005-10L</td>
<td>Digital Circuits Laboratory</td>
<td>O</td>
<td>1 credit</td>
<td>1P</td>
<td>G. Tröster</td>
</tr>
</tbody>
</table>

Abstract
Digital and analogue signals and their representation. Combinational and sequential circuits and systems, boolean algebra, K-maps. Finite state machines. Memory and computing building blocks in CMOS technology, programmable logic circuits.

Objective
Deepen and extend the knowledge from lecture and exercises, usage of design software Quartus II as well as an oscilloscope

Content
The contents of the digital circuits laboratory will deepen and extend the knowledge of the correspondent lecture and exercises. With the help of the logic device design software Quartus II different circuits will be designed and then tested on an evaluation board. You will build up the control for a 7-digit display as well as an adder and you will create different types of latches and flip-flops. At the end of the laboratory a small synthesizer will be programmed that is able to play self-created melodies. At the same time the usage of a modern oscilloscope will be taught in order to analyse the programmed circuits through the digital and analogue inputs.

Bachelor Studies (Programme Regulations 2012)

1. Semester

Course Units of the first year can be found in section Bachelor Studies (Programme Regulations 2016) - 1. Semester

3. Semester

Examination Blocks

Examination Block 1

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
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<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>401-0353-00L</td>
<td>Analysis III</td>
<td>O</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>E. Kowalski</td>
</tr>
</tbody>
</table>

Abstract
In this lecture we treat problems in applied analysis. The focus lies on the simplest cases of three fundamental types of partial differential equations of second order: the Laplace equation, the heat equation and the wave equation.

Content
1.) Klassifizierung von PDE's
   - linear, quasilinear, nicht-linear
   - elliptisch, parabolisch, hyperbolisch

2.) Quasilineare PDE
   - Methode der Charakteristiken (Beispiele)

3.) Elliptische PDE
   - Bsp: Laplace-Gleichung
   - Harmonische Funktionen, Maximumsprinzip, Mittelwerts-Formel.
   - Methode der Variablenseparation.

4.) Parabolische PDE
   - Bsp: Wärmeleitungsgleichung
   - Bsp: Inverse Wärmeleitungsgleichung
   - Methode der Variablenseparation

5.) Hyperbolische PDE
   - Bsp: Wellengleichung
   - Formel von d'Alembert in (1+1)-Dimensionen
   - Methode der Variablenseparation

6.) Green'sche Funktionen
   - Rechnen mit der Dirac-Deltafunktion
   - Idee der Green'schen Funktionen (Beispiele)

7.) Ausblick auf numerische Methoden
   - 5-Punkt-Diskretisierung des Laplace-Operators (Beispiele)

Literature

Zusätzliche Literatur:
Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley & Sons, Kap. 8, 11, 16 (sehr gutes Buch, als Referenz zu benutzen)
Norbert Hungerbühler, "Einführung in die partiellen Differentialgleichungen", vdf Hochschulverlag AG an der ETH Zürich.
G. Felder:Partielle Differentialgleichungen.
https://people.math.ethz.ch/~felder/PDG/

Prerequisites / notice
Prerequisites: Analysis I and II, Fourier series (Komplexe Analysis)
Modern, transistor-based electronics has transformed our lives and plays a crucial role in our economy since the 2nd half of last century. The main objective of this course in electronic circuits is to introduce the concept of active device, including operational amplifiers, and their use in amplification, signal conditioning, switching and filtering to students. In addition to gaining experience with typical electronic circuits that are found in common applications, including their own Gruppenarbeit and Fachpraktikum projects, students sharpen their understanding of linear circuits based on nonlinear devices, imperfections of electronic circuits and the concept of design (as opposed to analysis). The course is a prerequisite for higher semester subjects such as analog integrated circuits, RF circuits for wireless communications, A/D and D/A converters and optoelectronics.

**Content**

**Literature**

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**Examination Block 3**

The courses of the examination block 3 will be offered in spring semester.

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**Second Year Compulsory Laboratory Courses**

A minimum of 18 cp must be obtained from the category "Laboratory Courses, Projects, Seminars".

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**General Laboratory**

A maximum of 13 cp can be obtained from Projects & Seminars. Each course can be registered for once only.

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**Projects & Seminars**

Course can only be registered for once. A repeatedly registration in a later semester is not chargeable.
Abstract
Procurement of knowledge about the build up of systems as well as enhancement of general knowledge. Procurement of skills in the area of Electrical Engineering and Information Technology that are useful for the remaining terms as well during ones work life.

Objective
see above

Prerequisites / notice
Enrollment through the Online-Tool, https://isgapps.ee.ethz.ch/ppsapp/

227-0085-20L Projects & Seminars for 1 CP (2)
Only for Electrical Engineering and Information Technology BSc.

Abstract
Procurement of knowledge about the build up of systems as well as enhancement of general knowledge. Procurement of skills in the area of Electrical Engineering and Information Technology that are useful for the remaining terms as well during ones work life.

Objective
see above

Prerequisites / notice
Enrollment through the Online-Tool, https://isgapps.ee.ethz.ch/ppsapp/

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227-0085-30L Projects & Seminars for 2 CP (1)
Only for Electrical Engineering and Information Technology BSc.

Abstract
Procurement of knowledge about the build up of systems as well as enhancement of general knowledge. Procurement of skills in the area of Electrical Engineering and Information Technology that are useful for the remaining terms as well during ones work life.

Objective
see above

Prerequisites / notice
Enrollment through the Online-Tool, https://isgapps.ee.ethz.ch/ppsapp/

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227-0085-40L Projects & Seminars for 2 CP (2)
Only for Electrical Engineering and Information Technology BSc.

Abstract
Procurement of knowledge about the build up of systems as well as enhancement of general knowledge. Procurement of skills in the area of Electrical Engineering and Information Technology that are useful for the remaining terms as well during ones work life.

Objective
see above

Prerequisites / notice
Enrollment through the Online-Tool, https://isgapps.ee.ethz.ch/ppsapp/

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227-0085-50L Projects & Seminars for 3 CP
Only for Electrical Engineering and Information Technology BSc.

Abstract
Procurement of knowledge about the build up of systems as well as enhancement of general knowledge. Procurement of skills in the area of Electrical Engineering and Information Technology that are useful for the remaining terms as well during ones work life.

Objective
see above

Prerequisites / notice
Enrollment through the Online-Tool, https://isgapps.ee.ethz.ch/ppsapp/

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227-0085-60L Projects & Seminars for 4 CP
Only for Electrical Engineering and Information Technology BSc.

Abstract
Procurement of knowledge about the build up of systems as well as enhancement of general knowledge. Procurement of skills in the area of Electrical Engineering and Information Technology that are useful for the remaining terms as well during ones work life.

Objective
see above

Prerequisites / notice
Enrollment through the Online-Tool, https://isgapps.ee.ethz.ch/ppsapp/

✈✈✈ Group Projects

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0091-10L</td>
<td>Group Project I ■</td>
<td>W</td>
<td>6 credits</td>
<td>5A</td>
<td>Lecturers</td>
</tr>
<tr>
<td>Abstract</td>
<td>Students must work in groups in supervised projects for 150 to 180 hours minimum. The topics of the group work are open and can be technical of specific nature or more general in the context of engineering.</td>
<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>see above</td>
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</tr>
</tbody>
</table>

✈✈✈ Internship in Industry
Please note the conditions for Internships in industry as set forward by the "Guidelines for the "Laboratory Courses - Projects - Seminars ", see https://www.ee.ethz.ch/content/dam/ethz/special-interest/itet/department/Studies/Bachelor/Regulations/Richtlinien_Praktika-Projekte-Seminare_v5_final.pdf (German only).

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0093-10L</td>
<td>Internship in Industry</td>
<td>W</td>
<td>6</td>
<td>external organisers</td>
<td></td>
</tr>
</tbody>
</table>

Abstract
The main objective of the 12-week internship is to expose bachelor's students to the industrial work environment. During this period, students have the opportunity to be involved in on-going projects at the host institution.

Objective
Please note the conditions for Internships in industry as set forward by the "Guidelines for the "Laboratory Courses - Projects - Seminars ", see http://www.ee.ethz.ch/fileadmin/user_upload/d-itet/neue_website/Factsheets/Reglemente/Richtlinien_Praktika-Projekte-Seminare_v5_final.pdf (German only).

Additional Subjects

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0651-00L</td>
<td>Applied Circuit and PCB-Design</td>
<td>W</td>
<td>2</td>
<td>4G</td>
<td>A. Blanco Fontao</td>
</tr>
</tbody>
</table>

Abstract
Participants learn how to design a predefined electronic circuit and how to lay out the pertaining circuit board. CAE and CAD activities for design and simulation are carried out with the aid of Altium Designer.

Objective
The goal is to become acquainted with all those practical aspects of electronic circuit and PCB design by working through a modest but complete application example. This involves analysis of specifications, the evaluation of electronic parts, efficient testing and failure search, electromagnetic compatibility (EMC), the usage of industrial CAE/CAD tools for circuit simulation and PCB layout, generating production data for the board manufacturer, board mounting, testing and start up.

Content
- Understanding circuit, system, and product specifications
- Guidelines, standards, and regulations
- Design and development flow
- Introduction to the Altium Designer environment
- Selection of components and circuit sizing
- Preparing schematic symbols and footprints for CAE/CAD
- Working with database component libraries
- Logically structured schematic circuit diagrams
- Capturing a predefined circuit
- Definition of net classes and layout rules in schematics
- Design for EMC
- Checking schematic data
- Simulation of mixed signal circuits using Spice
- Hints for improved testing and debugging
- Component placement on the PCB
- Turning circuit diagrams into a workable layout
- Manual and automatic interconnect routing
- Definition of layout rules
- RF- and EMC-guidelines for circuit wire routing
- Differential pairs and impedance-controlled routing
- Introduction to PCB manufacturing
- Preparation of production and assembly data
- PCB and device assembly (component mounting)
- Final circuit testing and start up

Literature
All necessary documents will be available as electronic documents (PDF).

Prerequisites / notice
- The course is recommended to all students who plan to design an electronic circuit or a PCB in an upcoming term project or as part of their master thesis. Attending this course during the term before will ensure they are optimally prepared and will allow them to fully focus on their project.

- The number of participants is limited.

- For their own students and staff, the Department of Information Technology and Electrical Engineering provides electronic components and consumables free of charge. All other participants have to bear a 200 CHF fee for those items.

Third Year Core Courses

Can be freely combined, a list of recommendations is available under www.ee.ethz.ch/bachelor-kernfaecher

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0101-00L</td>
<td>Discrete-Time and Statistical Signal Processing</td>
<td>W</td>
<td>6</td>
<td>4G</td>
<td>H.A. Loeliger</td>
</tr>
</tbody>
</table>

Abstract
The course introduces some fundamental topics of digital signal processing with a bias towards applications in communications: discrete-time linear filters, equalization, DFT, discrete-time stochastic processes, elements of detection theory and estimation theory, LMMSE estimation and LMMSE filtering, LMS algorithm, Viterbi algorithm.

Objective
The course introduces some fundamental topics of digital signal processing with a bias towards applications in communications. The two main themes are linearity and probability. In the first part of the course, we deepen our understanding of discrete-time linear filters. In the second part of the course, we review the basics of probability theory and discrete-time stochastic processes. We then discuss some basic concepts of detection theory and estimation theory, as well as some practical methods including LMMSE estimation and LMMSE filtering, the LMS algorithm, and the Viterbi algorithm. A recurrent theme throughout the course is the stable and robust "inversion" of a linear filter.
Content

1. Discrete-time linear systems and filters:
   state-space realizations, z-transform and spectrum,
   decimation and interpolation, digital filter design,
   stable realizations and robust inversion.

2. The discrete Fourier transform and its use for digital filtering.

3. The statistical perspective:
   probability, random variables, discrete-time stochastic processes;
   detection and estimation: MAP, ML, Bayesian MMSE, LMMSE;
   Wiener filter, LMS adaptive filter, Viterbi algorithm.

Lecture notes

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0102-00L</td>
<td>Discrete Event Systems</td>
<td>6</td>
<td>L. Thiele, L. Vanbeever, R. Wattenhofer</td>
</tr>
</tbody>
</table>

Abstract

Introduction to discrete event systems. We start out by studying popular models of discrete event systems. In the second part of the course we analyze discrete event systems from an average-case and from a worst-case perspective. Topics include: Automata and Languages, Specification Models, Stochastic Discrete Event Systems, Worst-Case Event Systems, Verification, Network Calculus.

Objective

Over the past few decades the rapid evolution of computing, communication, and information technologies has brought about the proliferation of new dynamic systems. A significant part of activity in these systems is governed by operational rules designed by humans. The dynamics of these systems are characterized by asynchronous occurrences of discrete events, some controlled (e.g. hitting a keyboard key, sending a message), some not (e.g. spontaneous failure, packet loss).

The mathematical arsenal centered around differential equations that has been employed in systems engineering to model and study processes governed by the laws of nature is often inadequate or inappropriate for discrete event systems. The challenge is to develop new modeling frameworks, analysis techniques, design tools, testing methods, and optimization processes for this new generation of systems.

In this lecture we give an introduction to discrete event systems. We start out the course by studying popular models of discrete event systems, such as automata and Petri nets. In the second part of the course we analyze discrete event systems. We first examine discrete event systems from an average-case perspective: we model discrete events as stochastic processes, and then apply Markov chains and queuing theory for an understanding of the typical behavior of a system. In the last part of the course we analyze discrete event systems from a worst-case perspective using the theory of online algorithms and adversarial queuing.

Content

1. Introduction
2. Automata and Languages
3. Smarter Automata
4. Specification Models
5. Stochastic Discrete Event Systems
6. Worst-Case Event Systems
7. Network Calculus

Lecture notes

Available

Literature

[bertsekas] Data Networks
Dimitri Bertsekas, Robert Gallager

[borodin] Online Computation and Competitive Analysis
Allan Borodin, Ran El-Yaniv,
Cambridge University Press, 1998

[boudec] Network Calculus
J.-Y. Le Boudec, P. Thiran
Springer, 2001

[cassandras] Introduction to Discrete Event Systems
Christos Cassandras, Stéphane Lafortune

[fiat] Online Algorithms: The State of the Art
A. Fiat and G. Woeginger

D. Hochbaum

[schickinger] Diskrete Strukturen (Band 2: Wahrscheinlichkeitstheorie und Statistik)
T. Schickinger, A. Steger
Springer, Berlin, 2001

[sipser] Introduction to the Theory of Computation
Michael Sipser

227-0103-00L Control Systems | W | 6 credits | 2V+2U | F. Dörfler

Abstract

Study of concepts and methods for the mathematical description and analysis of dynamical systems. The concept of feedback. Design of control systems for single input - single output and multivariable systems.

Objective

Study of concepts and methods for the mathematical description and analysis of dynamical systems. The concept of feedback. Design of control systems for single input - single output and multivariable systems.

Content

Understanding of high-speed signal propagation in interconnects, microwave cables and integrated transmission lines such as microwave
table { width: 100%; border-collapse: collapse; }
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Type</th>
<th>Credits</th>
<th>Code</th>
<th>Instructor</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0110-00L</td>
<td>Advanced Electromagnetic Waves</td>
<td>W</td>
<td>6</td>
<td>2V+2U</td>
<td>P. Leuchtmann</td>
</tr>
<tr>
<td>227-0112-00L</td>
<td>High-Speed Signal Propagation</td>
<td>W</td>
<td>6</td>
<td>2V+2U</td>
<td>C. Bolognesi</td>
</tr>
<tr>
<td>227-0113-00L</td>
<td>Power Electronics</td>
<td>W</td>
<td>6</td>
<td>4G</td>
<td>J. W. Kolar</td>
</tr>
<tr>
<td>227-0121-00L</td>
<td>Communication Systems</td>
<td>W</td>
<td>6</td>
<td>4G</td>
<td>A. Wittenben</td>
</tr>
</tbody>
</table>

**Prerequisites / notice**

The application of the basic methods will be extensively explained using existing and future wireless and wired systems.

---

**Literature**


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**Prerequisites** Signal and Systems Theory II.

MATLAB is used for system analysis and simulation.
Introduction to Electric Power Transmission: System & Technology

**Abstract**
Introduction to theory and technology of electric power transmission systems.

**Objective**
At the end of this course, the student will be able to: describe the structure of electric power systems, name the most important components and describe what they are needed for, apply models for transformers and lines, explain the technology of overhead power lines, calculate stationary power flows, current and voltage transients and other basic parameters in simple power systems.

**Content**
Structure of electric power systems, transformer and power line models, analysis of and power flow calculation in basic systems, symmetrical and unsymmetrical three-phase systems, transient current and voltage processes, technology and principle of electric power systems.

**Lecture notes**
Lecture script in English, exercises and sample solutions, translation of important vocabulary; english-german.

**Literature**
- Analysis, Linear Algebra, Physics, Basics of Signal Theory, Basic skills in Matlab programming
- Webb A, Smith N.B. Introduction to Medical Imaging: Physics, Engineering and Clinical Applications; Cambridge University Press 2011

**Announcement**

With regard to 1. The course takes place next year and it is not clear whether the courses will be offered in the current order.

Q. Huang

227-0122-00L
Solid State Electronics and Optics

**Abstract**
"Solid State Electronics" is an introductory condensed matter physics course covering crystal structure, electron models, classification of metals, semiconductors, and insulators, band structure engineering, thermal and electronic transport in solids, magnetoresistance, and optical properties of solids.

**Objective**
Understand the fundamental physics behind the mechanical, thermal, electric, magnetic, and optical properties of materials.

**Prerequisites / notice**
Recommended background:
Undergraduate physics, mathematics, semiconductor devices

**Lecture notes**
Lecture Slides

**Literature**
- M. R. Bebbert und M. Breitbach, Digitale Netze, 1. Auflage, Teubner, 1999
- M. Bossert und M. Breitbach, Digitale Netze, 1. Auflage, Teubner, 1999
- J. Vörös, Biomedical Imaging, New course. Not to be confused with 227-0393-00L last offered in the Spring Semester 2015.
L1. Bioelectronics history, its applications and overview of the field
- Volta and Galvani dispute
- BMI, pacemaker, cochlear implant, retinal implant, limb replacement devices
- Fundamentals of biosensing
- Glucometer and ELISA

L2. Fundamentals of quantum and classical noise in measuring biological signals

L3. Biomeasurement techniques with photons

L4. Acoustics sensors
- Differential equation for quartz crystal resonance
- Acoustic sensors and their applications

L5. Engineering principles of optical probes for measuring and manipulating molecular and cellular processes

L6. Optical biosensors
- Differential equation for optical waveguides
- Optical sensors and their applications
- Plasmonic sensing

L7. Basic notions of molecular adsorption and electron transfer
- Quantum mechanics: Schrödinger equation energy levels from H atom to crystals, energy bands
- Electron transfer: Marcus theory, Gerischer theory

L8. Potentiometric sensors
- Fundamentals of the electrochemical cell at equilibrium (Nernst equation)
- Principles of operation of ion-selective electrodes

L9. Amperometric sensors and bioelectric potentials
- Fundamentals of the electrochemical cell with an applied overpotential to generate a faraday current
- Principles of operation of amperometric sensors
- Ion flow through a membrane (Fick equation, Nernst equation, Donnan equilibrium, Goldman equation)

L10. Channels, amplification, signal gating, and patch clamp Y4

L11. Action potentials and impulse propagation

L12. Functional electric stimulation and recording
- MEA and CMOS based recording
- Applying potential in liquid - simulation of fields and relevance to electric stimulation

L13. Neural networks memory and learning

Literature
Plonsey and Barr, Bioelectricity: A Quantitative Approach (Third edition)

Prerequisites / notice
Supervised exercises solving real-world problems. Some Matlab based exercises in groups.

Electives
This is but a short selection. Other courses from the ETH course catalogue may be chosen. Please consult the "Richtlinien zu Projekten, Praktika, Seminaren" (German only), published on our website (http://www.ee.ethz.ch/pps-richtlinien).

Economics, Law and Management Electives
These subjects are particularly suitable for students planning to apply to the Master's Degree Program in Energy Science and Technology (MSc EST) or Management, Technology and Economics (MSc MTEC).

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</table>

Abstract
Discovering Management offers an introduction to the field of business management and entrepreneurship for engineers and natural scientists. The module provides an overview of the principles of management, teaches knowledge about management that is highly complementary to the students' technical knowledge, and provides a basis for advancing the knowledge of the various subjects offered at D-MTEC.

Objective
Discovering Management combines in an innovate format a set of lectures and an advanced business game. The learning model for Discovering Management involves learning by doing. The objective is to introduce the students to the relevant topics of the management literature and give them a good introduction in entrepreneurship topics too. The course is a series of lectures on the topics of strategy, innovation, corporate finance, leadership, design thinking and corporate social responsibility. While the 14 different lectures provide the theoretical and conceptual foundations, the experiential learning outcomes result from the interactive business game. The purpose of the business game is to analyse the innovative needs of a large multinational company and develop a business case for the company to grow. This business case is as relevant to someone exploring innovation within an organisation as it is if you are planning to start your own business. By discovering the key aspects of entrepreneurial management, the purpose of the course is to advance students' understanding of factors driving innovation, entrepreneurship, and company success.
Discovering Management aims to broaden the students' understanding of the principles of business management, emphasizing the interdependence of various topics in the development and management of a firm. The lectures introduce students not only to topics relevant for managing large corporations, but also touch upon the different aspects of starting up your own venture. The lectures will be presented by the respective area specialists at D-MTEC.

The course broadens the view and understanding of technology by linking it with its commercial applications and with society. The lectures are designed to introduce students to topics related to strategy, corporate innovation, leadership, corporate and entrepreneurial finance, value chain analysis, corporate social responsibility, and business model innovation. Practical examples from industry experts will stimulate the students to critically assess these issues. Creative skills will be trained by the business game exercise, a participant-centered learning activity, which provides students with the opportunity to place themselves in the role of Chief Innovation Officer of a large multinational company. As they learn more about the specific case and identify the challenge they are faced with, the students will have to develop an innovative business case for this multinational corporation. Doing so, this exercise will provide an insight into the context of managerial problem-solving and corporate innovation, and enhance the students' appreciation for the complex tasks companies and managers deal with. The business game presents a realistic model of a company and provides a valuable learning platform to integrate the increasingly important development of the skills and competences required to identify entrepreneurial opportunities, analyse the future business environment and successfully respond to it by taking systematic decisions, e.g. critical assessment of technological possibilities.

Prerequisites / notice

Discovering Management is designed to suit the needs and expectations of Bachelor students at all levels as well as Master and PhD students not belonging to D-MTEC. By providing an overview of Business Management, this course is an ideal enrichment of the standard curriculum at ETH Zurich. No prior knowledge of business or economics is required to successfully complete this course.

363-0305-00L

Empirical Methods in Management

W 3 credits 2G A. Scherer

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

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

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

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

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

363-0503-00L

Principles of Microeconomics

W 3 credits 2G M. Filippini

Abstract
The course introduces basic principles, problems and approaches of microeconomics.

Objective
The learning objectives of the course are:
(1) Students must be able to discuss basic principles, problems and approaches in microeconomics. (2) Students can analyse and explain simple economic principles in a market using supply and demand graphs. (3) Students can contrast different market structures and describe firm and consumer behaviour. (4) Students can identify market failures such as externalities related to market activities and illustrate how these affect the economy as a whole. (5) Students can apply simple mathematical treatment of some basic concepts and can solve utility maximization and cost minimization problems.

Lecture notes
Lecture notes, exercises and reference material can be downloaded from Moodle.

Literature
The book can also be used for the course 'Principles of Macroeconomics' (Sturm)

For students taking only the course 'Principles of Microeconomics' there is a shorter version of the same book:

Complementary:

363-0511-00L

Managerial Economics

W 4 credits 3V S. Rausch, V. Hoffmann

Abstract
Managerial Economics applies economic theory and methods to business and economic decision-making. Economic ideas related to optimization, the theory of consumer demand, the theory of the firm, industrial organization and decision making under uncertainty are studied using methods of numerical analysis, statistical estimation, game theory and constrained optimization.

Objective
The objective of the course is to provide undergraduate and graduate students in MAVT with an understanding of the use of economic concepts for firm-level management decisions. The course covers a number of models and methods of analysis which are commonly employed in business decisions. The course covers the economic theory of choice, models of oligopoly and industrial organization, applications of game theory to contract design and agency theory, and the role of decision making under uncertainty focusing specifically on long-term investment decisions. The course will include three lectures by Professor Volker Hoffman focusing on related case-studies in management.

Literature
Mikrókönöme (Pearson Studium - Economic VWL) Gebundene Ausgabe, August 2013, Robert S. Pindyck, Dr. Daniel L. Rubinfeld.

Prerequisites / notice
The course acquaints students who have previous not studied economics to economic concepts and quantitative methods which can be used to solve management decision problems.

851-0703-00L

Introduction to Law

W 2 credits 2V O. Streiff Gnöfff

Abstract
This course introduces students into basic features of the legal system. Fundamental issues of constitutional law, administrative law, private law and the law of the EU are covered.

Not for MSc students belonging to D-MTEC!
The Role of Intellectual Property in Daily Routine: A Comprehensive Cookbook

The students shall obtain the following competences:
- They shall obtain a working knowledge on the legal aspects involved in setting up and managing an enterprise.
- They shall be acquainted with corporate functions as contracting, negotiation, claims management and dispute resolution
- They shall be familiar with the issues of corporate compliance, i.e., the system to ascertain that all legal and ethical rules are observed.
- They shall be able to contribute to the legal management of the company and to discuss legal issues.
- They shall have an understanding of the law as a part of the corporate strategy and as a valuable resource of the company.

The lecture will acquaint students with practical aspects of intellectual property and enable them to use the acquired knowledge in their future professional life.

Topics covered during the lecture will include:
- The importance of innovation in industrialised countries
- An overview of the different forms of intellectual property
- The protection of technical inventions and how to safeguard their commercialisation
- Patents as a source of technical and business information
- Practical aspects of intellectual property in day-to-day research, at the workplace and for the formation of start-ups.

Case studies will illustrate and deepen the topics addressed during the lecture.

The seminar will comprise practical exercises on how to use and search patent information. Basic knowledge of how to read and evaluate patent documents as well as how to use publicly available patent databases to obtain the required patent information will also be provided.

For students of chemistry-related degree programs, the lecture ‘Protecting inventions in chemistry’ (851-0738-03) will be offered in the autumn semester.
Introduction to Biomedical Engineering I

Objective
Understanding of physical and technical principles in biomechanics, biomaterials, tissue engineering, medical imaging as well as the history of biomedical engineering.

Content
Tissue and Cellular Biomechanics, Molecular Biomechanics and Biopolymers, Computational Biomechanics, Biomaterials, Tissue Engineering, Radiation and Radiographic Imaging, Diagnostic Ultrasound Imaging, Magnetic Resonance Imaging, Biomedical Optics and Lasers.

Lecture notes
Stored on ILIAS.

Literature

Academic Press

Additional third year core courses may be credited as electives.
Abstract
The course explains main principles of air transport in general and elaborates on simple interdisciplinary topics.
Since working on broad topics like aerodynamics, manufacturers, airport operation, business aviation, business models etc. the students get a good overview in air Transportation.

Objective
Understand and explain basics, principles and contexts in the broader air transport industry.
Lay the foundation of working in or with the air transport industry.
Ideal foundation for Aviation II - Management of Air Transport

Content
Weekly: 1h independent preparation; 2h lectures and 1 h training with an expert in the respective field
Concept: This course will be taught as Aviation I. A subsequent course is under evaluation.
Content: Transport as part of the overall transportation scheme; Aerodynamics; Aircraft (A/C) Designs & Structures; A/C Operations; Law Enforcement; Maintenance & Manufacturers; Airport Operations & Planning; Customs & Security; ATC & Airspace; Air Freight; General Aviation; Business Jet Operations; Business models within Airline Industry; Military Operations.
Technical visit: This course includes a guided tour at Zurich Airport (baggage sorting system, apron, ATC Tower).
Examination: written, 60 min, open books (Examination in German; Answers may be given in English)

Lecture notes
Slides are provided prior to each class

Literature
We will also use English papers

Prerequisites / notice
We will also use English papers

GESS Science in Perspective
Recommended Science in Perspective (Type B) for D-ITET.

see Science in Perspective: Type A: Enhancement of Reflection Capability

Language Courses
see Science in Perspective: Language Courses ETH/UZH

Electrical Engineering and Information Technology Bachelor - Key for Type

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

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<th>Type</th>
<th>Description</th>
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<tr>
<td>V</td>
<td>lecture</td>
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<td>G</td>
<td>lecture with exercise</td>
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<td>U</td>
<td>exercise</td>
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<td>S</td>
<td>seminar</td>
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<td>K</td>
<td>colloquium</td>
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<td>P</td>
<td>practical/laboratory course</td>
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<td>A</td>
<td>independent project</td>
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<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
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ECTS
European Credit Transfer and Accumulation System
Special students and auditors need special permission from the lecturers.
Electrical Engineering and Information Technology TC

More informations at: https://www.ethz.ch/de/studium/didaktische-ausbildung/studienangebot-zulassung/didaktik-zertifikat.html

Educational Science

General course offerings in the category Educational Science are listed under "Programme: Educational Science for Teaching Diploma and TC".

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>851-0240-00L</td>
<td>Human Learning (EW1)</td>
<td>O</td>
<td>2 credits</td>
<td>2G</td>
<td>E. Stern</td>
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<td>This lecture is only apt for students who intend to enrol in the programs &quot;Teaching Diploma&quot; or &quot;Teaching Certificate&quot;. It is about learning in childhood and adolescence.</td>
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<td>Abstract</td>
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<td>This course looks into scientific theories and also empirical studies on human learning and relates them to the school.</td>
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<td>Anyone wishing to be a successful teacher must first of all understand the learning process. Against this background, theories and findings on the way humans process information and on human behaviour are prepared in such a manner that they can be used for planning and conducting lessons. Students additionally gain an understanding of what is going on in learning and behavioural research so that teachers are put in a position where they can further educate themselves in the field of research into teaching and learning.</td>
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<td>Content</td>
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<td>Thematische Schwerpunkte:</td>
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<td>Lernen als Verhaltensänderung und als Informationsverarbeitung:</td>
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<td>Das menschliche Gedächtnis unter besonderer Berücksichtigung der Verarbeitung symbolischer Information; Lernen als Wissenskonstruktion und Kompetenzentwicklung unter besonderer Berücksichtigung des Wissenstransfers; Lernen durch Instruktion und Erklärungen; Die Rolle von Emotion und Motivation beim Lernen; Interindividuelle Unterschiede in der Lernfähigkeit und ihre Ursachen: Intelligenztheorien, Geschlechtsunterschiede beim Lernen</td>
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<td>Lernformen:</td>
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<td>Lecture notes</td>
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<td>Folien werden zur Verfügung gestellt.</td>
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<td>Literature</td>
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<td>Prerequisites / notice</td>
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<td>This lecture is only apt for students who intend to enrol in the programs &quot;Lehrdiplom&quot; or &quot;Didaktisches Zertifikat&quot;. It is about learning in childhood and adolescence.</td>
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<tr>
<td>851-0240-03L</td>
<td>Introduction to Test Theory and Test Construction in Educational Contexts (University of Zurich)</td>
<td>W</td>
<td>4 credits</td>
<td>2S</td>
<td>University lecturers</td>
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<td>Enrolment only possible with Teaching Diploma or DC matriculation.</td>
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<td>No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: 200a968</td>
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<td>Mind the enrolment deadlines at UZH:</td>
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<td><a href="http://www.uzh.ch/studies/application/mobilitaet_en.html">http://www.uzh.ch/studies/application/mobilitaet_en.html</a></td>
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<td></td>
<td>Abstract</td>
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<td></td>
<td>In this seminar, students establish the scientific fundamentals of performance measurement and educational diagnostics and study them on the basis of different current issues.</td>
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<td>At the end of the seminar, participants will be in a position to</td>
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<td>- describe the scientific fundamentals of test theory and test structure.</td>
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<td>- evaluate examples of scientifically-developed tests in their application context.</td>
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<td>- if necessary, critically question the performance assessment that they employ in practice and professionalise it still further.</td>
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<td>Content</td>
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<td>Die konkreten Inhalte des Seminars ergeben sich aufgrund der Präferenzen der Teilnehmenden und der daraus abgeleiteten Themenübersicht für Vorträge und Seminararbeiten. Im Rahmen der Startveranstaltung wird eine Liste mit möglichen Themen abgebildet und erläutert. Schwerpunkte der Themenvorschläge sind:</td>
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<td>- Testentwicklung</td>
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<td>- Gütekriterien von Tests</td>
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<td>- Aufgabenkonstruktion</td>
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<td>- Datenauswertung</td>
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<td>- Rasch-Modell</td>
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<td>- Internationale Vergleichstests</td>
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<td>- Zulassungsstätest</td>
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<td>Lecture notes</td>
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<td>Im Verlaufe des Semesters werden einzelne Unterlagen in den Veranstaltungen abgegeben. Dazu gehören auch die Handouts der entsprechenden, studentischen Vorträge.</td>
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<td>Literature</td>
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<tr>
<td></td>
<td>Als Grundlagenliteratur werden folgende Werke empfohlen:</td>
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<td></td>
<td>- Weitere Literatur wird in der Lehrveranstaltung genannt.</td>
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<td>Prerequisites / notice</td>
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<td>Die Leistungsanforderungen richten sich im Umfang nach der Zahl zu erwerbender ECTS-Punkte, wobei 1 ECTS-Punkt einem Zeitaufwand von ca. 30 Arbeitsstunden entspricht. ETHZ-Studierende können im Rahmen dieser Veranstaltung 3 ECTS-Punkte erwerben. Dazu sind folgende Leistungen zu erbringen:</td>
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<td>- Präsenz und aktive mündliche Mitarbeit in der Lehrveranstaltung (MA)</td>
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<td>- Pflichtlektüre entsprechend der Angaben in der Lehrveranstaltung</td>
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<td>- Referat (RE)</td>
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<td>- Schreiben einer schriftlichen Arbeit</td>
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<td>Weitere Angaben zu den Leistungsanforderungen werden im Rahmen der Startveranstaltung abgegeben und erläutert.</td>
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</tbody>
</table>

851-0240-16L Colloquium on the Science of Learning and Instruction W 1 credit 1K E. Stern, P. Greutmann, further lecturers

Abstract
In the colloquium we discuss scientific projects concerning the teaching in mathematics, computer science, natural sciences and technology (STEM). The colloquium is conducted by the professorships participating in the Competence Center EducETH (ETH) and in the Institute for Educational Sciences (UZH).

Objective
Participants are exemplarily introduced to different research methods used in research on learning and instruction and learn to weigh advantages and disadvantages of these approaches.

851-0240-22L Coping with Psychosocial Demands of Teaching (EW4 W 2 credits 3S A. Deiglmayr, P. Greutmann,
851-0242-05L  
**Cognitively Activating Instructions in MINT Subjects**  
*W*  
Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).

**Abstract**  
This course unit can only be enrolled after successful participation in, or during enrollment in the course "Human Learning (EW 1)".

**Objective**  
- Get to know cognitively activating instructions in MINT subjects  
- Get information about recent literature on learning and instruction  
- Get to know intelligence tests  
- Understanding findings relevant for education

**Prerequisites / notice**  
Für eine reibungslose Semesterplanung wird um frühe Anmeldung und persönliches Erscheinen zum ersten Lehrveranstaltungstermin ersucht.

851-0242-07L  
**Human Intelligence**  
*W*  
Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).

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

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

851-0242-08L  
**Research Methods in Educational Science**  
*W*  
Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).

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

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

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**Subject Didactics and Professional Training**

**Number**

<table>
<thead>
<tr>
<th>151-1061-00L</th>
<th>Subject Didactics I for D-MAVT and D-ITET</th>
<th>O</th>
<th>4 credits</th>
<th>3G</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Abstract</strong></td>
<td>Didactical methods in mechanical and electrical engineering.</td>
<td></td>
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</tr>
</tbody>
</table>
| **Objective** | - The students can plan, conduct and critically reflect single lessons.  
- They orient themselves towards the academic goals and take into account existing knowledge, the professional environment and the ambitions of the students.  
- They can apply the basic teaching principles meaningfully in their subject and suitably structure the learning phases.  
- They can reduce and present complex technical content such that it is in a form suitable for the students to learn.  
- They have considered examples of the common conceptual errors encountered by students  
- They have considered examples of the common conceptual errors encountered by students |
| **Content** | - Didactic analysis  
- Competences and goals  
- Preparation and wrap-up of lessons  
- Process and structure of a typical lesson  
- Teaching techniques (informative introduction to lessons, Advance Organizer, learning assignments, frontal teaching, questions, assignments, feedback)  
- Assignments and short tests  
- Media and language competence  
- Conceptual change, misconceptions, integration of the subcomponents of a lesson. |
| **Prerequisites / notice** | Voraussetzung: Erziehungswissenschaftliche Lehrveranstaltung schon absolviert oder gleichzeitig. |

<table>
<thead>
<tr>
<th>227-0853-00L</th>
<th>Mentored Work Subject Didactics Electrical Engineering and Information Technology I</th>
<th>W</th>
<th>2 credits</th>
<th>4A</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Only for students who enrolled before HS 2011 into TC.</strong></td>
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</tbody>
</table>
Prerequisites: successful completion of FD I and FD II.

Abstract
In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.

Objective
The objective is for the students:
- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.
- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

Content
The anzuwendenende grössere didakt. Methode ist zum Stoff und Programm passend auszuwählen aus
- (Mini-) Leitprogramm
- Gelenktes Entdeckendes Lernen
- Puzzle
- Werkstatt
- Projektarbeit
Zu diesen Themen sind die vorhandenen Manuals aus den IFV zu verwenden, bzw. wo nötig zu adaptieren.

Objective
Students apply the insights, abilities and skills they have acquired within the context of an educational institution. They observe 10 lessons and teach 20 lessons independently. Two of them are as assessed as Examination Lessons.
- They learn the skills of the teaching trade.
- They learn to assess pupils' work.
- They practice finding the balance between instruction and openness so that pupils can and, indeed, must make their own cognitive contribution.
- They learn to assess pupils' work.
- Together with the teacher in charge of their teacher training, the students constantly evaluate their own performance.

Content

Lecture notes
Wird von der Praktikumslehrperson bestimmt.

Dataset: 06.03.2019 12:57 Autumn Semester 2016 Page 508 of 1571

Anlässlich der Hospitationen erläutert die Praktikumslehrperson ihre fachlichen, fachdidaktischen und pädagogischen Überlegungen, auf deren Basis sie den Unterricht geplant hat und tauscht sich mit dem/der Studierenden aus. Die von dem/der Studierenden gehaltenen Lektionen werden vor- und nachbesprochen.

Die Themen für die beiden Prüfungslektionen am Schluss des Praktikums erfahren die Studierenden in der Regel eine Woche vor dem Prüfungstermin. Sie erstellen eine Vorbereitung gemäß Anleitung und reichen sie bis am Vortrag um 12 Uhr den beiden Prüfungsexperten (Fachdidaktiker/-in, Departementsvertreter/-in) ein. Die gehaltenen Lektionen werden kriteriumsbasiert beurteilt. Die Beurteilung umfasst auch die schriftliche Vorbereitung und eine mündliche Reflexion des Kandidaten/der Kandidatin über die gehaltenen Lektionen im Rahmen eines kurzen Kolloquiums.

**Further Subject Didactics**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0854-00L</td>
<td>Mentored Work Subject Didactics Electrical Engineering and Information Technology II</td>
<td>O</td>
<td>2</td>
<td>4A</td>
<td>M. Thaler</td>
</tr>
</tbody>
</table>

**Abstract**
In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.

**Objective**
The objective is for the students:
- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.
- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

**Content**
- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.
- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

**Lecture notes**
Eine kurze Anleitung zur mentorierten Arbeit in Fachdidaktik wird zur Verfügung gestellt.

**Literature**
K. Frey, Allgemeine Didaktik, FH-Skript bzw. Lehrbuch des Praktikumslehrers.

Die Arbeit sollte vor Beginn des Praktikums abgeschlossen werden.
Electrical Engineering and Information Technology Master

Major Courses

A total of 42 CP must be achieved during the Master Program. The individual study plan is subject to the tutor's approval.

Communication

Core Subjects

These core subjects are particularly recommended for the field of "Communication".

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0147-00L</td>
<td>VLSI II: Design of Very Large Scale Integration</td>
<td>W</td>
<td>7</td>
<td>5G</td>
<td>H. Kaelin, F. K. Gürkaynak, M. Korb</td>
</tr>
<tr>
<td></td>
<td>Circuits</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Abstract</td>
<td>This second course in our VLSI series is concerned with how to turn digital circuit netlists into safe, testable and manufacturable mask layout, taking into account various parasitic effects. Low-power circuit design is another important topic. Economic aspects and management issues of VLSI projects round off the course.</td>
<td></td>
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<tr>
<td>Objective</td>
<td>Know how to design digital VLSI circuits that are safe, testable, durable, and make economic sense.</td>
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<tr>
<td>Content</td>
<td>The second course begins with a thorough discussion of various technical aspects at the circuit and layout level before moving on to economic issues of VLSI. Topics include: - The difficulties of finding fabrication defects in large VLSI chips. - How to make integrated circuit testable (design for test). - Synchronous clocking disciplines compared, clock skew, clock distribution, input/output timing. - Synchronization and metastability. - CMOS transistor-level circuits of gates, flip-flops and random access memories. - Sinks of energy in CMOS circuits. - Power estimation and low-power design. - Current research in low-energy computing. - Layout parasitics, interconnceted delay, static timing analysis. - Switching currents, ground bounce, IR-drop, power distribution. - Floorplanning, chip assembly, packaging. - Layout design at the mask level, physical design verification. - Electromigration, electrostatic discharge, and latch-up. - Models of industrial cooperation in microelectronics. - The caveats of virtual components. - The cost structures of ASIC development and manufacturing. - Market requirements, decision criteria, and case studies. - Yield models. - Avenues to low-volume fabrication. - Marketing considerations and case studies. - Management of VLSI projects.</td>
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</tr>
<tr>
<td>Literature</td>
<td>All written documents in English.</td>
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</tr>
<tr>
<td>Prerequisites / notice</td>
<td>Students are offered the opportunity to design a circuit of their own which then gets actually fabricated as a microchip! Students who elect to participate in this program register for a term project at the Integrated Systems Laboratory in parallel to attending the VLSI II course.</td>
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<tr>
<td>Prerequisites</td>
<td>“VLSI I: from Architectures to Very Large Scale Integration Circuits and FPGAs” or equivalent knowledge.</td>
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<tr>
<td>Further details:</td>
<td><a href="http://www.iis.ee.ethz.ch/stud_area/vorlesungen/vlsi2.en.html">http://www.iis.ee.ethz.ch/stud_area/vorlesungen/vlsi2.en.html</a></td>
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</tbody>
</table>

| 227-0417-00L | Information Theory I                                       | W    | 6    | 4G      | A. Lapidoth              |
| Abstract     | This course covers the basic concepts of information theory and of communication theory. Topics covered include the entropy rate of a source, mutual information, typical sequences, the asymptotic equi-partition property, Huffman coding, channel capacity, the channel coding theorem, the source-channel separation theorem, and feedback capacity. |
| Objective    | The fundamentals of Information Theory including Shannon's source coding and channel coding theorems |
| Content      | The entropy rate of a source. Typical sequences, the asymptotic equi-partition property, the source coding theorem, Huffman coding, Arithmetic coding, channel capacity, the channel coding theorem, the source-channel separation theorem, feedback capacity |
| Literature   | T.M. Cover and J. Thomas, Elements of Information Theory (second edition) |

| 227-0427-00L | Signal and Information Processing: Modeling, Filtering, Learning | W    | 6    | 4G      | H.A. Loeliger            |
| Content      | Lecture notes |
| Lecture notes | Lecture notes. |
| Prerequisites / notice | Prerequisites: - local bachelors: course "Discrete-Time and Statistical Signal Processing" (5. Sem.) - others: solid basics in linear algebra and probability theory |

| 227-0439-00L | Wireless Access Systems                                    | W    | 6    | 2V+2U   | A. Wittneben            |

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2V+2U

Wireless access systems support locally constrained wireless connectivity and mobile access to a backbone network (typically the Internet). In this course, the student develops a comprehensive understanding of existing and upcoming wireless access technologies (including WiFi, Bluetooth, RFID, NFC, VANET) and related Physical Layer and Medium Access Control Layer problems and opportunities.

The course consists of two tracks. The track “Technology&Systems” is structured as regular lecture. In the introduction, we will discuss the challenges and potential of pervasive wireless access and study some fundamentals of short/medium range wireless communications. The main body of this track is devoted to existing and upcoming systems. A comprehensive survey of Ultrawide band (UWB) as the promising transmission technology for pervasive wireless access completes this track. In the track “Simulate&Practice” we form student teams that implement and analyze functional blocks of the physical layer of various advanced wireless access systems based on MATLAB simulations. The track includes combination tasks where different teams combine their functional blocks (e.g., transmitter, receiver) in order to simulate the complete physical layer.

1. Short range wireless communication: fundamental Physical Layer challenges and solutions
2. Wireless Local Area Network (WLAN)
3. Vehicular Networks (VANET)
4. Ultra-Wideband (UWB) technology: fundamental principles, promises and solutions
5. Wireless Body Area Networks (WBAN)
6. Wireless Personal Area Networks (Bluetooth, Zigbee)
7. Radio Frequency Identification (RFID) and Near Field Communication (NFC)

Lecture notes: Lecture Slides and handouts.

Literature: Selected Books

Prerequisites / notice: Requirements: Knowledge of fundamental principles of digital communication systems (e.g., 227-0121-00 G Kommunikationssysteme) is helpful but not mandatory. Lecture is given in English.

Recommended Subjects

These courses are recommended, but you are free to choose courses from any other special field. Please consult your tutor.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0102-00L</td>
<td>Discrete Event Systems</td>
<td>W</td>
<td>6</td>
<td>4G</td>
<td>L. Thiele, L. Vanbever, R. Wattenhofer</td>
</tr>
</tbody>
</table>

Abstract: Introduction to discrete event systems. We start out by studying popular models of discrete event systems. In the second part of the course we analyze discrete event systems from an average-case and from a worst-case perspective. Topics include: Automata and Languages, Specification Models, Stochastic Discrete Event Systems, Worst-Case Event Systems, Verification, Network Calculus.

Objective: Over the past few decades the rapid evolution of computing, communication, and information technologies has brought about the proliferation of new dynamic systems. A significant part of activity in these systems is governed by operational rules designed by humans. The dynamics of these systems are characterized by asynchronous occurrences of discrete events, some controlled (e.g., hitting a keyboard key, sending a message), some not (e.g., spontaneous failure, packet loss).

The mathematical arsenal centered around differential equations that has been employed in systems engineering to model and study processes governed by the laws of nature is often inadequate or inappropriate for discrete event systems. The challenge is to develop new modeling frameworks, analysis techniques, design tools, testing methods, and optimization processes for this new generation of systems.

In this lecture we give an introduction to discrete event systems. We start out the course by studying popular models of discrete event systems, such as automata and Petri nets. In the second part of the course we analyze discrete event systems from a worst-case perspective using the theory of online algorithms and adversarial queuing.

Content:
1. Introduction
2. Automata and Languages
3. Smarter Automata
4. Specification Models
5. Stochastic Discrete Event Systems
6. Worst-Case Event Systems
7. Network Calculus

Lecture notes: Available

Literature:
[bertsekas] Data Networks
Dimitri Bertsekas, Robert Gallager

[borodin] Online Computation and Competitive Analysis
Allan Borodin, Ran El-Yaniv.
Cambridge University Press, 1998

[boudec] Network Calculus
J.-Y. Le Boudec, P. Thiran
Springer, 2001

[cassandras] Introduction to Discrete Event Systems
Christos Cassandras, Stéphane Lafortune

[fiat] Online Algorithms: The State of the Art
A. Fiat and G. Woeginger

D. Hochbaum

[schickinger] Diskrete Strukturen (Band 2: Wahrscheinlichkeitstheorie und Statistik)
T. Schickinger, A. Steger
Springer, Berlin, 2001

[sipser] Introduction to the Theory of Computation
Michael Sipser.

227-0102-00L | Control Systems                     | W    | 6    | 2V+2U | F. Dörfler               |

Abstract: Study of concepts and methods for the mathematical description and analysis of dynamical systems. The concept of feedback. Design of control systems for single input - single output and multivariable systems.
Objective
Study of concepts and methods for the mathematical description and analysis of dynamical systems. The concept of feedback. Design of control systems for single input - single output and multivariable systems.

Content

Literature

Prerequisites / notice
Prerequisites: Signal and Systems Theory II.

MATLAB is used for system analysis and simulation.

227-0112-00L High-Speed Signal Propagation W 6 credits 2V+2U C. Bolognesi
Understanding of high-speed signal propagation in microwave cables and printed circuit boards.

As clock frequencies rise in the GHz domain, there is a need grasp signal propagation to maintain good signal integrity in the face of symbol interference and cross-talk.

The course is of high value to all interested in high-speed analog (RF, microwave) or digital systems.

Understanding of high-speed signal propagation in interconnects, microwave cables and integrated transmission lines such as microwave integrated circuits and/or printed circuit boards.

As system clock frequencies continuously rise in the GHz domain, a need urgently develops to understand high-speed signal propagation in order to maintain good signal integrity in the face of phenomena such as inter-symbol interference (ISI) and cross-talk.

Concepts such as Scattering parameters (or S-parameters) are key to the characterization of networks over wide bandwidths. At high frequencies, all structures effectively become "transmission lines." Unless care is taken, it is highly probable that one ends-up with a bad transmission line that causes the designed system to malfunction.

Filters will also be considered because it turns out that some of the problems associated by lossy transmission channels (lines, cables, etc) can be corrected by adequate filtering in a process called "equalization."

Content

Butterworth-, Chebychev- and Bessel filter approximations: filter synthesis from low-pass filter prototypes.

Script: Leitungen und Filter (In German).

Exercises will be held in German, but assistants also speak English.

227-0166-00L Analog Integrated Circuits W 6 credits 2V+2U Q. Huang
This course provides a foundation in analog integrated circuit design based on bipolar and CMOS technologies.

Integrated circuits are responsible for much of the progress in electronics in the last 50 years, particularly the revolutions in the Information and Communications Technologies we witnessed in recent years. Analog integrated circuits play a crucial part in the highly integrated systems that power the popular electronic devices we use daily. Understanding their design is beneficial to both future designers and users of such systems.

The basic elements, design issues and techniques for analog integrated circuits will be taught in this course.

Review of bipolar and MOS devices and their small-signal equivalent circuit models; Building blocks in analog circuits such as current sources, active load, current mirrors, supply independent biasing etc; Amplifiers: differential amplifiers, cascode amplifier, high gain structures, output stages, gain bandwidth product of op-amps; Stability; Comparators; Second-order effects in analog circuits such as mismatch, noise and offset; A/D and D/A converters; Introduction to switched capacitor circuits.

The exercise sessions aim to reinforce the lecture material by well guided step-by-step design tasks. The circuit simulator SPECTRE is used to facilitate the tasks. There is also an experimental session on op-amp measurements.

Literature

227-0301-00L Optical Communication Fundamentals W 6 credits 2V+1U+1P J. Leuthold
The path of an analog signal in the transmitter to the digital world in a communication link and back to the analog world at the receiver is discussed. The lecture covers the fundamentals of all important optical and optoelectronic components in a fiber communication system. This includes the transmitter, the fiber channel and the receiver with the electronic digital signal processing elements.

An in-depth understanding on how information is transmitted from source to destination. Also the mathematical framework to describe the important elements will be passed on. Students attending the lecture will further get engaged in critical discussion on societal, economical and environmental aspects related to the on-going exponential growth in the field of communications.

Chapter 1: Introduction: Analog/Digital conversion, The communication channel, Shannon channel capacity, Capacity requirements.


Chapter 4: The Receiver: Photodiodes, Receiver noise, Detector schemes (direct detection, coherent detection), Bit-error ratios and error estimations.

Chapter 5: Digital Signal Processing Techniques: Digital signal processing in a coherent receiver, Error detection techniques, Error correction coding.

Chapter 6: Pulse Shaping and Multiplexing Techniques: WDM/FDM, TDM, OFDM, Nyquist Multiplexing, OCDMA.

Chapter 7: Optical Amplifiers: Semiconductor Optical Amplifiers, Erbium Doped Fiber Amplifiers, Raman Amplifiers.
Overview of the most important concepts of image formation, perception and analysis, Computer Vision. Gaining own experience

The first part of the course starts off from an overview of existing and emerging applications that need computer vision. It shows that the

Image Analysis and Computer Vision

Course material Script, computer demonstrations, exercises and problem solutions

Terahertz: Technology & Applications

U. Sennhauser

W. K. Sankaran

Comprehensive copy of transparencies

Failures have to be avoided by proper design, material selection and manufacturing. Properties, degradation mechanisms, and expected

This is an introductory course on Terahertz (THz) technology and applications. Devices operating in THz frequency range (0.1 to 10 THz)

INTRODUCTION

Chapter 1: Introduction to THz Physics

Chapter 2: Components of THz Technology

THz TECHNOLOGY MODULES

Chapter 3: THz Generation

Chapter 4: THz Detection

Chapter 5: THz Manipulation

APPLICATIONS

Chapter 6: THz Imaging

Chapter 7: THz Communication

Chapter 8: THz Energy Harvesting

- Yun-Shik Lee, Principles of Terahertz Science and Technology, Springer 2009


Whenever we deviate from the main material discussed in these books, softcopy of lectures notes will be provided.

Prerequisites:

Good foundation in electromagnetics & knowledge of microwave or optical communication is helpful.

Prerequisites / notice

notice

Lecture notes

Lecture notes are handed out.

Literture

Govind P. Agrawal; "Fiber-Optic Communication Systems"; Wiley, 2010


227-0377-00L Physics of Failure and Failure Analysis of Electronic Devices and Equipment

W 3 credits 2V U. Sennhauser

Abstract

Failures have to be avoided by proper design, material selection and manufacturing. Properties, degradation mechanisms, and expected lifetime of materials are introduced and the basics of failure analysis and analysis equipment are presented. Failures will be demonstrated experimentally and the opportunity is offered to perform a failure analysis with advanced equipment in the laboratory.

Objective

Introduction to the degradation and failure mechanisms and causes of electronic components, devices and systems as well as to methods and tools of reliability testing, characterization and failure analysis.

Content

Summary of reliability and failure analysis terminology; physics of failure: materials properties, physical processes and failure mechanisms; failure analysis of ICs, PCBs, opto-electronics, discrete and other components and devices; basics and properties of instruments; application in circuit design and reliability analysis

Lecture notes

Comprehensive copy of transparencies

227-0447-00L Image Analysis and Computer Vision

W 6 credits 3V+1U L. Van Gool, O. Göksel, E. Konukoglu

Abstract


Objective

Overview of the most important concepts of image formation, perception and analysis, and Computer Vision. Gaining own experience through practical computer and programming exercises.

Content

The first part of the course starts off from an overview of existing and emerging applications that need computer vision. It shows that the realm of image processing is no longer restricted to the factory floor, but is entering several fields of our daily life. First it is investigated how the parameters of the electromagnetic waves are related to our perception. Also the interaction of light with matter is considered. The most important hardware components of technical vision systems, such as cameras, optical devices and illumination sources are discussed. The course then turns to the steps that are necessary to arrive at the discrete images that serve as input to algorithms. The next part describes necessary preprocessing steps of image analysis, that enhance image quality and/or detect specific features. Linear and non-linear filters are introduced for that purpose. The course will continue by analyzing procedures allowing to extract additional types of basic information from multiple images, with motion and depth as two important examples. The estimation of image velocities (optical flow) will get due attention and methods for object tracking will be presented. Several techniques are discussed to extract three-dimensional information about objects and scenes. Finally, approaches for the recognition of specific objects as well as object classes will be discussed and analyzed.

Lecture notes

Course material Script, computer demonstrations, exercises and problem solutions

Prerequisites / notice

Prerequisites:

Basic concepts of mathematical analysis and linear algebra. The computer exercises are based on Linux and C.

The course language is English.

227-0455-00L Terahertz: Technology & Applications

W 3 credits 2V K. Sankaran

Abstract

This course will provide a solid foundation for understanding physical principles of THz applications. We will discuss various building blocks of THz technology - components dealing with generation, manipulation, and detection of THz electromagnetic radiation. We will introduce THz applications in the domain of imaging, communications, and energy harvesting.

Objective

This is an introductory course on Terahertz (THz) technology and applications. Devices operating in THz frequency range (0.1 to 10 THz) have been increasingly studied in the recent years. Progress in nonlinear optical materials, ultrafast optical and electronic techniques has strengthened research in THz application developments. Due to unique interaction of THz waves with materials, applications with new capabilities can be developed. In theory, they can penetrate somewhat like X-rays, but are not considered harmful radiation, because THz energy level is low. They should be able to provide resolution as good or better than magnetic resonance imaging (MRI), possibly with simpler equipment. Imaging, very-high bandwidth communication, and energy harvesting are the most widely explored THz application areas. We will study the basics of THz generation, manipulation, and detection. Our emphasis will be on the physical principles and applications of THz in the domain of imaging, communication and energy harvesting.

Content

INTRODUCTION

Chapter 1: Components of THz Technology

Chapter 2: Components of THz Technology

THz TECHNOLOGY MODULES

Chapter 3: THz Generation

Chapter 4: THz Detection

Chapter 5: THz Manipulation

APPLICATIONS

Chapter 6: THz Imaging

Chapter 7: THz Communication

Chapter 8: THz Energy Harvesting

Prerequisites / notice

Suitable for Master Students as well as Doctoral Students.

227-0468-00L Analog Signal Processing and Filtering

W 6 credits 2V+2U H. Schmid

Abstract

This lecture provides a wide overview over analog filters (continuous-time and discrete-time), signal-processing systems, and sigma-delta conversion, and gives examples with sensor interfaces and class-D audio drivers. All systems and circuits are treated using a signal-flow view. The lecture is suitable for both analog and digital designers.

Objective

This lecture provides a wide overview over analog filters (continuous-time and discrete-time), signal-processing systems, and sigma-delta conversion, and gives examples with sensor interfaces and class-D audio drivers. All systems and circuits are treated using a signal-flow view. The lecture is suitable for both analog and digital designers. The way the exam is done allows for the different interests of the two groups.

The learning goal is that the students can apply signal-flow graphs and can understand the signal flow in such circuits and systems (including non-ideal effects) well enough to gain an understanding of further circuits and systems by themselves.
## Hardware/Software Codesign

Students will be familiarized with the most important concepts and algorithms for supervised and unsupervised learning; reinforce the


The theory of fundamental machine learning concepts is presented in the lecture, and illustrated with relevant applications. Students can

W. J. M. Buhmann

Network Security

The course provides advanced knowledge in the design of complex computer systems, in particular embedded systems. Models and

yes

Material for exercises, copies of transparencies.

Fundamentals of acoustics, measuring and analyzing of acoustical events, anatomy and properties of the ear. Outdoor sound propagation,

Introduction to the fundamentals of acoustics in the area of sound field calculations, measurement of acoustical events, outdoor sound

3V+2U+2A

The course covers the following subjects: (a) Models for describing hardware and software components (specification), (b) Hardware-

L. Thiele

The course requirements include: solid basic knowledge in analysis, statistics and numerical methods for CSE as well as practical programming

Prerequisites for the course is a basic knowledge in the following areas: computer architecture, digital design, software design, embedded

lecture notes

Prerequisites / notice

The course requires solid basic knowledge in analysis, statistics and numerical methods for CSE as well as practical programming

The base for these lectures are lecture notes and two or three published scientific papers. From these papers we will together develop the

The course is accompanied by practical machine learning projects.

Topics covered in the lecture include:

- Bayesian theory of optimal decisions
- Maximum likelihood and Bayesian parameter inference
- Classification with discriminant functions: Perceptrons, Fisher’s LDA and support vector machines (SVM)
- Ensemble methods: Bagging and Boosting
- Regression: least squares, ridge and LASSO penalization, non-linear regression and the bias-variance trade-off
- Non parametric density estimation: Parzen windows, nearest neighbour
- Dimension reduction: principal component analysis (PCA) and beyond

- Knowledge of the Laplace transform and z transform and their interpretation (transfer functions, poles and zeros, bode diagrams, stability

- Maximum likelihood and Bayesian parameter inference
- Classification with discriminant functions: Perceptrons, Fisher’s LDA and support vector machines (SVM)
- Ensemble methods: Bagging and Boosting
- Regression: least squares, ridge and LASSO penalization, non-linear regression and the bias-variance trade-off
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- Regression: least squares, ridge and LASSO penalization, non-linear regression and the bias-variance trade-off
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- Regression: least squares, ridge and LASSO penalization, non-linear regression and the bias-variance trade-off
- Non parametric density estimation: Parzen windows, nearest neighbour
- Dimension reduction: principal component analysis (PCA) and beyond

The course is accompanied by practical machine learning projects.
The course provides advanced knowledge in the design of complex computer systems, in particular embedded systems. Models and hardware/software codesign risk management and the vulnerability lifecycle of software and networked services are discussed. Threats like denial of service, spam, worms, and viruses are studied in-depth. Fundamental security related concepts like identity, availability, authentication and secure channels are introduced. State of the art technologies like secure shell, network and transport layer security, intrusion detection and prevention systems, cross-site scripting, secret implementation techniques and more for securing the Internet and web applications are presented. Several case studies illustrate the dark side of the Internet and explain how to protect against current threats. A hands-on computer lab that accompanies the lecture gives a deep dive on firewalls, penetration testing and intrusion detection. This lecture is intended for students with an interest in securing Internet services and networked devices. Students are assumed to have knowledge in networking as taught in the Communication Networks lecture.

Due to recent changes in the Swiss law, ETH requires each student of this course to sign a written declaration that he/she will not use the information given in this for illegal purposes. This declaration will have to be signed and submitted no later than at the beginning of the second lesson.

### Computers and Networks

#### Core Subjects

*These core subjects are particularly recommended for the field of “Computers and Networks”.*

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>227-0778-00L</td>
<td>Hardware/Software Codesign</td>
<td>W</td>
<td>6 credits</td>
<td>2V+2U</td>
<td>L. Thiele</td>
</tr>
<tr>
<td>227-0781-00L</td>
<td>Low-Power System Design</td>
<td>W</td>
<td>6 credits</td>
<td>2V+2U</td>
<td>J. Beutel</td>
</tr>
<tr>
<td>252-1414-00L</td>
<td>System Security</td>
<td>W</td>
<td>5 credits</td>
<td>2V+2U</td>
<td>S. Capkun, A. Perrig</td>
</tr>
</tbody>
</table>

### Prerequisites / notice

Knowledge in computer networking and Internet protocols (e.g. course Communication Networks (D-ITET) or Operating Systems and Networks (D-INFK)).

Due to recent changes in the Swiss law, ETH requires each student of this course to sign a written declaration that he/she will not use the information given in this for illegal purposes. This declaration will have to be signed and submitted no later than at the beginning of the second lesson.
Content

The first part of the lecture covers individual system's aspects starting with tamperproof or tamperresistant hardware in general over operating system related security mechanisms to application software systems such as host based intrusion detection systems. The main topics covered are: tamper resistant hardware, CPU support for security, protection mechanisms in the kernel, file system security (permissions / ACLs / network filesystem issues), IPC Security, mechanisms in more modern OS, such as Capabilities and Zones, Libraries and Software tools for security assurance, etc.

In the second part, the focus is on system design and methodologies for building secure systems. Topics include: patch management, common software faults (buffer overflows, etc.), writing secure software (design, architecture, QA, testing), compiler-supported security, language-supported security, logging and auditing (BSM audit, dtrace, ...), cryptographic support, and trustworthy computing (TGG, SGX).

Along the lectures, model cases will be elaborated and evaluated in the exercises.

263-4640-00L Network Security W 6 credits 2V+1U+2A A. Perrig, T. P. Dübdendorfer, S. Frei

Abstract
This lecture discusses fundamental concepts and technologies in the area of network security. Several case studies illustrate the dark side of the Internet and explain how to protect against such threats. A hands-on computer lab that accompanies the lecture gives a deep dive on firewalls, penetration testing and intrusion detection.

Objective
Students are aware of current threats that Internet services and networked devices face and can explain appropriate countermeasures.

Content
Risk management and the vulnerability lifecycle of software and networked services are discussed. Threats like denial of service, spam, worms, and viruses are studied in-depth. Fundamental security related concepts like identity, availability, authentication and secure channels are introduced. State of the art technologies like secure shell, network and transport layer security, intrusion detection and prevention systems, cross-domain, secure implementation techniques and more for securing the Internet and web applications are presented. Several case studies illustrate the dark side of the Internet and explain how to protect against current threats. A hands-on computer lab that accompanies the lecture gives a deep dive on firewalls, penetration testing and intrusion detection.

This lecture is intended for students with an interest in securing Internet services and networked devices. Students are assumed to have knowledge in networking as taught in the Communication Networks lecture.

Prerequisites / notice
Knowledge in computer networking and Internet protocols (e.g. course Communication Networks (D-ITET) or Operating Systems and Networks (D-INFK)).

Due to recent changes in the Swiss law, ETH requires each student of this course to sign a written declaration that he/she will not use the information given in this for illegal purposes. This declaration will have to be signed and submitted no later than at the beginning of the second lesson.

Recommended Subjects

These courses are recommended, but you are free to choose courses from any other special field. Please consult your tutor.

Number Title Type ECTS Hours Lecturers
227-0101-00L Discrete-Time and Statistical Signal Processing W 6 credits 4G H.A. Loeliger

Abstract
The course introduces fundamental topics of digital signal processing with a bias towards applications in communications: discrete-time linear filters, equalization, DFT, discrete-time stochastic processes, elements of detection theory and estimation theory, LMMSE estimation and LMMSE filtering, LMS algorithm, Viterbi algorithm.

Objective
The course introduces some fundamental topics of digital signal processing with a bias towards applications in communications. The two main themes are linearity and probability. In the first part of the course, we deepen our understanding of discrete-time linear filters. In the second part of the course, we review the basics of probability theory and discrete-time stochastic processes. We then discuss some basic concepts of detection theory and estimation theory, as well as some practical methods including LMMSE estimation and LMMSE filtering, the LMS algorithm, and the Viterbi algorithm. A recurrent theme throughout the course is the stable and robust "inversion" of a linear filter.

Content
1. Discrete-time linear systems and filters:
   - state-space realizations, z-transform and spectrum, decimation and interpolation, digital filter design, stable realizations and robust inversion.

2. The discrete Fourier transform and its use for digital filtering.

3. The statistical perspective:
   - probability, random variables, discrete-time stochastic processes; detection and estimation: MAP, ML, Bayesian MMSE, LMMSE; Wiener filter, LMS adaptive filter, Viterbi algorithm.

Lecture notes
Lecture Notes.

227-0103-00L Control Systems W 6 credits 2V+2U F. Dörfler

Abstract
Study of concepts and methods for the mathematical description and analysis of dynamical systems. The concept of feedback. Design of control systems for single input - single output and multivariable systems.

Objective
Study of concepts and methods for the mathematical description and analysis of dynamical systems. The concept of feedback. Design of control systems for single input - single output and multivariable systems.

Content

Literature

Prerequisites / notice
Prerequisites: Signal and Systems Theory II.

MATLAB is used for system analysis and simulation.

227-0197-00L Wearable Systems I W 6 credits 4G G. Tröster, U. Blanke

Data: 06.03.2019 12:57 Autumn Semester 2016 Page 516 of 1571
Abstract

Context recognition in mobile communication systems like mobile phone, smart watches and wearable computer will be studied using advanced methods from sensor data fusion, pattern recognition, statistics, data mining and machine learning.

Context comprises the behavior of individuals and of groups, their activities as well as the local and social environment.

Objective

Using internal sensors and sensors in our environment including data from the wristwatch, bracelet or internet (crowd sourcing), our ‘smart phone’ detects our context continuously, e.g. where we are, what we are doing, with whom we are together, what is our constitution, what are our needs. Based on this information our ‘smart phone’ offers us the appropriate services like a personal assistant. Context comprises user’s behavior, his activities, his local and social environment.

In the data path from the sensor level to signal segmentation to the classification of the context, advanced methods of signal processing, pattern recognition and machine learning will be applied. Sensor data generated by crowdsourcing methods are integrated. The validation using MATLAB is followed by implementation and testing on a smart phone.

Context recognition as the crucial function of mobile systems is the main focus of the course. Using Matlab the participants implement and verify the discussed methods also using a smart phone.

Content

Using internal sensors and sensors in our environment including data from the wristwatch, bracelet or internet (crowd sourcing), our ‘smart phone’ detects our context continuously, e.g. where we are, what we are doing, with whom we are together, what is our constitution, what are our needs. Based on this information our ‘smart phone’ offers us the appropriate services like a personal assistant. Context recognition - what is the situation of the user, his activity, his environment, how is he doing, what are his needs - as the central functionality of mobile systems constitutes the focus of the course.

The main topics of the course include

Sensor nets, sensor signal processing, data fusion, time series (segmentation, similarly measures), supervised learning (Bayes Decision Theory, Decision Trees, Random Forest, KNN-Methods, Support Vector Machine, Adaboost, Deep Learning), clustering (k-means, dbscan, topic models), Recommender Systems, Collaborative Filtering, Crowdsourcing.

The exercises show concrete design problems like motion and gesture recognition using distributed sensors, detection of activity patterns and identification of the local environment.

Presentations of the PhD students and the visit at the Wearable Computing Lab introduce in current research topics and international research projects.

Lecture notes

Lecture notes for all lessons, assignments and solutions.

http://www.ife.ee.ethz.ch/education/wearable_systems_1

Literature

Literature will be announced during the lessons.

Prerequisites / notice

No special prerequisites

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
<th>Prerequisites</th>
<th>Language</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0377-00L</td>
<td>Physics of Failure and Failure Analysis of Electronic Devices and Equipment</td>
<td>3</td>
<td></td>
<td>german/english (depending on the participants)</td>
</tr>
<tr>
<td>252-0437-00L</td>
<td>Distributed Algorithms</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>227-0447-00L</td>
<td>Image Analysis and Computer Vision</td>
<td>6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Abstract

Courses physiological failure analysis of electronic devices and equipment, and distributed algorithms. The course gives an introduction to the basics of failure analysis and failure analysis equipment and presents advanced methods from sensor data fusion, pattern recognition, statistics, data mining and machine learning.

Objective

Become acquainted with models and algorithms for distributed systems.

Content

Verteilte Algorithmen sind Verfahren, die dadurch charakterisiert sind, dass mehrere autonome Prozesse gleichzeitig Teile eines gemeinsamen Problems in kooperativer Weise bearbeiten und der dabei erforderliche Informationsaustausch ausschliesslich über Nachrichten erfolgt. Derartige Algorithmen kommen im Rahmen verteilter Systeme zum Einsatz, bei denen kein gemeinsamer Speicher existiert und die Übertragungszeit von Nachrichten i.a. nicht vernachlässigt werden kann. Da dabei kein Prozess eine aktuelle konsistente Sicht des globalen Zustands besitzt, führt dies zu interessanten Problemen. Im einzelnen werden u.a. folgende Themen behandelt:

- Models of distributed computations, time space diagrams, virtual time, logical clocks and causality, wave algorithms, parallel and distributed graph traversal, consistent snapshots, mutual exclusion, election and symmetry breaking, distributed termination detection, garbage collection in distributed systems, monitoring distributed systems, global predicates.

- Become acquainted with models and algorithms for distributed systems.

Verteilte Algorithmen sind Verfahren, die dadurch charakterisiert sind, dass mehrere autonome Prozesse gleichzeitig Teile eines gemeinsamen Problems in kooperativer Weise bearbeiten und der dabei erforderliche Informationsaustausch ausschliesslich über Nachrichten erfolgt. Derartige Algorithmen kommen im Rahmen verteilter Systeme zum Einsatz, bei denen kein gemeinsamer Speicher existiert und die Übertragungszeit von Nachrichten i.a. nicht vernachlässigt werden kann. Da dabei kein Prozess eine aktuelle konsistente Sicht des globalen Zustands besitzt, führt dies zu interessanten Problemen. Im einzelnen werden u.a. folgende Themen behandelt:

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- Became acquainted with models and algorithms for distributed systems.

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- Became acquainted with models and algorithms for distributed systems.

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Content

The first part of the course starts off from an overview of existing and emerging applications that need computer vision. It shows that the realm of image processing is no longer restricted to the factory floor, but is entering several fields of our daily life. First it is investigated how the parameters of the electromagnetic waves are related to our perception. Also the interaction of light with matter is considered. The most important hardware components of technical vision systems, such as cameras, optical devices and illumination sources are discussed. The course then turns to the steps that are necessary to arrive at the discrete images that serve as input to algorithms. The next part describes necessary preprocessing steps of image analysis, that enhance image quality and/or detect specific features. Linear and non-linear filters are introduced for that purpose. The course will continue by analyzing procedures allowing to extract additional types of basic information from multiple images, with motion and depth as two important examples. The estimation of image velocities (optical flow) will get due attention and methods for object tracking will be presented. Several techniques are discussed to extract three-dimensional information about objects and scenes. Finally, approaches for the recognition of specific objects as well as object classes will be discussed and analyzed.

Lecture notes

Course material Script, computer demonstrations, exercises and problem solutions

Prerequisites / notice

Basic concepts of mathematical analysis and linear algebra. The computer exercises are based on Linux and C.

The course language is English.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
<th>ECTS</th>
<th>Language</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0555-00L</td>
<td>Fault Tolerance in Distributed Systems</td>
<td>W 4 G 3</td>
<td>R. Wattenhofer</td>
<td></td>
</tr>
<tr>
<td>Abstract</td>
<td>Fault-tolerance (failure models, consensus, agreement), replication (primary copy, 2PC, 3PC, Paxos, quorum systems), shared memory (spin locks, concurrency)</td>
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<tr>
<td>Objective</td>
<td>Become acquainted with pertinent technologies and architectures of fault-tolerant distributed systems</td>
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<tr>
<td>Content</td>
<td>We discuss fault-tolerance issues (models, consensus, agreement) as well as replication issues (primary copy, 2PC, 3PC, Paxos, quorum systems, distributed storage) and problems with asynchronous multiprocessing (shared memory, spin locks, concurrency).</td>
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<tr>
<td>Prerequisites / notice</td>
<td>This lecture takes place in the second half of the semester; the lecture is the second part of the lecture &quot;Verteilte Systeme&quot; (Distributed Systems, 227-0219-00L). Students may attend at most one of the two lectures.</td>
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</table>

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<th>Language</th>
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<tr>
<td>227-0627-00L</td>
<td>Applied Computer Architecture</td>
<td>W 6 G 4</td>
<td>A. Gunzinger</td>
<td></td>
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<tr>
<td>Abstract</td>
<td>This lecture gives an overview of the requirements and the architecture of parallel computer systems, performance, reliability and costs.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Objective</td>
<td>Understand the function, the design and the performance modeling of parallel computer systems.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Content</td>
<td>The lecture &quot;Applied Computer Architecture&quot; gives technical and corporate insights in the innovative Computer Systems/Architectures (CPU, GPU, FPGA, special processors) and their real implementations and applications. Often the designs have to deal with technical limits. Which computer architecture allows the control of the over 1000 magnets at the Swiss Light Source (SLS)? Which architecture is behind the alarm center of the Swiss Railway (SBB)? Which computer architectures are applied for driver assistance systems? Which computer architecture is hidden behind a professional digital audio mixing desk? How can data streams of about 30 TB/s, produced by a proteome accelerator, be processed in real time? Can the weather forecast also be processed with GPUs? How can a good computer architecture be found? Which are the driving factors in successful computer architecture design?</td>
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<th>Language</th>
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<tbody>
<tr>
<td>151-0593-00L</td>
<td>Embedded Control Systems</td>
<td>W 4 G 6</td>
<td>J. S. Freudenberg, M. Schmid Daners, C. Onder</td>
<td></td>
</tr>
<tr>
<td>Abstract</td>
<td>This course provides a comprehensive overview of embedded control systems. The concepts introduced are implemented and verified on a microprocessor-controlled haptic device.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>Familiarize students with main architectural principles and concepts of embedded control systems. An embedded system is a microprocessor used as a component in another piece of technology, such as cell phones or automobiles. In this intensive two-week block course the students are presented the principles of embedded digital control systems using a haptic device as an example for a mechatronic system. A haptic interface allows for a human to interact with a computer through the sense of touch. Subjects covered in lectures and practical lab exercises include: - The application of C-programming on a microprocessor - Digital I/O and serial communication - Quadrature decoding for wheel position sensing - Queued analog-to-digital conversion to interface with the analog world - Pulse width modulation - Timer interrupts to create sampling time intervals - System dynamics and virtual worlds with haptic feedback - Introduction to rapid prototyping</td>
<td></td>
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</tr>
</tbody>
</table>
| Content     | This course is restricted to 33 students due to limited lab infrastructure. Interested students please contact Marianne Schmid (E-Mail: marischm@ethz.ch)

Lecture notes

Script and exercises sheets.

Prerequisites / notice

Prerequisites: Basics of computer architecture.

http://www.idsc.ethz.ch/education/lectures/embedded-control-systems.html

<table>
<thead>
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<th>Language</th>
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<tbody>
<tr>
<td>252-1411-00L</td>
<td>Security of Wireless Networks</td>
<td>W 5 G 2</td>
<td>S. Kapkun</td>
<td></td>
</tr>
<tr>
<td>Abstract</td>
<td>Core Elements: Wireless communication channel, Wireless network architectures and protocols, Attacks on wireless networks, Protection techniques.</td>
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<tr>
<td>Objective</td>
<td>After this course, the students should be able to describe and classify security goals and attacks in wireless networks; describe security architectures of the following wireless systems and networks: 802.11, GSM/UMTS, RFID, ad hoc/sensor networks; reason about security protocols for wireless network; implement mechanisms to secure 802.11 networks.</td>
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<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
<th>ECTS</th>
<th>Language</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0559-00L</td>
<td>Seminar in Distributed Computing</td>
<td>W 2 G 2</td>
<td>R. Wattenhofer</td>
<td></td>
</tr>
<tr>
<td>Abstract</td>
<td>In this seminar participating students present and discuss recent research papers in the area of distributed computing. The seminar consists of algorithmic as well as systems papers in distributed computing theory, peer-to-peer computing, ad hoc and sensor networking, or multi-core computing.</td>
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</table>

Data: 06.03.2019 12:57 Autumn Semester 2016 Page 518 of 1571
Objective

In the last two decades, we have experienced an unprecedented growth in the area of distributed systems and networks; distributed computing now encompasses many of the activities occurring in today’s computer and communications world. This course introduces the basics of distributed computing, highlighting common themes and techniques. We study the fundamental issues underlying the design of distributed systems: communication, coordination, synchronization, uncertainty. We explore essential algorithmic ideas and lower bound techniques.

In this seminar, students present the latest work in this domain.

Content

Seminar language: English

Lecture notes

Different each year. For details see: www.disco.ethz.ch/courses.html

Literature

Slides of presentations will be made available.

The actual paper selection can be found on www.disco.ethz.ch/courses.html.

Electronics and Photonics

Core Subjects

These core subjects are particularly recommended for the field of “Electronics and Photonics”.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0147-00L</td>
<td>VLSI II: Design of Very Large Scale Integration</td>
<td>W</td>
<td>7</td>
<td>5G</td>
<td>H. Kaeslin, F. K. Gürkaynak, M. Korb</td>
</tr>
</tbody>
</table>

Abstract

This second course in our VLSI series is concerned with how to turn digital circuit netlists into safe, testable and manufacturable mask layout, taking into account various parasitic effects. Low-power circuit design is another important topic. Economic aspects and management issues of VLSI projects round off the course.

Objective

Know how to design digital VLSI circuits that are safe, testable, durable, and make economic sense.

Content

The second course begins with a thorough discussion of various technical aspects at the circuit and layout level before moving on to economic issues of VLSI. Topics include:
- The difficulties of finding fabrication defects in large VLSI chips.
- How to make integrated circuit testable (design for test).
- Synchronous clocking disciplines compared, clock skew, clock distribution, input/output timing.
- Synchronization and metastability.
- CMOS transistor-level circuits of gates, flip-flops and random access memories.
- Sinks of energy in CMOS circuits.
- Power estimation and low-power design.
- Current research in low-energy computing.
- Layout parasitics, interconnected delay, static timing analysis.
- Electromigration, electrostatic discharge, and latch-up.
- Models of industrial cooperation in microelectronics.
- The caveats of virtual components.
- The cost structures of ASIC development and manufacturing.
- Yield models.
- Avenues to low-volume fabrication.
- Marketing considerations and case studies.
- Management of VLSI projects.

Exercises are concerned with back-end design (floorplanning, placement, routing, clock and power distribution, layout verification). Industrial CAD tools are being used.

Lecture notes


Prerequisites / notice

All written documents in English.

Literature


Highlight:

Students are offered the opportunity to design a circuit of their own which then gets actually fabricated as a microchip! Students who elect to participate in this program register for a term project at the Integrated Systems Laboratory in parallel to attending the VLSI II course.

Prerequisites:

"VLSI I: from Architectures to Very Large Scale Integration Circuits and FPGAs" or equivalent knowledge.

Further details:

http://www.iis.ee.ethz.ch/stud_area/vorlesungen/vlsi2.en.html

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>227-0197-00L</td>
<td>Wearable Systems I</td>
<td>W</td>
<td>6</td>
<td>4G</td>
<td>G. Tröster, U. Blanke</td>
</tr>
</tbody>
</table>

Abstract

Context recognition in mobile communication systems like mobile phone, smart watches and wearable computer will be studied using advanced methods from sensor data fusion, pattern recognition, statistics, data mining and machine learning.

Context comprises the behavior of individuals and of groups, their activities as well as the local and social environment.

Objective

Using internal sensors and sensors in our environment including data from the wristwatch, bracelet or internet (crowd sourcing), our ‘smart phone’ detects our context continuously, e.g. where we are, what we are doing, with whom we are together, what is our constitution, what are our needs. Based on this information our ‘smart phone’ offers us the appropriate services like a personal assistant. Context comprises user’s behavior, his activities, his local and social environment.

In the data path from the sensor level to signal segmentation to the classification of the context, advanced methods of signal processing, pattern recognition and machine learning will be applied. Sensor data generated by crowdsourcing methods are integrated. The validation using MATLAB is followed by implementation and testing on a smart phone.

Context recognition as the crucial function of mobile systems is the main focus of the course. Using MatLab the participants implement and verify the discussed methods also using a smart phone.
Using internal sensors and sensors in our environment including data from the wristwatch, bracelet or internet (crowd sourcing), our 'smart phone' detects our context continuously, e.g. where we are, what we are doing, with whom we are together, what is our constitution, what are our needs. Based on this information our 'smart phone' offers us the appropriate services like a personal assistant. Context recognition - what is the situation of the user, his activity, his environment, how is he doing, what are his needs - as the central functionality of mobile systems constitutes the focus of the course.

The main topics of the course include

Sensor nets, sensor signal processing, data fusion, time series (segmentation, similarity measures), supervised learning (Bayes Decision Theory, Decision Trees, Random Forest, KNN-Methods, Support Vector Machine, AdaBoost, Deep Learning), clustering (k-means, dbscan, topic models), Recommender Systems, Collaborative Filtering, Crowdsourcing.

The exercises show concrete design problems like motion and gesture recognition using distributed sensors, detection of activity patterns and identification of the local environment.

Presentations of the PhD students and the visit at the Wearable Computing Lab introduce in current research topics and international research projects.

**Lecture notes**

Language: german/english (depending on the participants)

http://www.ife.ee.ethz.ch/education/wearable_systems_1

**Literature**

Content will be announced during the lessons.

No special prerequisites

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
<th>E-Learning Modules</th>
<th>Instructor</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0301-00L</td>
<td>Optical Communication Fundamentals</td>
<td>6</td>
<td>W</td>
<td>J. Leuthold</td>
</tr>
<tr>
<td>Objective</td>
<td>An in-depth understanding on how information is transmitted from source to destination. Also the mathematical framework to describe the important elements will be passed on. Students attending the lecture will further get engaged in critical discussion on societal, economical and environmental aspects related to the on-going exponential growth in the field of communications.</td>
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<tr>
<td>Lecture notes</td>
<td>Lecture notes are handed out.</td>
<td></td>
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<tr>
<td>Literature</td>
<td>Govind P. Agrawal; &quot;Fiber-Optic Communication Systems&quot;; Wiley, 2010</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prerequisites / notice</td>
<td>Fundamentals of Electromagnetic Fields &amp; Bachelor Lectures on Physics.</td>
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<tr>
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<th>Instructor</th>
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<tbody>
<tr>
<td>227-0663-00L</td>
<td>Nano-Optics</td>
<td>6</td>
<td>W</td>
<td>L. Novotny</td>
</tr>
<tr>
<td>Abstract</td>
<td>Nano-Optics is the study of optical phenomena and techniques on the nanometer scale. It is an emerging field of study motivated by the rapid advance of nanoscience and technology. It embraces topics such as plasmonics, optical antennas, optical trapping and manipulation, and high-resolution imaging and spectroscopy.</td>
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<tr>
<td>Objective</td>
<td>Understanding concepts of light localization and light-matter interactions on the nanoscale.</td>
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<tr>
<td>Content</td>
<td>* Electrodynamics (or equivalent) * Physics II</td>
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<tr>
<td>Prerequisites / notice</td>
<td>- No special prerequisites</td>
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<tr>
<th>Course</th>
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<th>E-Learning Modules</th>
<th>Instructor</th>
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</thead>
<tbody>
<tr>
<td>227-1033-00L</td>
<td>Neuromorphic Engineering I</td>
<td>6</td>
<td>W</td>
<td>T. Delbrück, G. Indiveri, S.C. Liu</td>
</tr>
<tr>
<td>Registration in this class requires the permission of the instructors. Class size will be limited to available lab spots. Preference is given to students that require this class as part of their major.</td>
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<tr>
<td>Objective</td>
<td>Understanding the characteristics of neuromorphic circuit elements.</td>
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<tr>
<td>Content</td>
<td>Neuromorphic circuits are inspired by the organizing principles of biological neural circuits. Their computational primitives are based on physics of semiconductor devices. Neuromorphic architectures often rely on collective computation in parallel networks. Adaptation, learning and memory are implemented locally within the individual computational elements. Transistors are often operated in weak inversion (below threshold), where they exhibit exponential I-V characteristics and low currents. These properties lead to the feasibility of high-density, low-power implementations of functions that are computationally intensive in other paradigms. Application domains of neuromorphic circuits include silicon retinas and cochleas for machine vision and audition, real-time emulations of networks of biological neurons, and the development of autonomous robotic systems. This course covers devices in CMOS technology (MOS transistor below and above threshold, floating-gate MOS transistor, phototransducers), static circuits (differential pair, current mirror, transconductance amplifiers, etc.), dynamic circuits (linear and nonlinear filters, adaptive circuits), systems (silicon neuron, silicon retina and cochlea) and an introduction to multi-chip systems that communicate events analogous to spikes. The lectures are accompanied by weekly laboratory sessions.</td>
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<tr>
<td>Literature</td>
<td>S.-C. Liu et al.: Analog VLSI Circuits and Principles; various publications.</td>
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</table>
**Prerequisites / notice**

- The course is highly recommended for those who intend to take the spring semester course 'Neuromorphic Engineering II', that teaches the conception, simulation, and physical layout of such circuits with chip design tools.

- Prerequisites: Background in basics of semiconductor physics helpful, but not required.

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### Recommended Subjects

These courses are recommended, but you are free to choose courses from any other special field. Please consult your tutor.

<table>
<thead>
<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>227-0121-00L</td>
<td>Communication Systems</td>
<td>W</td>
<td>6</td>
<td>4G</td>
<td>A. Wittenneben</td>
</tr>
<tr>
<td>Abstract</td>
<td>Information Theory, Signal Space Analysis, Baseband Transmission, Passband Transmission, Example und Channel, Data Link Layer, MAC, Example Layer 2, Layer 3, Internet</td>
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<tr>
<td>Objective</td>
<td>Introduction into the fundamentals of digital communication systems. Selected examples on the application of the fundamental principles in existing and upcoming communication systems</td>
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<tr>
<td>Content</td>
<td>Covered are the lower three layer of the OSI reference model: the physical, the data link, and the network layer. The basic terms of information theory are introduced. After this, we focus on the methods for the point to point communication, which may be addressed elegantly and coherently in the signal space. Methods for error detection and correction as well as protocols for the retransmission of perturbed data will be covered. Also the medium access for systems with shared medium will be discussed. Finally, algorithms for routing and flow control will be treated.</td>
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<tr>
<td>Lecture notes</td>
<td>Lecture Slides</td>
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</table>

| 227-0157-00L | Semiconductor Devices: Physical Bases and Simulation | W    | 4    | 3G    | A. Schenk |
| Abstract     | The course addresses the physical principles of modern semiconductor devices and the foundations of their modeling and numerical simulation. Necessary basic knowledge on quantum-mechanics, semiconductor physics and device physics is provided. Computer simulations of the most important devices and of interesting physical effects supplement the lectures. |
| Objective    | The course aims at the understanding of the principle physics of modern semiconductor devices, of the foundations in the physical modeling of transport and its numerical simulation. During the course also basic knowledge on quantum-mechanics, semiconductor physics and device physics is provided. |
| Content      | The main topics are: transport models for semiconductor devices (quantum transport, Boltzmann equation, drift-diffusion model, hydrodynamic model), physical characterization of silicon (intrinsische properties, scattering processes), mobility of cold and hot carriers, recombination (Shockley-Read-Hall statistics, Auger recombination), impact ionization, metal-semiconductor contact, metal-insulator-semiconductor structure, and heterojunctions. The exercises are focussed on the theory and the basic understanding of the operation of special devices, as single-electron transistor, resonant tunneling diode, pn-diode, bipolar transistor, MOSFET, and laser. Numerical simulations of such devices are performed with an advanced simulation package (Sentaurus-Synopsys). This enables to understand the physical effects by means of computer experiments. |
| Lecture notes| The script (in book style) can be downloaded from: http://www.iis.ee.ethz.ch/schenk/vorlesung |
| Literature   | The script (in book style) is sufficient. Further reading will be recommended in the lecture. |
| Prerequisites / notice | Qualifications: Physics I-II, Semiconductor devices (4. semester). |

| 227-0166-00L | Analog Integrated Circuits | W    | 6    | 2V+2U | Q. Huang |
| Abstract     | This course provides a foundation in analog integrated circuit design based on bipolar and CMOS technologies. Integrated circuits are responsible for much of the progress in electronics in the last 50 years, particularly the revolutions in the Information and Communications Technologies we witnessed in recent years. Analog integrated circuits play a crucial part in the highly integrated systems that power the popular electronic devices we use daily. Understanding their design is beneficial to both future designers and users of such systems. The basic elements, design issues and techniques for analog integrated circuits will be taught in this course. |
| Objective    | Review of bipolar and MOS devices and their small-signal equivalent circuit models; Building blocks in analog circuits such as current sources, active load, current mirrors, supply independent biasing etc; Amplifiers: differential amplifiers, cascode amplifier, high gain structures, output stages, gain bandwidth product of op-amps; Stability; Comparators; Second-order effects in analog circuits such as mismatch, noise and offset; A/D and D/A converters; Introduction to switched capacitor circuits. The exercise sessions aim to reinforce the lecture material by well guided step-by-step design tasks. The circuit simulator SPECTRE is used to facilitate the tasks. There is also an experimental session on op-amp measurements. |
| Content      | Handouts of presented slides. No script but an accompanying textbook is recommended. |
| Lecture notes| Handouts of presented slides. No script but an accompanying textbook is recommended. |

| 227-0377-00L | Physics of Failure and Failure Analysis of Electronic Devices and Equipment | W    | 3    | 2V    | U. Sennhauser |
| Abstract     | Failures have to be avoided by proper design, material selection and manufacturing. Properties, degradation mechanisms, and expected lifetime of materials are introduced and the basics of failure analysis and analysis equipment are presented. Failures will be demonstrated experimentally and the opportunity is offered to perform a failure analysis with advanced equipment in the laboratory. |
| Objective    | Introduction to the degradation and failure mechanisms and causes of electronic components, devices and systems as well as to methods and tools of reliability testing, characterization and failure analysis. |
| Content      | Summary of reliability and failure analysis terminology; physics of failure: materials properties, physical processes and failure mechanisms; failure analysis of ICs, PCBs, opto-electronics, discrete and other components and devices; basics and properties of instruments; application in circuit design and reliability analysis |
| Lecture notes| Comprehensive copy of transparencies |

| 227-0455-00L | THz: Technology & Applications | W    | 3    | 2V    | K. Sankaran |
| Abstract     | This course will provide a solid foundation for understanding physical principles of THz applications. We will discuss various building blocks of THz technology - components dealing with generation, manipulation, and detection of THz electromagnetic radiation. We will introduce THz applications in the domain of imaging, communications, and energy harvesting. |
At the beginning, signal-flow graphs in general and driving-point signal-flow graphs in particular are introduced. We will use them during 3G M. P. M. Ciappa.

This is an introductory course on Terahertz (THz) technology and applications. Devices operating in THz frequency range (0.1 to 10 THz) have been increasingly studied in the recent years. Progress in nonlinear optical materials, ultrafast optical and electronic techniques has strengthened research in THz application developments. Due to unique interaction of THz waves with materials, applications with new capabilities can be developed. In theory, they can penetrate somewhat like X-rays, but are not considered harmful radiation, because THz energy level is low. They should be able to provide resolution as good or better than magnetic resonance imaging (MRI), possibly with simpler equipment. Imaging, very-high bandwidth communication, and energy harvesting are the most widely explored THz application areas. We will study the basics of THz generation, manipulation, and detection. Our emphasis will be on the physical principles and applications of THz in the domain of imaging, communication and energy harvesting.

**Objective**

The learning goal is that the students can apply signal-flow graphs and can understand the signal flow in such circuits and systems (including non-ideal effects) well enough to gain an understanding of further circuits and systems by themselves.

**Content**

The beginning, signal-flow graphs in general and driving-point signal-flow graphs in particular are introduced. We will use them during the whole term to analyze circuits and understand how signals propagate through them. The theory and CMOS implementation of active filters is then discussed in detail using the example of Gm-C filters and active-RC filters. The ideal and nonideal behaviour of opamps, current conveyors, and inductor simulators follows. The link to the practical design of circuits and systems is done with an overview over different quality measures and figures of merit used in scientific literature and datasheets. Finally, an introduction to discrete-time and mixed-domain filters and circuits is given, including sensor read-out amplifiers, correlated double sampling, and chopping, and an introduction to sigma-delta A/D and D/A conversion on a system level.

**Literature**

- Yun-Shik Lee, Principles of Terahertz Science and Technology, Springer 2009

**Prerequisites / notice**

Good foundation in electromagnetics & knowledge of microwave or optical communication is helpful.

Whenever we deviate from the main material discussed in these books, softcopy of lectures notes will be provided.
C. Hafner: Presentation material

The lecture "Applied Computer Architecture" gives technical and corporate insights in the innovative Computer Systems/Architectures. This lecture consists of a theoretical part (50%) and of laboratory exercises and demonstrations (50%).

Schroeder D.K, Semiconductor Material and Device Characterization, Wiley Ed.

W. A. Gunzinger: Characterization of the Electronic Properties of Semiconductor Materials for Semiconductor Devices

The seminar aims at instructing graduate and PhD students in the basics of presentation techniques, i.e. "how to give a professional talk".

W. W. 3G, J. Leuthold, J. Smajic: In the "Fachseminar IIS" the students learn to communicate topics, ideas or problems of scientific research by listening to more experienced authors and by presenting scientific work in a conference-like situation for a specific audience.

Handouts to the lecture (approx. 250 pp.)

Eiichi Ohno: "Introduction to Power Electronics"

The characterization of the electronic properties of semiconductor and related materials is fundamental to manufacture integrated devices, which fulfill the required specifications. By this lecture, the students shall get acquainted with the main electrical characterization techniques of the electronic properties of semiconductors and thin film materials used in microelectronics, as well as with their physical principles. This knowledge is intended to provide the future engineer with the theoretical background and experimental tools for process control in semiconductor manufacturing, parameter extraction in device simulation, and design of dependable devices.

Handouts to the lecture (approx. 200 pp.)

W. J. Baliga: "Physics Modern Power Devices"

B. J. Baliga: "Semiconductor Power Devices"

S. K. Ghandi: "Semiconductor Power Devices"

B. J. Baliga: "Physics Modern Power Devices"

O. F. Balesstra Ed., "Nanoscale CMOS: innovative materials, modeling and characterization, ISTE"

227-0620-00L Characterization of the Electronic Properties of Materials for Semiconductor Devices

W 4 credits

3G

Objective

This lecture provides theoretical and experimental knowledge on the techniques for the characterization of the main electronic properties of semiconductors and thin film materials used in microelectronics, with special focus on silicon.

Content

This lecture consists of a theoretical part (80%) and of laboratory exercises and demonstrations (20%). In the first section of the lecture, methods and procedures are presented for the experimental characterization of relevant electronic parameters in the bare semiconductor (mainly silicon), like resistivity, carrier and doping density, contact resistance, defect density, carrier lifetime, mobility.

The second section deals with techniques involving basic structures and devices (contact chains, MIS capacitors, diodes, gated diodes, BJTs, MOSFETs) for the characterization of atomic transport, mechanical stress, dielectric thickness, impact ionization, channel mobility, instabilities, defect formation at interfaces and in thin film dielectrics, carrier transport and trapping in thin film dielectrics, quasi-static and dynamic device characteristics. The list of the covered methods includes among others probing, Kelvin measurements, VanderPauw technique, Hall spectroscopy, SIMS, Raman spectroscopy, spreading resistance, scanning probe techniques, static/high-speed I-V, static/high-frequency C-V, current voltage decay, carrier recombinatination techniques, Zerbst techniques, deep level transient spectroscopy, split C-V, charge pumping, and inverse modeling techniques using TCAD. All methods are presented in conjunction with the proper test structures. During the laboratory activities, a selection of the experimental techniques discussed in the lecture are demonstrated on the base of realistic examples.

Handouts to the lecture

Lecture notes

Lecture notes

S. K. Ghandi: "Semiconductor Power Devices"

B. J. Baliga: "Physics Modern Power Devices"

S. K. Ghandi: "Semiconductor Power Devices"

227-0627-00L Applied Computer Architecture

W 6 credits

4G

A. Gunzinger

Objective

Understand the function, the design and the performance modeling of parallel computer systems.

Content

This lecture gives an overview of the requirements and the architecture of parallel computer systems, performance, reliability and costs. It covers aspects of programming parallel computer systems in detail. It includes performances of parallel computer systems and gives insights into parallel computer systems.

Prerequisites / notice

Script and exercises sheets.

227-0659-00L Integrated Systems Seminar

W 1 credit

1S

A. Schenk

Abstract

In the "Fachseminar IIS" the students learn to communicate topics, ideas or problems of scientific research by listening to more experienced authors and by presenting scientific work in a conference-like situation for a specific audience.

Objective

The seminar aims at instructing graduate and PhD students in the basics of presentation techniques, i.e. "how to give a professional talk". Attendees have the possibility to become acquainted with a current topic by a literature study, and to present the results thereof in a 20 minutes talk in English. The participation at the seminar gives also an overview on current problems in modern nano- and opto-electronics.

Content

The seminar topics are simulation of nanoelectronic processes and devices, and the optical as well as electronic simulation of optoelectronic devices as lasers, photodiodes, etc.

Presentation material

227-2037-00L Physical Modelling and Simulation

W 5 credits

4G

C. Hafner, J. Leuthold, J. Smajic

Abstract

This module consists of (a) an introduction to fundamental equations of electromagnetics, mechanics and heat transfer, (b) a detailed overview of numerical methods for field simulations, and (c) practical examples solved in form of small projects.

Objective

Basic knowledge of the fundamental equations and effects of electromagnetics, mechanics, and heat transfer. Knowledge of the main concepts of numerical methods for physical modelling and simulation. Ability (a) to develop own simple field simulation programs, (b) to select an appropriate field solver for a given problem, (c) to perform field simulations, (d) to evaluate the obtained results, and (e) to interactively improve the models until sufficiently accurate results are obtained.
Content
The module begins with an introduction to the fundamental equations and effects of electromagnetics, mechanics, and heat transfer. After the introduction follows a detailed overview of the available numerical methods for solving electromagnetic, thermal and mechanical boundary value problems. This part of the course contains a general introduction into numerical methods, differential and integral forms, linear equation systems, Finite Difference Method (FDM), Boundary Element Method (BEM), Method of Moments (MoM), Multiple Multipole Program (MMP) and Finite Element Method (FEM). The theoretical part of the course finishes with a presentation of multiphysics simulations through several practical examples of HF-engineering such as coupled electromagnetic-mechanical and electromagnetic-thermal analysis of MEMS.

In the second part of the course the students will work in small groups on practical simulation problems. For solving practical problems the students can develop and use own simulation programs or chose an appropriate commercial field solver for their specific problem. This practical simulation work of the students is supervised by the lecturers.

<table>
<thead>
<tr>
<th>151-0601-00L</th>
<th>Theory of Robotics and Mechatronics</th>
<th>W</th>
<th>4 credits</th>
<th>3G</th>
<th>P. Korba, S. Stoeter, B. Nelson</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Abstract</strong></td>
<td>This course provides an introduction and covers the fundamentals of the field, including rigid motions, homogeneous transformations, forward and inverse kinematics of multiple degree of freedom manipulators, velocity kinematics, motion planning, trajectory generation, sensing, vision, and control. Its a requirement for the Robotics Vertiefung and for the Masters in Mechatronics and Microsystems.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>Robotics is often viewed from three perspectives: perception (sensing), manipulation (affecting changes in the world), and cognition (intelligence). Robotic systems integrate aspects of all three of these areas. This course provides an introduction to the theory of robotics, and covers the fundamentals of the field, including rigid motions, homogeneous transformations, forward and inverse kinematics of multiple degree of freedom manipulators, velocity kinematics, motion planning, trajectory generation, sensing, vision, and control. This course is a requirement for the Robotics Vertiefung and for the Masters in Mechatronics and Microsystems.</td>
<td></td>
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<tr>
<td><strong>Content</strong></td>
<td>An introduction to the theory of robotics, and covers the fundamentals of the field, including rigid motions, homogeneous transformations, forward and inverse kinematics of multiple degree of freedom manipulators, velocity kinematics, motion planning, trajectory generation, sensing, vision, and control.</td>
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</tbody>
</table>

**Prerequisites / notice**
The course will be taught in English.

<table>
<thead>
<tr>
<th>151-0605-00L</th>
<th>Nanosystems</th>
<th>W</th>
<th>4 credits</th>
<th>4G</th>
<th>A. Stemmer, J.N. Tisserant</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Abstract</strong></td>
<td>From atoms to molecules to condensed matter: characteristic properties of simple nanosystems and how they evolve when moving towards complex ensembles.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>Familiarize students with basic science and engineering principles governing the nano domain.</td>
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<tr>
<td><strong>Content</strong></td>
<td>Special emphasis is placed on the emerging field of molecular electronic devices.</td>
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</tbody>
</table>

**Literature**

**Prerequisites / notice**
Lectures and Mini-Review presentations: Thursday 10-13, ML F 36

**Course format:**
Homework: Mini-Reviews
Students select a paper (list distributed in class) and expand the topic into a Mini-Review that illuminates the particular field beyond the immediate results reported in the paper.

<table>
<thead>
<tr>
<th>151-0620-00L</th>
<th>Embedded MEMS Lab</th>
<th>W</th>
<th>5 credits</th>
<th>3P</th>
<th>C. Hierold, S. Blunier, M. Haluska</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Abstract</strong></td>
<td>Practical course: Students are introduced to the process steps required for the fabrication of MEMS (Micro Electro Mechanical System) and carry out the fabrication and testing steps in the clean rooms by themselves. Additionally, they learn the requirements for working in clean rooms. Processing and characterization will be documented and analyzed in a final report. Limited access</td>
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<tr>
<td><strong>Objective</strong></td>
<td>Students learn the individual process steps that are required to make a MEMS (Micro Electro Mechanical System). Students carry out the process steps themselves in laboratories and clean rooms. Furthermore, participants become familiar with the special requirements (cleanliness, safety, operation of equipment and handling hazardous chemicals) of working in the clean rooms and laboratories. The entire production, processing, and characterization of the MEMS is documented and evaluated in a final report.</td>
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<tr>
<td><strong>Content</strong></td>
<td>With guidance from a tutor, the individual silicon micromachining steps that are required for the fabrication of an accelerometer are carried out:</td>
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<tr>
<td><strong>Prerequisites / notice</strong></td>
<td>- Photolithography, dry etching, wet etching, sacrificial layer etching, critical point drying, various cleaning procedures - Packaging and electrical connection of a MEMS device - Testing and characterization of the MEMS device - Written documentation and evaluation of the entire production, processing and characterization</td>
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</tbody>
</table>

**Literature**
A document containing theory, background and practical course content is distributed at the first meeting of the course.

The document provides sufficient information for the participants to successfully participate in the course.

Data: 06.03.2019 12:57  Autumn Semester 2016  Page 524 of 1571
Electromagnetic oscillations known as surface plasmon polaritons have many unique properties that are useful across a broad set of applications in biology, chemistry, physics, and optics. The field of plasmonics has arisen to understand the behavior of surface plasmon polaritons and to develop applications in areas such as catalysis, imaging, photovoltaics, and sensing. In particular, metallic nanoparticles and patterned metallic interfaces have been developed to utilize plasmonic resonances. The aim of this course is to provide the basic knowledge to understand and apply the principles of plasmonics. The course will strive to be approachable to students from a diverse set of science and engineering backgrounds.

**Content**
- Fundamentals of Plasmonics
- Basic electromagnetic theory
- Optical properties of metals
- Surface plasmon polaritons on surfaces
- Localized surface plasmons
- Applications of Plasmonics
- Waveguides
- Extraordinary optical transmission
- Enhanced spectroscopy
- Sensing
- Metamaterials

**Prerequisites / notice**
Participating students are required to attend all scheduled lectures and meetings of the course.

Participating students are required to provide proof that they have personal accident insurance prior to the start of the laboratory portion of the course.

This master's level course is limited to 15 students per semester for safety and efficiency reasons.

If there are more than 15 students registered, we regret to restrict access to this course by the following rules:

**Priority 1:** master students of the master's program in "Micro and Nanosystems"

**Priority 2:** master students of the master's program in "Mechanical Engineering" with a specialization in Microsystems and Nanoscale Engineering, who attended the bachelor course "151-0621-00L Microsystems Technology" successfully.

**Priority 3:** master students, who attended the bachelor course "151-0621-00L Microsystems Technology" successfully.

**Priority 4:** all other students (PhD, bachelor, master) with a background in silicon or microsystems process technology.

If there are more students in one of these priority groups than places available, we will decide by drawing lots.

Students will be notified at the first lecture of the course (introductory lecture) as to whether they are able to participate.

The course is offered in autumn and spring semester.

**151-0911-00L**

**Introduction to Plasmonics**

<table>
<thead>
<tr>
<th>Prerequisites / notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participating students are required to attend all scheduled lectures and meetings of the course.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Objective</th>
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<tbody>
<tr>
<td>This course provides fundamental knowledge of surface plasmon polaritons and discusses their applications in plasmonics.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Content</th>
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<tbody>
<tr>
<td>Electromagnetic oscillations known as surface plasmon polaritons have many unique properties that are useful across a broad set of applications in biology, chemistry, physics, and optics. The field of plasmonics has arisen to understand the behavior of surface plasmon polaritons and to develop applications in areas such as catalysis, imaging, photovoltaics, and sensing. In particular, metallic nanoparticles and patterned metallic interfaces have been developed to utilize plasmonic resonances. The aim of this course is to provide the basic knowledge to understand and apply the principles of plasmonics. The course will strive to be approachable to students from a diverse set of science and engineering backgrounds.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Literature</th>
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</table>

<table>
<thead>
<tr>
<th>Prerequisites / notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physics I, Physics II</td>
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</table>

**363-0389-00L**

**Technology and Innovation Management**

<table>
<thead>
<tr>
<th>Objective</th>
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<tbody>
<tr>
<td>This course focuses on the analysis of innovation as a pervasive process that cut across organizational and functional boundaries. It looks at the sources of innovation, at the tools and techniques that organizations deploy to routinely innovate, and the strategic implications of technical change.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Content</th>
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<tbody>
<tr>
<td>This course looks at technology and innovation management as a process. Continuously, organizations are faced with a fundamental decision: they have to allocate resources between well-known tasks that reliably generate positive results; or explore new ways of doing things, new technologies, products and services. The latter is a high risk choice. Its rewards can be high, but the chances of success are small. How do firms organize to take these decisions? What kind of management skills are necessary to take them? What kind of tools and methods are deployed to sustain managerial decision-making in highly volatile environments? These are the central questions on which this course focuses, relying on a combination of lectures, case-based discussion, guest speakers, simulations and group work.</td>
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</table>

<table>
<thead>
<tr>
<th>Literature</th>
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<tbody>
<tr>
<td>Slides will be available on the TIMGROUP website.</td>
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</table>

<table>
<thead>
<tr>
<th>Prerequisites / notice</th>
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</thead>
<tbody>
<tr>
<td>No specific background in economics or management is required.</td>
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</table>

**Energy and Power Electronics**

**Core Subjects**

These core subjects are particularly recommended for the field of "Energy and Power Electronics".

**Number**

<table>
<thead>
<tr>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0247-00L</td>
<td>Power Electronic Systems I</td>
<td>W</td>
<td>6 credits</td>
<td>4G</td>
</tr>
</tbody>
</table>

Basics of the switching behavior, gate drive and snubber circuits of power semiconductors are discussed. Soft-switching and resonant DC/DC converters are analyzed in detail and high frequency loss mechanisms of magnetic components are explained. Space vector modulation of three-phase inverters is introduced and the main power components are designed for typical industry applications.
Objective
Detailed understanding of the principle of operation and modulation of advanced power electronics converter systems, especially of zero voltage switching and zero current switching non-isolated and isolated DC/DC converter systems and three-phase voltage DC link inverter systems. Furthermore, the course should convey knowledge on the switching frequency related losses of power semiconductors and inductive power components and introduce the concept of space vector calculus which provides a basis for the comprehensive discussion of three-phase PWM converters systems in the lecture Power Electronic Systems II.

Content
Basics of the switching behavior and gate drive circuits of power semiconductor devices and auxiliary circuits for minimizing the switching losses are explained. Furthermore, zero voltage switching, zero current switching, and resonant DC/DC converters are discussed in detail; the operating behavior of isolated full-bridge DC/DC converters is detailed for different secondary side rectifier topologies; high frequency loss mechanisms of magnetic components of converter circuits are explained and approximate calculation methods are presented; the concept of space vector calculus for analyzing three-phase systems is introduced; finally, phase-oriented and space vector modulation of three-phase inverter systems are discussed related to voltage DC link inverter systems and the design of the main power components based on analytical calculations is explained.

Prerequisites / notice
Prerequisites: Introductory course on power electronics.

Lecture notes
Lecture notes and associated exercises including correct answers, simulation program for interactive self-learning including visualization/animation features.

227-0517-00L Electrical Drive Systems II W 6 credits 4G P. Steimer, G. Scheuer, C. A. Stutz

Abstract
In the course “Drive System II” the power semiconductors are repeated. The creation of converters based on the combination of switches/cells and based topologies is explained. Another main focus is on the 3-level inverter with its switching and transfer functions. Further topics are the control of the synchronous machine, of line-side converters and issues with converter-fed machines.

Objective
The students establish a deeper understanding in regards of the design of the main components of an electrical drive system. They establish knowledge on the most important interaction with the grid and the machine and their related high dynamic control.

Content
Converter topologies (switch or cell based), multi-pulse diode rectifiers, system aspects of transformer and electrical machines, 3-level inverter with its switching and transfer functions, grid side harmonics, modeling and control of synchronous machines (including permanent magnet machines), control of line-side converters, reflection effects with power cables, winding isolation and bearing stress. Field trip to ABB Semiductors.

Literature
Skript is sold at the beginning of the lectures or can be downloaded from liias

Prerequisites / notice
Prerequisites: Electrical Drive Systems I (recommended), Basics in electrical engineering, power electronics, automation and mechatronics

227-0526-00L Power System Analysis W 6 credits 4G G. Hug

Abstract
The goal of this course is understanding the stationary and dynamic problems in electrical power systems. The course includes the development of stationary models of the electrical network, their mathematical representation and special characteristics and solution methods of large linear and non-linear systems of equations related to electrical power networks.

Objective
The goal of this course is understanding the stationary and dynamic problems in electrical power systems. The course includes the development of stationary models of the electrical network, their mathematical representation and special characteristics and solution methods of large linear and non-linear systems of equations related to electrical power networks.

Content
The electrical power transmission system, the energy management system, requirements of the electrical power transmission (demand oriented, operationally, economically), network planning and network operation, models of N-port network components (line, cables, shunts, transformers), the p.u. computation, computer oriented network models, linear networks (solution methods - direct, iterative), algorithms for the solution of non-linear sets of equations, derived from the electrical power system (Newton-Raphson), power flow computation (problem definition, solution methods), three phase short-circuit computation, application of power flow algorithms. Introduction to power system stability.

Prerequisites / notice
Prerequisites: Introductory course on power electronics.

227-0567-00L Design of Power Electronic Systems W 6 credits 4G F. Krismer

Abstract
Complete design process: from given specifications to a complete power electronic system; selection / design of suitable passive power components; static and dynamic properties of power semiconductors; optimized EMI filter design; heat sink optimization; additional circuitry, e.g. gate driver; system optimization.

Objective
Basic knowledge of design and optimization of a power electronic system; furthermore, lecture and exercises thoroughly discuss key subjects of power electronics that are important with respect to a practical realization, e.g. how to select suitable power components, how to determine switching losses, calculation of high frequency losses, EMI filter design and realization, thermal considerations.

Content
Complete design process: from given specifications to a complete power electronic system. Selection and / or design of suitable passive power components: specific properties, parasitic components, tolerances, high frequency losses, thermal considerations, reliability. Static and dynamic characteristics of power semiconductors. Optimized design of the EMI filter. Thermal characterization of the converter, optimized heat sink design. Additional circuitry: gate driver, measurement, control. Converter start up: typical sequence of events, circuitry required. Overall system optimization: identifying couplings between different components of the considered power electronic system, optimization targets and issues.

Lecture notes
Lecture notes. Course is supported by WWW-teaching system.

Prerequisites / notice
Prerequisites: Introductory course on power electronics.

227-0731-00L Power Market I - Portfolio and Risk Management W 6 credits 4G D. Reichelt, G. A. Koeppe

Abstract
Portfolio and risk management in the electrical power business, Pan-European power market and trading, futures and forward contracts, hedging, options and derivatives, performance indicators for the risk management, modelling of physical assets, cross-border trading, ancillary services, balancing power market, Swiss market model

Objective
Content
1. Pan-European power market and trading
   1.1. Power trading
   1.2. Development of the European power markets
   1.3. Energy economics
   1.4. Spot and OTC trading
   1.5. European energy exchange EEX

2. Market model
   2.1. Market place and organisation
   2.2. Balance groups / balancing energy
   2.3. Ancillary services
   2.4. Market for ancillary services
   2.5. Cross-border trading
   2.6. Capacity auctions

3. Portfolio and Risk management
   3.1. Portfolio management 1 (introduction)
   3.2. Forward and futures contracts
   3.3. Risk management 1 (m2m, VaR, hpfc, volatility, cVaR)
   3.4. Risk management 2 (PaR)
   3.5. Contract valuation (HPFC)
   3.6. Portfolio management 2
   2.8. Risk Management 3 (enterprise wide)

4. Energy & Finance I
   4.1. Options 1 basics
   4.2. Options 2 hedging with options
   4.3. Introduction to derivatives (swaps, cap, floor, collar)
   4.4. Financial modelling of physical assets
   4.5. Trading and hydro power
   4.6. Incentive regulation

Lecture notes
Handouts of the lecture
Prerequisites / notice
1 excursion per semester, 2 case studies, guest speakers for specific topics.
Course Moodle: https://moodle-app2.let.ethz.ch/course/view.php?id=2196

Recommended Subjects
These courses are recommended, but you are free to choose courses from any other special field. Please consult your tutor.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0101-00L</td>
<td>Discrete-Time and Statistical Signal Processing</td>
<td>W</td>
<td>6 credits</td>
<td>4G</td>
<td>H.A. Loeliger</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course introduces some fundamental topics of digital signal processing with a bias towards applications in communications: discrete-time linear filters, equalization, DFT, discrete-time stochastic processes, elements of detection theory and estimation theory, LMMSE estimation and LMMSE filtering, LMS algorithm, Viterbi algorithm.</td>
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<tr>
<td>Objective</td>
<td>The course introduces some fundamental topics of digital signal processing with a bias towards applications in communications. The two main themes are linearity and probability. In the first part of the course, we deepen our understanding of discrete-time linear filters. In the second part of the course, we review the basics of probability theory and discrete-time stochastic processes. We then discuss some basic concepts of detection theory and estimation theory, as well as some practical methods including LMMSE estimation and LMMSE filtering, the LMS algorithm, and the Viterbi algorithm. A recurrent theme throughout the course is the stable and robust &quot;inversion&quot; of a linear filter.</td>
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<tr>
<td>Content</td>
<td>1. Discrete-time linear systems and filters: state-space realizations, z-transform and spectrum, decimation and interpolation, digital filter design, stable realizations and robust inversion.</td>
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<td>2. The discrete Fourier transform and its use for digital filtering.</td>
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<td>3. The statistical perspective: probability, random variables, discrete-time stochastic processes; detection and estimation: MAP, ML, Bayesian MMSE, LMMSE; Wiener filter, LMS adaptive filter, Viterbi algorithm.</td>
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<tr>
<td>Lecture notes</td>
<td>Lecture Notes.</td>
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</table>

| 227-0121-00L | Communication Systems | W    | 6 credits | 4G    | A. Wittneben    |
| Abstract | Information Theory, Signal Space Analysis, Baseband Transmission, Passband Transmission, Example und Channel, Data Link Layer, MAC, Example Layer 2, Layer 3, Internet |
| Objective | Introduction into the fundamentals of digital communication systems. Selected examples on the application of the fundamental principles in existing and upcoming communication systems. |
| Content | Covered are the lower three layer of the OSI reference model: the physical, the data link, and the network layer. The basic terms of information theory are introduced. After this, we focus on the methods for the point to point communication, which may be addressed elegantly and coherently in the signal space. Methods for error detection and correction as well as protocols for the retransmission of perturbed data will be covered. Also the medium access for systems with shared medium will be discussed. Finally, algorithms for routing and flow control will be treated. |
| Lecture notes | Lecture Slides. |

| 227-0225-00L | Linear System Theory | W    | 6 credits | 5G    | M. Kamgarpour    |
| Abstract | The class is intended to provide a comprehensive overview of the theory of linear dynamical systems, their use in control, filtering, and estimation and their applications to areas ranging from avionics to systems biology. |
| Objective | By the end of the class students should be comfortable with the fundamental results in linear system theory and the mathematical tools used to derive them. |
### Lecture notes

**Prerequisites / notice**

Prerequisites: Control Systems I (227-0103-00) or equivalent and sufficient mathematical maturity.

**Content**

<table>
<thead>
<tr>
<th>Lecture notes</th>
<th>227-0523-00L</th>
<th>Railway Systems I</th>
<th>W</th>
<th>6 credits</th>
<th>4G</th>
<th>M. Meyer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>Basic characteristis of railway vehicles and their interfaces with the railway infrastructure:</td>
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<tr>
<td>Objective</td>
<td>- Transportation tasks and vehicle types</td>
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<td></td>
<td>- Running dynamics</td>
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<td></td>
<td>- Mechanical part of rail vehicles</td>
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<td></td>
<td>- Brakes</td>
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<td></td>
<td>- Traction chain and auxiliary supply</td>
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<td></td>
<td>- Railway power supply</td>
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<td></td>
<td>- Signalling systems</td>
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<td></td>
<td>- Traffic control and maintenance</td>
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<tr>
<td>Content</td>
<td>EST I (Frühjahrsemester) - Begriffen, Grundlagen, Merkmale</td>
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<tr>
<td>1. Einführung:</td>
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<tr>
<td>1.1 Geschichte und Struktur des Bahnsystems</td>
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<td>1.2 Fahrdynamik</td>
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<td>2. Vollbahnfahrzeuge:</td>
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<tr>
<td>2.1 Mechanik: Kasten, Drehgestelle, Lauftechnik, Adhäsion</td>
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<td>2.2 Bremsen</td>
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<td>2.3 Traktionsantriebssysteme</td>
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<td>2.4 Hilfsbetriebe und Komfortanlagen</td>
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<td>2.5 Steuerung und Regelung</td>
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<td>3 Infrastruktur:</td>
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<tr>
<td>3.1 Fahrweg</td>
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<td>3.2 Bahnstromversorgung</td>
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<tr>
<td>3.3 Sicherungsanlagen</td>
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<tr>
<td>4 Betrieb:</td>
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<tr>
<td>4.1 Interoperabilität, Normen und Zulassung</td>
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<td>4.2 RAMS, LCC</td>
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<tr>
<td>4.3 Anwendungsbeispiele</td>
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</tbody>
</table>

Voraussichtlich ein oder zwei Gastvorträge

**Prerequisites**

- Control Systems I (227-0103-00) or equivalent

**Content**

<table>
<thead>
<tr>
<th>Lecture notes</th>
<th>227-0618-00L</th>
<th>Modeling, Characterization and Reliability of Power Semiconductors</th>
<th>W</th>
<th>6 credits</th>
<th>4G</th>
<th>M. P. M. Ciappa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>This lecture provides theoretical and experimental knowledge on the techniques for the characterization and numerical modeling of power semiconductors, as well on the related built-in reliability strategies.</td>
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<tr>
<td>Objective</td>
<td>The students shall get acquainted with the most important concepts and techniques for characterization, numerical modeling and built-in reliability of modern power semiconductor devices. This knowledge is intended to provide the future engineer with the theoretical background and tools for the design of dependable power devices and systems.</td>
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<tr>
<td>Content</td>
<td>This lecture consists of a theoretical part (50%) and of laboratory exercises and demonstrations (50%). The theoretical part covers the basic techniques and procedures for characterization, modeling and built-in reliability of modern power semiconductor devices with special attention to MOS and IGBT. The starting part on technology provides an overview on the main device families and includes a review of the most relevant application-oriented aspects of the device physics, thermal management, and packaging. The second section deals with the basic experimental characterization techniques for the definition of the semiconductor material properties, electrical characteristics, safe operating area, and junction temperature of the devices. The following section introduces the basic principles for electrical, thermal, and electro-thermal simulation of power semiconductors by Technology Computed Aided Design (TCAD) and compact modeling. Finally, procedures are methods are presented to implement efficient built-in reliability programs targeted on power semiconductors. They include failure physics, dedicated failure analysis techniques, accelerated testing, defect screening, and lifetime modeling. During the laboratory activities, selections of the experimental techniques presented in the lecture are demonstrated on the base of realistic examples. Furthermore, schematic power devices will be simulated by the students with advanced TCAD tools and circuit simulators.</td>
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<tr>
<td>Lecture notes</td>
<td>Handouts to the lecture (approx. 250 pp.)</td>
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</table>
Introduction to process automation and its application in process industry and power generation

R. D'Andrea

2V+1U
4 credits


Prerequisites / notice
Exercises: Tuesday 15-16

Practical exercises will illustrate some topics, e.g. some control software coding using industry standard programming tools based on IEC61131-3.

Globalization of markets increases global competition and requires enterprises to continuously improve their performance to sustainably survive. Engineers substantially contribute to the success of an enterprise provided they understand and follow fundamental international market forces, economic basics and operational business management.

The goal of the lecture is to get a basic understanding of international market mechanisms and their consequences for a successful enterprise. Students will learn by practical examples how to analyze international markets, competition as well as customer needs and how they convert into a successful portfolio an enterprise offers to the global market. They will understand the basics of international business management, why efficient organizations and effective business processes are crucial for the successful survival of an enterprise and how all this can be implemented.

The first part of the course provides an overview about the development of international markets, the expected challenges and the players in the market. The second part is focusing on the economic aspects of an enterprise, their importance for the long term success and how to effectively manage an international business. Based on these fundamentals the third part of the course explains how an innovative product portfolio of a company can be derived from considering the most important external factors and which consequences in respect of product innovation, competitive product pricing, organization and business processes emerge. Each part of the course includes practical examples to demonstrate the procedure.

The lecture will be held in three blocks each of them on a Saturday. Each block will focus on one of the three main topics of the course. Between the blocks the students will work on specific case studies to deepen the subject matter. About two weeks after the third block a written examination will be conducted.

Introduction to Dynamic Programming and Optimal Control. Covers the fundamental concepts of Dynamic Programming & Optimal Control.

Dynamic Programming Algorithm; Deterministic Systems and Shortest Path Problems; Infinite Horizon Problems, Bellman Equation; Deterministic Continuous-Time Optimal Control.

Requirements: Knowledge of advanced calculus, introductory probability theory, and matrix-vector algebra.

Lecturers
M. Kamgarpour
W. Hofbauer

Prerequisites / notice
Prerequisites: Control Systems I (227-0103-00) or equivalent and sufficient mathematical maturity.

Phonetics and automation philosophy, RT-UML.

Analysis and design of open loop control problems: discrete automata, decision tables, petri-nets, drive control and object oriented function group automation philosophy, RT-UML.

Engineering: Application programming in IEC61131-3 (function blocks, sequence control, structured text); process visualization and operation; engineering integration from sensor, cabling, topology design, function, visualization, diagnosis, to documentation; Industry standards (e.g. OPC, Profibus); Ergonomic design, safety (IEC61508) and availability, supervision and diagnosis.

Practical examples from process industry, power generation and newspaper production.

Slides will be available as .PDF documents, see “Learning materials” (for registered students only)

Practical exercises will illustrate some topics, e.g. some control software coding using industry standard programming tools based on IEC61131-3.

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These core subjects are particularly recommended for the field of “Systems and Control”.

Number Title Type ECTS Hours Lecturers
227-0563-00L Dynamic Programming and Optimal Control W 4 credits 2V+1U R. D’Andrea

227-0697-00L Industrial Process Control W 4 credits 3G G. Maier, A. Horch

227-0225-00L Linear System Theory W 6 credits 5G M. Kamgarpour

227-0697-00L Industrial Process Control W 4 credits 3G G. Maier, A. Horch

/core subjects
Prerequisites / notice

Exercises: Tuesday 15-16

Practical exercises will illustrate some topics, e.g. some control software coding using industry standard programming tools based on IEC61131-3.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0563-01L</td>
<td>Dynamic Programming and Optimal Control</td>
<td>W</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>R. D'Andrea</td>
</tr>
</tbody>
</table>

Abstract
Introduction to Dynamic Programming and Optimal Control.

Objective
Covers the fundamental concepts of Dynamic Programming & Optimal Control.

Content
- Dynamic Programming Algorithm; Deterministic Systems and Shortest Path Problems; Infinite Horizon Problems, Bellman Equation; Deterministic Continuous-Time Optimal Control.

Literature
- Requirements: Knowledge of advanced calculus, introductory probability theory, and matrix-vector algebra.

Recommended Subjects

These courses are recommended, but you are free to choose courses from any other special field. Please consult your tutor.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>227-0102-00L</td>
<td>Discrete Event Systems</td>
<td>W</td>
<td>6 credits</td>
<td>4G</td>
<td>L. Thiele, L. Vanbever, R. Wattenhofer</td>
</tr>
</tbody>
</table>

Abstract
Introduction to discrete event systems. We start out by studying popular models of discrete event systems. In the second part of the course we analyze discrete event systems from an average-case and from a worst-case perspective.

Objective
- Over the past few decades the rapid evolution of computing, communication, and information technologies has brought about the proliferation of new dynamic systems. A significant part of activity in these systems is governed by operational rules designed by humans. The dynamics of these systems is characterized by asynchronous occurrences of discrete events, some controlled (e.g. hitting a keyboard key, sending a message), some not (e.g. spontaneous failure, packet loss).

- The mathematical arsenal centered around differential equations that has been employed in systems engineering to model and study processes governed by the laws of nature is often inadequate or inappropriate for discrete event systems. The challenge is to develop new modeling frameworks, analysis techniques, design tools, testing methods, and optimization processes for this new generation of systems.

- In this lecture we give an introduction to discrete event systems. We start out the course by studying popular models of discrete event systems, such as automata and Petri nets. In the second part of the course we analyze discrete event systems. We first examine discrete event systems from an average-case perspective: we model discrete events as stochastic processes, and then apply Markov chains and queuing theory for an understanding of the typical behavior of a system. In the last part of the course we analyze discrete event systems from a worst-case perspective using the theory of online algorithms and adversarial queuing.

Content
- 1. Introduction
- 2. Automata and Languages
- 3. Smarter Automata
- 4. Specification Models
- 5. Stochastic Discrete Event Systems
- 6. Worst-Case Event Systems
- 7. Network Calculus

Lecture notes
Available

Literature
- [bertsekas] Data Networks
  Dimitri Bertsekas, Robert Gallager
- [borodin] Online Computation and Competitive Analysis
  Allan Borodin, Ran El-Yaniv
  Cambridge University Press, 1998
- [boudec] Network Calculus
  J.-Y. Le Boudec, P. Thiran
  Springer, 2001
- [cassandras] Introduction to Discrete Event Systems
  Christos Cassandras, Stéphane Lafortune
- [fEt] Online Algorithms: The State of the Art
  A. Fiat and G. Woeginger
  D. Hochbaum
- [schickinger] Diskrete Strukturen (Band 2: Wahrscheinlichkeitstheorie und Statistik)
  T. Schickinger, A. Steger
  Springer, Berlin, 2001
- [sipser] Introduction to the Theory of Computation
  Michael Sipser

227-0447-00L Image Analysis and Computer Vision W 6 credits 3V+1U L. Van Gool, O. Gökşel, E. Konukoglu

Abstract

Objective
Overview of the most important concepts of image formation, perception and analysis, and Computer Vision. Gaining own experience through practical computer and programming exercises.
The first part of the course starts off from an overview of existing and emerging applications that need computer vision. It shows that the realm of image processing is no longer restricted to the factory floor, but is entering several fields of our daily life. First it is investigated how the parameters of the electromagnetic waves are related to our perception. Also the interaction of light with matter is considered. The most important hardware components of technical vision systems, such as cameras, optical devices and illumination sources are discussed. The course then turns to the steps that are necessary to arrive at the discrete images that serve as input to algorithms. The next part describes necessary preprocessing steps of image analysis, that enhance image quality and/or detect specific features. Linear and non-linear filters are introduced for that purpose. The course will continue by analyzing procedures allowing to extract additional types of basic information from multiple images, with motion and depth as two important examples. The estimation of image velocities (optical flow) will get due attention and methods for object tracking will be presented. Several techniques are discussed to extract three-dimensional information about objects and scenes. Finally, approaches for the recognition of specific objects as well as object classes will be discussed and analyzed.

Lecture notes
Course material, Script, computer demonstrations, exercises and problem solutions

Prerequisites / notice
Basic concepts of mathematical analysis and linear algebra. The computer exercises are based on Linux and C.

The course language is English.

227-052-00L Power System Analysis

Abstract
The goal of this course is understanding the stationary and dynamic problems in electrical power systems. The course includes the development of stationary models of the electrical network, their mathematical representation and special characteristics and solution methods of large linear and non-linear systems of equations related to electrical power networks.

Objective
The goal of this course is understanding the stationary and dynamic problems in electrical power systems. The course includes the development of stationary models of the electrical network, their mathematical representation and special characteristics and solution methods of large linear and non-linear systems of equations related to electrical power networks.

Content
The electrical power transmission system, the energy management system, requirements of the electrical power transmission (demand oriented, operationally, economically), network planning and network operation, models of N-port network components (line, cables, shunts, transformers), the p.u. computation, computer oriented network models, linear networks (solution methods - direct, iterative), algorithms for the solution of non-linear sets of equations, derived from the electrical power system (Newton-Raphson), power flow computation (problem definition, solution methods), three phase short-circuit computation, application of power flow algorithms. Introduction to power system stability.

Lecture notes
Lecture notes. Course is supported by WWW-teaching system.

227-0689-00L System Identification

Abstract
Theory and techniques for the identification of dynamic models from experimentally obtained system input-output data.

Objective
To provide a series of practical techniques for the development of dynamical models from experimental data, with the emphasis being on the development of models suitable for feedback control design purposes. To provide sufficient theory to enable the practitioner to understand the trade-offs between model accuracy, data quality and data quantity.

Content
Introduction to modeling: Black-box and grey-box models; Parametric and non-parametric models; ARX, ARMAX (etc.) models. Predictive, open-loop, black-box identification methods. Time and frequency domain methods. Subspace identification methods.

Literature

Prerequisites / notice
Control systems (227-0216-00L) or equivalent.

227-0945-00L Cell and Molecular Biology for Engineers I

This course is part I of a two-semester course.

Abstract
The course gives an introduction into cellular and molecular biology, specifically for students with a background in engineering. The focus will be on the basic organization of eukaryotic cells, molecular mechanisms and cellular functions. Textbook knowledge will be combined with results from recent and technological innovations in biology.

Objective
After completing this course, engineering students will be able to apply their previous training in the quantitative and physical sciences to modern biology. Students will also learn the principles how biological models are established, and how these models can be tested.

Content
Lectures will include the following topics: DNA, chromosomes, RNA, protein, genetics, gene expression, membrane structure and function, vesicular traffic, cellular communication, energy conversion, cytoskeleton, cell cycle, cellular growth, apoptosis, autophagy, cancer, development and stem cells.

In addition, three journal clubs will be held, where one/two publications will be discussed (part I: 1 Journal club, part II: 2 Journal Clubs). For each journal club, students (alone or in groups of up to three students) have to write a summary and discussion of the publication. These written documents will be graded and count as 25% for the final grade.

Lecture notes
Scripts of all lectures will be available.

Literature

151-0104-00L Uncertainty Quantification for Engineering & Life

Abstract
Quantification of uncertainties in computational models pertaining to applications in engineering and life sciences. Exploitation of massively available data to develop computational models with quantifiable predictive capabilities. Applications of Uncertainty Quantification and Propagation to problems in mechanics, control, systems and cell biology.

Objective
The course will teach fundamental concept of Uncertainty Quantification and Propagation (UQ+P) for computational models of systems in Engineering and Life Sciences. Emphasis will be placed on practical and computational aspects of UQ+P including the implementation of relevant algorithms in multilcore architectures.

Content
Topics that will be covered include: Uncertainty quantification under parametric and non-parametric modelling uncertainty, Bayesian inference with model class assessment, Markov Chain Monte Carlo simulation, prior and posterior reliability analysis.

Lecture notes
The class will be largely based on the book: Data Analysis: A Bayesian Tutorial by Devinderjit Sivia as well as on class notes and related literature that will be distributed in class.
### Literature
1. Data Analysis: A Bayesian Tutorial by Devinderjit Sivia
2. Probability Theory: The Logic of Science by E. T. Jaynes
3. Class Notes

### Prerequisites / notice
Fundamentals of Probability, Fundamentals of Computational Modeling

### 151-0532-00L Nonlinear Dynamics and Chaos I

| W | 4 credits | 2V+2U | G. Haller, F. Kogelbauer |

**Abstract**
Basic facts about nonlinear systems; stability and near-equilibrium dynamics; bifurcations; dynamical systems on the plane; non-autonomous dynamical systems; chaotic dynamics.

**Objective**
This course is intended for Masters and Ph.D. students in engineering sciences, physics and applied mathematics who are interested in the behavior of nonlinear dynamical systems. It offers an introduction to the qualitative study of nonlinear physical phenomena modeled by differential equations or discrete maps. We discuss applications in classical mechanics, electrical engineering, fluid mechanics, and biology. A more advanced Part II of this class is offered every other year.

**Content**
1. Basic facts about nonlinear systems: Existence, uniqueness, and dependence on initial data.
2. Near equilibrium dynamics: Linear and Lyapunov stability
3. Bifurcations of equilibria: Center manifolds, normal forms, and elementary bifurcations
4. Nonlinear dynamical systems on the plane: Phase plane techniques, limit sets, and limit cycles.
5. Time-dependent dynamical systems: Floquet theory, Poincare maps, averaging methods, resonance

**Lecture notes**
The class lecture notes will be posted electronically after each lecture. Students should not rely on these but prepare their own notes during the lecture.

**Prerequisites / notice**
- Prerequisites: Analysis, linear algebra and a basic course in differential equations.
- Exam: two-hour written exam in English.
- Homework: A homework assignment will be due roughly every other week. Hints to solutions will be posted after the homework due dates.

### 151-0573-00L System Modeling

| W | 4 credits | 2V+2U | G. Ducard, C. Onder |

**Abstract**

**Objective**

**Content**
Introduction to generic system modeling approaches for control-oriented models based on first principles and on experimental data. Examples: mechatronic, thermodynamic, chemistry, fluid dynamic, energy, and process engineering systems. Model scaling, linearization, order reduction, and balancing. Estimation techniques (least-squares methods). Class case studies: Loud-speaker, Water-propelled rocket, geostationary satellites, etc.

**Lecture notes**
The handouts in English will be sold in the first lecture.

**Literature**
A list of references is included in the handouts.

### 151-0601-00L Theory of Robotics and Mechatronics

| W | 4 credits | 3G | P. Korba, S. Stoeter, B. Nelson |

**Abstract**
This course provides an introduction and covers the fundamentals of the field, including rigid motions, homogeneous transformations, forward and inverse kinematics of multiple degree of freedom manipulators, velocity kinematics, motion planning, trajectory generation, sensing, vision, and control. It's a requirement for the Robotics Vertiefung and for the Masters in Mechatronics and Microsystems.

**Objective**
Robotics is often viewed from three perspectives: perception (sensing), manipulation (affecting changes in the world), and cognition (intelligence). Robotic systems integrate aspects of all three of these areas. This course provides an introduction to the theory of robotics, and covers the fundamentals of the field, including rigid motions, homogeneous transformations, forward and inverse kinematics of multiple degree of freedom manipulators, velocity kinematics, motion planning, trajectory generation, sensing, vision, and control. This course is a requirement for the Robotics Vertiefung and for the Masters in Mechatronics and Microsystems.

**Content**
An introduction to the theory of robotics, and covers the fundamentals of the field, including rigid motions, homogeneous transformations, forward and inverse kinematics of multiple degree of freedom manipulators, velocity kinematics, motion planning, trajectory generation, sensing, vision, and control.

**Lecture notes**
The handouts will be available.

**Literature**
The course will be taught in English.

### 151-0563-01L Dynamic Programming and Optimal Control

| W | 4 credits | 2V+1U | R. D’Andrea |

**Abstract**
Introduction to Dynamic Programming and Optimal Control.

**Objective**
Covers the fundamental concepts of Dynamic Programming & Optimal Control.

**Content**
Dynamic Programming Algorithm; Deterministic Systems and Shortest Path Problems; Infinite Horizon Problems, Bellman Equation; Deterministic Continuous-Time Optimal Control.

**Literature**

**Prerequisites / notice**
Requirements: Knowledge of advanced calculus, introductory probability theory, and matrix-vector algebra.

### 376-1219-00L Rehabilitation Engineering II: Rehabilitation of Sensory and Vegetative Functions

| W | 3 credits | 2V | R. Riener, R. Gassert, L. Marchal Crespo |

**Abstract**
Rehabilitation Engineering is the application of science and technology to ameliorate the handicaps of individuals with disabilities to reintegrate them into society. The goal is to present classical and new rehabilitation engineering principles applied to compensate or enhance motor, sensory, and cognitive functions. Focus is on the restoration and treatment of the human sensory and vegetative system.

**Objective**
Provide knowledge on the anatomy and physiology of the human sensory system, related dysfunctions and pathologies, and how rehabilitation engineering can provide sensory restoration and substitution.

This lecture is independent from Rehabilitation Engineering I. Thus, both lectures can be visited in arbitrary order.
Introduction, problem definition, overview
Rehabilitation of visual function
- Anatomy and physiology of the visual sense
- Technical aids (glasses, sensor substitution)
- Retina and cortex implants
Rehabilitation of hearing function
- Anatomy and physiology of the auditory sense
- Hearing aids
- Cochlea Implants
Rehabilitation and use of kinesthetic and tactile function
- Anatomy and physiology of the kinesthetic and tactile sense
- Tactile/haptic displays for motion therapy (incl. electrical stimulation)
- Role of displays in motor learning
Rehabilitation of vestibular function
- Anatomy and physiology of the vestibular sense
- Rehabilitation strategies and devices (e.g. BrainPort)
Rehabilitation of vegetative Functions
- Cardiac Pacemaker
- Phrenic stimulation, artificial breathing aids
- Bladder stimulation, artificial sphincter
- Brain stimulation and recording
- Deep brain stimulation for patients with Parkinson, epilepsy, depression
- Brain-Computer Interfaces

Literature
Introductory Books:


Selected Journal Articles and Web Links:


Prerequisites / notice
VideoTact, ForeThought Development, LLC. http://my.execpc.com/?dwysocki/videotac.html

Target Group:
Students of higher semesters and PhD students of
- D-MAVT, D-ITET, D-INFK, D-HEST
- Biomedical Engineering, Robotics, Systems and Control
- Medical Faculty, University of Zurich

Students of other departments, faculties, courses are also welcome
This lecture is independent from Rehabilitation Engineering I. Thus, both lectures can be visited in arbitrary order.
4V+2U

W

Mathematical Optimization

Failures have to be avoided by proper design, material selection and manufacturing. Properties, degradation mechanisms, and expected U. Sennhauser


Computational Systems Biology

Introduction to basic techniques and problems in mathematical optimization, and their applications to problems in engineering.

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

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

Information about relevant literature will be given in the lecture.

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

<table>
<thead>
<tr>
<th>401-3901-00L</th>
<th>Mathematical Optimization</th>
<th>W</th>
<th>11 credits</th>
<th>4V+2U</th>
<th>R. Weismantel</th>
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<tbody>
<tr>
<td>Objective</td>
<td>Advanced optimization theory and algorithms.</td>
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<tr>
<td>Content</td>
<td>1. Linear optimization: The geometry of linear programming, the simplex method for solving linear programming problems, Farkas' Lemma and infeasibility certificates, duality theory of linear programming.</td>
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<td>3. Integer optimization: Ties between linear and integer optimization, total unimodularity, complexity theory, cutting plane theory.</td>
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<td>4. Combinatorial optimization: Network flow problems, structural results and algorithms for matroids, matchings and, more generally, independence systems.</td>
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<tr>
<th>636-0007-00L</th>
<th>Computational Systems Biology</th>
<th>W</th>
<th>6 credits</th>
<th>3V+2U</th>
<th>J. Stelling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>Study of fundamental concepts, models and computational methods for the analysis of complex biological networks. Topics: Systems approaches in biology, biology and reaction network fundamentals, modeling and simulation approaches (topological, probabilistic, stoichiometric, qualitative, linear / nonlinear ODEs, stochastic), and systems analysis (complexity reduction, stability, identification).</td>
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<tr>
<td>Objective</td>
<td>The aim of this course is to provide an introductory overview of mathematical and computational methods for the modeling, simulation and analysis of biological networks.</td>
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<tr>
<td>Content</td>
<td>Biology has witnessed an unprecedented increase in experimental data and, correspondingly, an increased need for computational methods to analyze this data. The explosion of sequenced genomes, and subsequently, of bioinformatics methods for the storage, analysis and comparison of genetic sequences provides a prominent example. Recently, however, an additional area of research, captured by the label &quot;Systems Biology&quot;, focuses on how networks, which are more than the mere sum of their parts' properties, establish biological functions. This is essentially a task of reverse engineering. The aim of this course is to provide an introductory overview of corresponding computational methods for the modeling, simulation and analysis of biological networks.</td>
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<td>We will start with an introduction into the basic units, functions and design principles that are relevant for biology at the level of individual cells. Making extensive use of example systems, the course will then focus on methods and algorithms that allow for the investigation of biological networks with increasing detail. These include (i) graph theoretical approaches for revealing large-scale network organization, (ii) probabilistic (Bayesian) network representations, (iii) structural network analysis based on reaction stoichiometries, (iv) qualitative methods for dynamic modeling and simulation (Boolean and piece-wise linear approaches), (v) mechanistic modeling using ordinary differential equations (ODEs) and finally (vi) stochastic simulation methods.</td>
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Subjects of General Interest

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>227-0377-00L</td>
<td>Physics of Failure and Failure Analysis of Electronic Devices and Equipment</td>
<td>W</td>
<td>3 credits</td>
<td>2V</td>
<td>U. Sennhauser</td>
</tr>
<tr>
<td>Abstract</td>
<td>Failures have to be avoided by proper design, material selection and manufacturing. Properties, degradation mechanisms, and expected lifetime of materials are introduced and the basics of failure analysis and analysis equipment are presented. Failures will be demonstrated experimentally and the opportunity is offered to perform a failure analysis with advanced equipment in the laboratory.</td>
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<td>Objective</td>
<td>Introduction to the degradation and failure mechanisms and causes of electronic components, devices and systems as well as to methods and tools of reliability testing, characterization and failure analysis.</td>
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<td>Content</td>
<td>Summary of reliability and failure analysis terminology; physics of failure: materials properties, physical processes and failure mechanisms; failure analysis of ICs, PCBs, opto-electronics, discrete and other components and devices; basics and properties of instruments; application in circuit design and reliability analysis.</td>
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<tr>
<td>Lecture notes</td>
<td>Comprehensive copy of transparencies</td>
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<tr>
<td>363-0790-00L</td>
<td>Technology Entrepreneurship</td>
<td>W</td>
<td>2 credits</td>
<td>2V</td>
<td>U. Claesson, B. Clarysse</td>
</tr>
<tr>
<td>Abstract</td>
<td>Technology ventures are significantly changing the global economic picture. Technological skills increasingly need to be complemented by entrepreneurial understanding. This course offers the fundamentals in theory and practice of entrepreneurship in new technology ventures. Main topics covered are success factors in the creation of new firms, including founding, financing and growing a venture.</td>
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<tr>
<td>Objective</td>
<td>A critical understanding of dos and don'ts is provided through highlighting and discussing real life examples and cases.</td>
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<tr>
<td>Content</td>
<td>See course website: <a href="http://www.entrepreneurship.ethz.ch/sresources/courses/tech-entrepreneurship.html">http://www.entrepreneurship.ethz.ch/sresources/courses/tech-entrepreneurship.html</a></td>
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<tr>
<td>Lecture notes</td>
<td>See comprehensive slides. Please see course website for more information.</td>
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<tr>
<td>151-0317-00L</td>
<td>Visualization, Simulation and Interaction - Virtual Reality II</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>A. Kunz</td>
</tr>
<tr>
<td>Abstract</td>
<td>This lecture provides deeper knowledge on the possible applications of virtual reality, its basic technology, and future research fields. The goal is to provide a strong knowledge on Virtual Reality for a possible future use in business processes.</td>
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<tr>
<td>Objective</td>
<td>Virtual Reality can not only be used for the visualization of 3D objects, but also offers a wide application field for small and medium enterprises (SME). This could be for instance an enabling technology for net-based collaboration, the transmission of images and other data, the interaction of the human user with the digital environment, or the use of augmented reality systems. The goal of the lecture is to provide a deeper knowledge of today's VR environments that are used in business processes. The technical background, the algorithms, and the applied methods are explained more in detail. Finally, future tasks of VR will be discussed and an outlook on ongoing international research is given.</td>
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</table>
Introduction into Virtual Reality; basics of augmented reality; interaction with digital data, tangible user interfaces (TUI); basics of simulation; compression procedures of image-, audio-, and video signals; new materials for force feedback devices; introduction into data security; cryptography; definition of free-form surfaces; digital factory; new research fields of virtual reality.

Lecture notes
The handout is available in German and English.

Prerequisites / notice
Prerequisites:
"Visualization, Simulation and Interaction - Virtual Reality I" is recommended.

Didactical concept:
The course consists of lectures and exercises.

Semester Projects

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-1101-00L</td>
<td>How to Write Scientific Texts in Engineering Sciences</td>
<td>E-</td>
<td>0</td>
<td></td>
<td>J. Leuthold</td>
</tr>
<tr>
<td></td>
<td>Strongly recommended prerequisite for Semester Projects and Master Theses at D-ITET (MSc BME, MSc EEIT, MSc EST).</td>
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</table>

Abstract
The 4 hour lecture covers the basics of writing & presenting a scientific text. The focus will be on the structure and elements of a scientific text and not on the language. After rules, good practice of scientific writing and an overview on software tools will be part of the training. The lecture will be thought on two afternoons. Some exercises will be built into the lecture.

Objective
Knowledge on structure and content of a scientific text. The course further is arranged to stimulate a discussion on how to properly write a legible scientific text versus writing an interesting novel. We will further discuss the practice of properly citing and critically reflect on recent plagiarism allegations.

Content
* Topic 1: Structure of a Scientific Text (The Title, the author list, the abstract, State-of-the-Art, the “in this paper” paragraph, the scientific part, the summary, Equations, Figures).

  * Topic 2: Power Point Presentations.

  * Topic 3: Citation Rules and Citation Software.

  * Topic 4: Guidelines for Research Integrity.

Literature
ETH "Citation Etiquette", see www.plagiate.ethz.ch.


Prerequisites / notice
Students should already have a Bachelor degree and plan to do either a semester project or a master thesis in the immediate future.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>227-1572-01L</td>
<td>Semester Project (Nr 1)</td>
<td>W</td>
<td>8</td>
<td>20A</td>
<td>Supervisors</td>
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<tr>
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<td>Registration in mystudies required! Supervisor must be a professor at D-ITET or associated, see <a href="https://www.ee.ethz.ch/studies/main-master/projects-and-master-thesis.html">https://www.ee.ethz.ch/studies/main-master/projects-and-master-thesis.html</a></td>
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</table>

Abstract
Semester projects are designed to train the students for independent scientific work. A project uses the student's technical and social skills acquired during the master's program. The semester project comprises 280 hours of work and is supervised by a professor.

Objective
see above

Prerequisites / notice
Supervisor must be a professor at D-ITET or associated, see https://www.ee.ethz.ch/studies/main-master/projects-and-master-thesis.html

<table>
<thead>
<tr>
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<th>Lecturers</th>
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<tr>
<td>227-1572-02L</td>
<td>Semester Project (Nr 2)</td>
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<td>Registration in mystudies required! Supervisor must be a professor at D-ITET or associated, see <a href="https://www.ee.ethz.ch/studies/main-master/projects-and-master-thesis.html">https://www.ee.ethz.ch/studies/main-master/projects-and-master-thesis.html</a></td>
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Abstract
Semester projects are designed to train the students for independent scientific work. A project uses the student's technical and social skills acquired during the master's program. The semester project comprises 280 hours of work and is supervised by a professor.

Objective
see above

GESS Science in Perspective
Recommended Science in Perspective (Type B) for D-ITET

see Science in Perspective: Type A: Enhancement of Reflection Capability

see Science in Perspective: Language Courses ETH/UZH

Industrial Internship

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<tbody>
<tr>
<td>227-1550-00L</td>
<td>Internship in Industry Only for Electrical Engineering and Information Technology MSc.</td>
<td>Z</td>
<td>0</td>
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<td>external organisers</td>
</tr>
</tbody>
</table>

Abstract
The main objective of the 12-week internship is to expose master's students to the industrial work environment. During this period, students have the opportunity to be involved in on-going projects at the host institution.

Objective
see above

Master’s Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>227-1101-00L</td>
<td>How to Write Scientific Texts in Engineering Sciences</td>
<td>E-</td>
<td>0</td>
<td></td>
<td>J. Leuthold</td>
</tr>
<tr>
<td></td>
<td>Strongly recommended prerequisite for Semester Projects and Master Theses at D-ITET (MSc BME, MSc EEIT, MSc EST).</td>
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</tbody>
</table>
Abstract
The 4 hour lecture covers the basics of writing & presenting a scientific text. The focus will be on the structure and elements of a scientific text and not on the language. Citation rules, good practice of scientific writing and an overview on software tools will be part of the training. The lecture will be thought on two afternoons. Some exercises will be built into the lecture.

Objective
Knowledge on structure and content of a scientific text. The course further is arranged to stimulate a discussion on how to properly write a legible scientific text versus writing an interesting novel. We will further discuss the practice of properly citing and critically reflect on recent plagiarism allegations.

Content
* Topic 1: Structure of a Scientific Text (The Title, the author list, the abstract, State-of-the-Art, the "in this paper" paragraph, the scientific part, the summary, Equations, Figures).
* Topic 2: Power Point Presentations.
* Topic 3: Citation Rules and Citation Software.
* Topic 4: Guidelines for Research Integrity.

Literature
ETH "Citation Etiquette", see www.plagiate.ethz.ch.


Prerequisites / notice
Students should already have a Bachelor degree and plan to do either a semester project or a master thesis in the immediate future.

<table>
<thead>
<tr>
<th>Number</th>
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<tr>
<td>227-1501-00L</td>
<td>Master's Thesis</td>
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<td>30</td>
<td>68D</td>
<td>Supervisors</td>
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<td>Admission only if ALL of the following apply:</td>
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<td></td>
<td>a) bachelor program successfully completed;</td>
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<td></td>
<td>b) acquired (if applicable) all credits from additional</td>
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<td>requirements for admission to master program;</td>
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<td>c) successfully completed both semester projects.</td>
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<td>Note: the conditions above are not applicable to incoming exchange students.</td>
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<td>Registration in mystudies required!</td>
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<tr>
<td></td>
<td>Supervisor must be a professor at D-ITET or associated,</td>
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</table>

Abstract
The Master Program finishes with a 6-months Master Thesis which is directed by a Professor of the Department or a Professor of another Department who is associated with the D-ITET. Students gain the ability to conduct independent scientific research on a specific research problem.

Objective
see above

Prerequisites / notice
Supervisor must be a professor at D-ITET or associated, see https://www.ee.ethz.ch/studies/main-master/projects-and-master-thesis.html

Generally Accessible Seminars and Colloquia

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>227-0919-00L</td>
<td>Knowledge-Based Image Interpretation</td>
<td>Z</td>
<td>0</td>
<td>2S</td>
<td>L. Van Gool</td>
</tr>
<tr>
<td>Abstract</td>
<td>With the lecture series on special topics of Knowledge based image interpretation we sporadically offer special talks.</td>
<td></td>
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<tr>
<td>Objective</td>
<td>To become acquainted with selected, recent results in image analysis and interpretation.</td>
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<tr>
<th>Number</th>
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<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>227-0920-00L</td>
<td>Seminar in Systems and Control</td>
<td>Z</td>
<td>0</td>
<td>1S</td>
<td>F. Dörfler, R. D'Andrea, J. Lygeros, R. Smith</td>
</tr>
<tr>
<td>Abstract</td>
<td>Current topics in Systems and Control presented mostly by external speakers from academia and industry</td>
<td></td>
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<tr>
<td>Objective</td>
<td>see above</td>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>227-0955-00L</td>
<td>Seminar in Electromagnetics, Photonics and Terahertz</td>
<td>Z</td>
<td>3</td>
<td>2K</td>
<td>J. Leuthold</td>
</tr>
<tr>
<td>Abstract</td>
<td>Selected topics of the current research activities at the IEF and closely related institutions are discussed.</td>
<td></td>
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<tr>
<td>Objective</td>
<td>Have an overview on the research activities of the IEF institute.</td>
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<tr>
<th>Number</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>227-0970-00L</td>
<td>Research Topics in Biomedical Engineering</td>
<td>Z</td>
<td>0</td>
<td>2K</td>
<td>M. Rudin, S. Kozerke, K. P. Prüssmann, M. Stampanoni, K. Stephan, J. Vörös</td>
</tr>
<tr>
<td>Abstract</td>
<td>Current topics in Biomedical Engineering presented by speakers from academia and industry.</td>
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<tr>
<td>Objective</td>
<td>see above</td>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>227-0980-00L</td>
<td>Seminar on Biomedical Magnetic Resonance</td>
<td>Z</td>
<td>0</td>
<td>2K</td>
<td>K. P. Prüßmann, S. Kozerke, M. Rudin</td>
</tr>
<tr>
<td>Abstract</td>
<td>Actuel developments and problems of magnetic resonance imaging (MRI)</td>
<td></td>
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<tr>
<td>Objective</td>
<td>Getting insight to advanced topics in Magnetic Resonance Imaging</td>
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</table>

Course Units for Additional Admission Requirements
The courses below are only available for MSc students with additional requirements.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>227-0101-AAL</td>
<td>Discrete-Time and Statistical Signal Processing</td>
<td>E</td>
<td>6</td>
<td>8R</td>
<td>H.A. Loeliger</td>
</tr>
<tr>
<td>Abstract</td>
<td>Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.</td>
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<tr>
<td>Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.</td>
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</tbody>
</table>
Abstract
The course introduces some fundamental topics of digital signal processing with a bias towards applications in communications: discrete-time linear filters, equalization, DFT, discrete-time stochastic processes, elements of detection theory and estimation theory, LMMSE estimation and LMMSE filtering, LMS algorithm, Viterbi algorithm.

Objective
The course introduces some fundamental topics of digital signal processing with a bias towards applications in communications. The two main themes are linearity and probability. In the first part of the course, we deepen our understanding of discrete-time linear filters. In the second part of the course, we review the basics of probability theory and discrete-time stochastic processes. We then discuss some basic concepts of detection theory and estimation theory, as well as some practical methods including LMMSE estimation and LMMSE filtering, the LMS algorithm, and the Viterbi algorithm. A recurrent theme throughout the course is the stable and robust "inversion" of a linear filter.

Content
1. Discrete-time linear systems and filters: state-space realizations, $z$-transform and spectrum, decimation and interpolation, digital filter design, stable realizations and robust inversion.

2. The discrete Fourier transform and its use for digital filtering.

3. The statistical perspective: probability, random variables, discrete-time stochastic processes; detection and estimation: MAP, ML, Bayesian MMSE, LMMSE; Wiener filter, LMS adaptive filter, Viterbi algorithm.

Lecture notes
Lecture Notes.


course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract
Study of concepts and methods for the mathematical description and analysis of dynamical systems. The concept of feedback. Design of control systems for single input - single output and multivariable systems.

Objective
Study of concepts and methods for the mathematical description and analysis of dynamical systems. The concept of feedback. Design of control systems for single input - single output and multivariable systems.

Content

Literature

Prerequisites / notice
MATLAB is used for system analysis and simulation.

Abstract
This course provides a foundation in analog integrated circuit design based on bipolar and CMOS technologies.

Objective
Integrated circuits are responsible for much of the progress in electronics in the last 50 years, particularly the revolutions in the Information and Communications Technologies we witnessed in recent years. Analog integrated circuits play a crucial part in the highly integrated systems that power the popular electronic devices we use daily. Understanding their design is beneficial to both future designers and users of such systems.

The basic elements, design issues and techniques for analog integrated circuits will be taught in this course.

Content
Review of bipolar and MOS devices and their small-signal equivalent circuit models; Building blocks in analog circuits such as current sources, active load, current mirrors, supply independent biasing etc; Amplifiers: differential amplifiers, cascode amplifier, high gain structures, output stages, gain bandwidth product of op-amps; Stability; Comparators; Second-order effects in analog circuits such as mismatch, noise and offset; A/D and D/A converters; Introduction to switched capacitor circuits.

Lecture notes
Handouts of slides. No script but an accompanying textbook is recommended.

Literature
Content:
- discussion of the field equations relevant for high voltage engineering.
- analytical and numerical solutions/solving of this equations, as well as the derivation of the important equivalent circuits for the description of the fields and losses in insulations
- introduction to kinetic theory of gases
- mechanisms of the breakdown in gaseous, liquid and solid insulations, as well as insulation systems
- methods for the mathematical determination of the electric withstand of gaseous, liquid and solid insulations
- application of the expertise on high voltage components
- excursions to manufacturers of high voltage components
- exercise to learn on computer-modeling in high voltage engineering

Lecture notes: Handouts

Literature:

<table>
<thead>
<tr>
<th>Electrical Engineering and Information Technology Master - Key for Type</th>
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<td>O</td>
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<td>W+</td>
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<th>Key for Hours</th>
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<table>
<thead>
<tr>
<th>ECTS</th>
<th>European Credit Transfer and Accumulation System</th>
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<tbody>
<tr>
<td>Special students and auditors need special permission from the lecturers.</td>
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### Compulsory Core Courses

<table>
<thead>
<tr>
<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>151-1633-00L</td>
<td>Energy Conversion</td>
<td>O</td>
<td>4 credits</td>
<td>3G</td>
<td>H. G. Park</td>
</tr>
</tbody>
</table>

  **Abstract**: Fundamentals of Thermal Sciences in association with Energy Conversion.

  **Objective**: To become acquainted and familiarized with basic principles of fundamental thermal sciences (Thermodynamics, Heat Transfer, etc.) as well as their linkage to energy conversion technologies.

  **Content**: Thermodynamics (first and second laws), Heat Transfer (conduction/convection/radiation), Technical Applications.

  **Lecture notes**: Slides will be distributed by e-mail every week.


  **Prerequisites / notice**: This course is intended for students outside of D-MAVT.

| 227-1631-00L   | Energy System Analysis                                               | W     | 4 credits | 3G    | G. Hug, S. Hellweg, F. Noembrini, A. Schlüter |

  **Abstract**: The course provides an introduction to the methods and tools for analysis of energy consumption, energy production and energy flows. Environmental aspects are included as well as economical considerations. Different sectors of the society are discussed, such as electric power, buildings, and transportation. Models for energy system analysis planning are introduced.

  **Objective**: The purpose of the course is to give the participants an overview of the methods and tools used for energy systems analysis and how to use them in simple practical examples.

  **Content**: The course gives an introduction to methods and tools for analysis of energy consumption, energy production and energy flows. Both larger systems, e.g., countries, and smaller systems, e.g., industries, homes, vehicles, are studied. The tools and methods are applied to various problems during the exercises. Different conventions of energy statistics used are introduced.

  The course provides also an introduction to energy systems models for developing scenarios of future energy consumption and production. Bottom-up and Top-Down approaches are addressed and their features and applications discussed.

  The course contains the following parts:

  - Part I: Energy flows and energy statistics
  - Part II: Environmental impacts
  - Part III: Electric power systems
  - Part IV: Energy in buildings
  - Part V: Energy in transportation
  - Part VI: Energy systems models

  **Lecture notes**: Handouts


| 227-0122-00L   | Introduction to Electric Power Transmission: System & Technology      | O     | 6 credits | 4G    | C. Franck, G. Hug      |

  **Abstract**: Introduction to theory and technology of electric power transmission systems.

  **Objective**: At the end of this course, the student will be able to: describe the structure of electric power systems, name the most important components and describe what they are needed for, apply models for transformers and lines, explain the technology of overhead power lines, calculate stationary power flows, current and voltage transients and other basic parameters in simple power systems.

  **Content**: Structure of electric power systems, transformer and power line models, analysis of and power flow calculation in basic systems, symmetrical and unsymmetrical three-phase systems, transient current and voltage processes, technology and principle of electric power systems.

  **Lecture notes**: Lecture script in English, exercises and sample solutions, translation of important vocabulary: english-german.

### Elective Core Courses

These courses are particularly recommended, other ETH-courses from the field of Energy Science and Technology at large may be chosen in accordance with your tutor.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>101-0577-00L</td>
<td>An Introduction to Sustainable Development in the Built Environment</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>G. Habert</td>
</tr>
</tbody>
</table>

  **Abstract**: This year the UN Conference in Paris will shape future world objectives to tackle climate change. This course provides an introduction to the notion of sustainable development when applied to our built environment.
At the end of the semester, the students have an understanding of the term of sustainable development, its history, the current political and scientific discourses and its relevance for our built environment.

In order to address current challenges of climate change mitigation and resource depletion, students will learn a holistic approach of sustainable development. Ecological, economical and social constraints will be presented and students will learn about methods for argumentation and tools for assessment (i.e. life cycle assessment).

For this purpose an overview of sustainable development is presented with an introduction to the history of sustainability and its today definition as well as the role of cities, urbanisation and material resources (i.e. energy, construction material) in social economic and environment aspects.

The course aims to promote an integral view and understanding of sustainability and describing different spheres (social/cultural, ecological, economical, and institutional) that influence our built environment.

Students will acquire critical knowledge and understand the role of involved stakeholders, their motivations and constraints, learn how to evaluate challenges, identify deficits and define strategies to promote a more sustainable construction.

After the course students should be able to define the relevance of specific local, regional or territorial aspects to achieve coherent and applicable solutions toward sustainable development.

The course offers an environmental, socio-economic and socio-technical perspective focussing on buildings, cities and their transition to resilience with sustainable development. Students will learn on theory and application of current scientific pathways towards sustainable development.

The following topics give an overview of the themes that are to be worked on during the lecture.

- Overview on the history and emergence of sustainable development
- Overview on the current understanding and definition of sustainable development
- Case Study 1: Sustainable construction, the role of construction industry (national/international)
- Case Study 2: Cities, forms of settlements
- Case Study 3: Material resources, scenarios, energy, construction materials, urban metabolism
- Case Study 4: Buildings, heating/cooling, consumers, prosumers and other stakeholder, cooperations
- Method 1: Life cycle assessment (planning, construction, operation/use, deconstruction)
- Method 2: Economics for sustainable construction
- Method 3: Construction, flexibility, modularity
- Synthesis 1: Climate Change mitigation and adaptation in cities
- Synthesis 2: Transition to sustainable development

All relevant information will be online available before the lectures. For each lecture slides of the lecture will be provided.

A final exam evaluates the acquired knowledge individually.

Lab reports for all attended experiments have to be submitted by the study groups.

Research areas of the participating institutes (fluid dynamics, energy technology, process engineering) are attended by students in small groups.

Fundamentals of scientific documentation & reporting.

In-class introduction to representative measurement techniques in the research areas of the participating institutes (fluid dynamics, energy technology, process engineering).

Student participation in 8-10 laboratory experiments (study groups of 3-5 students, dependent on the number of course participants and available experiments)

Lab reports for all attended experiments have to be submitted by the study groups.

A final exam evaluates the acquired knowledge individually.

Presentations, handouts and instructions are provided for each experiment.


Basic understanding in the following areas:
- fluid mechanics, thermodynamics, heat and mass transfer
- electrical engineering / electronics
- numerical data analysis and processing (e.g. using MATLAB)

Physical fundamentals of the fission reaction and the sustainable chain reaction, thermal design, construction, function and operation of nuclear reactors and power plants, light water reactors and other reactor types, conversion and breeding

Students get an overview on energy conversion in nuclear power plants, on construction and function of the most important types of nuclear reactors with special emphasis to light water reactors. They obtain the mathematical/physical basis for quantitative assessments concerning most relevant aspects of design, dynamic behaviour as well as material and energy flows.

Nuclear physics of fission and chain reaction. Thermodynamics of nuclear reactors. Design of the reactor core. Introduction into the dynamic behaviour of nuclear reactors. Overview on types of nuclear reactors, difference between thermal reactors and fast breeders. Construction and operation of nuclear power plants with pressurized and boiling water reactors, role and function of the most important safety systems, special features of the energy conversion.

Hand-outs will be distributed. Additional literature and information on the website of the lab: https://www.ethz.ch/content/specialinterest/mavt/energy-technology/lab-of-nuclear-energy-systems/en/studium/teaching-materials/151-0163-00l-nuclear-energy-conversion.html


R. L. Murray: Nuclear Energy (Sixth Edition), An Introduction to the Concepts, Systems, and Applications of Nuclear Processes, Elsevier
Understand the principles, and learn the design procedures and the behaviour of turbomachines.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
<th>Semester</th>
<th>Instructor</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0567-00L</td>
<td>Engine Systems</td>
<td>W 4</td>
<td>6 credits</td>
<td>C. Onder</td>
</tr>
<tr>
<td>151-0569-00L</td>
<td>Vehicle Propulsion Systems</td>
<td>W 4</td>
<td>6 credits</td>
<td>C. Onder, P. Elbert</td>
</tr>
<tr>
<td>227-0247-00L</td>
<td>Power Electronic Systems I</td>
<td>W 6</td>
<td>6 credits</td>
<td>J. W. Kolar</td>
</tr>
<tr>
<td>227-0523-00L</td>
<td>Railway Systems I</td>
<td>W 6</td>
<td>6 credits</td>
<td>M. Meyer</td>
</tr>
</tbody>
</table>

**Objective**

**Abstract**

**Content**

**Lecture notes**

**Prerequisites / notice**

---

**Introduction to Modeling and Control of Internal Combustion Engine Systems**

- Physical description and mathematical models of components and subsystems (mixture formation, load control, supercharging, emissions, drive train components, etc.).
- Case studies of model-based optimal design and control of engine systems with the goal of minimizing fuel consumption and emissions.

**Lecture notes**

- Introduction to Modeling and Control of Internal Combustion Engine Systems
- Guzzella Lino, Onder Christopher H.
- ISBN: 978-3-642-10774-0

**Prerequisites / notice**

- Combined homework and testbench exercise (air-to-fuel-ratio control or idle-speed control) in groups

---

**Power Electronic Systems I**

- Basics of the switching behavior, gate drive and snubber circuits of power semiconductors are discussed. Soft-switching and resonant DC/DC converters are analyzed in detail and high frequency loss mechanisms of magnetic components are explained. Space vector modulation of three-phase inverters is introduced and the main power components are designed for typical industry applications.

**Objective**

- Detailed understanding of the principle of operation and modulation of advanced power electronics converter systems, especially of zero voltage switching and zero current switching non-isolated and isolated DC/DC converter systems and three-phase voltage DC link inverter systems.
- Furthermore, the course should convey knowledge on the switching frequency related losses of power semiconductors and inductive power components and introduce the concept of space vector calculus which provides a basis for the comprehensive discussion of three-phase PWM converters systems in the lecture Power Electronic Systems II.

**Content**

- Basics of the switching behavior and gate drive circuits of power semiconductor devices and auxiliary circuits for minimizing the switching losses are explained. Furthermore, zero voltage switching, zero current switching, and resonant DC/DC converters are discussed in detail: the operating behavior of isolated full-bridge DC/DC converters is detailed for different secondary side rectifier topologies; high frequency loss mechanisms of magnetic components of converter circuits are explained and approximate calculation methods are presented; the concept of space vector calculus for analyzing three-phase systems is introduced; finally, phase-oriented and space vector modulation of three-phase inverter systems are discussed related to voltage DC link inverter systems and the design of the main power components based on analytical calculations is explained.

**Lecture notes**

- Lecture notes and associated exercises including correct answers, simulation program for interactive self-learning including visualization/animation features.

**Prerequisites / notice**

- Prerequisites: Introductory course on power electronics.
Content

EST I (Frühjahrsemester) - Begriffen, Grundlagen, Merkmale

1 Einführung:
1.1 Geschichte und Struktur des Bahnsystems
1.2 Fahrdynamik

2 Vollbahnfahrzeuge:
2.3 Mechanik: Kasten, Drehgestelle, Lauftechnik, Adhäsion
2.2 Bremsen
2.3 Traktionsantriebssysteme
2.4 Hilfsbetriebe und Komfortanlagen
2.5 Steuerung und Regelung

3 Infrastruktur:
3.1 Fahrweg
3.2 Bahnstromversorgung
3.3 Sicherungsanlagen

4 Betrieb:
4.1 Interoperabilität, Normen und Zulassung
4.2 RAMS, LCC
4.3 Anwendungsbeispiele

Voraussichtlich ein oder zwei Gastreferate

Geplante Exkursionen:
Betriebszentrale SBB, Zürich Flughafen
Reparatur und Unterhalt, SBB Zürich Altstetten
Fahrzeugfertigung, Stadler Bussnang

Prerequisites / notice

Dozent: Dr. Markus Meyer, Emkamatik GmbH

Voraussichtlich ein oder zwei Gastvorträge von anderen Referenten.

EST I (Herbstsemester) kann als in sich geschlossene einsemestrige Vorlesung besucht werden. EST II (Frühjahrsemester) dient der weiteren Vertiefung der Fahrzeugtechnik und der Integration in die Bahninfrastruktur.

227-0526-00L Power System Analysis W 6 credits 4G G. Hug

Abstract
The goal of this course is understanding the stationary and dynamic problems in electrical power systems. The course includes the development of stationary models of the electrical network, their mathematical representation and special characteristics and solution methods of large linear and non-linear systems of equations related to electrical power networks.

Objective
The goal of this course is understanding the stationary and dynamic problems in electrical power systems. The course includes the development of stationary models of the electrical network, their mathematical representation and special characteristics and solution methods of large linear and non-linear systems of equations related to electrical power networks.

Content
The electrical power transmission system, the energy management system, requirements of the electrical power transmission (demand oriented, operationally, economically), network planning and network operation, models of N-port network components (line, cables, shunts, transformers), the p.u. computation, computer oriented network models, linear networks (solution methods - direct, iterative), algorithms for the solution of non-linear sets of equations, derived from the electrical power system (Newton-Raphson), power flow computation (problem definition, solution methods), three phase short-circuit computation, application of power flow algorithms. Introduction to power system stability.

Lecture notes
Lecture notes. Course is supported by WWW-teaching system.

227-0731-00L Power Market I - Portfolio and Risk Management W 6 credits 4G D. Reichelt, G. A. Koeppe

Abstract
Portfolio and risk management in the electrical power business, Pan-European power market and trading, futures and forward contracts, hedging, options and derivatives, performance indicators for the risk management, modelling of physical assets, cross-border trading, ancillary services, balancing power market, Swiss market model

Objective
Content
1. Pan-European power market and trading
1.1. Power trading
1.2. Development of the European power markets
1.3. Energy economics
1.4. Spot and OTC trading
1.5. European energy exchange EEX

2. Market model
2.1. Market place and organisation
2.2. Balance groups / balancing energy
2.3. Ancillary services
2.4. Market for ancillary services
2.5. Cross-border trading
2.6. Capacity auctions

3. Portfolio and Risk management
3.1. Portfolio management 1 (introduction)
3.2. Forward and futures contracts
3.3. Risk management 1 (m2m, VaR, hpfc, volatility, cVaR)
3.4. Risk management 2 (PaR)
3.5. Contract valuation (HPFC)
3.6. Portfolio management 2
3.7. Risk Management 3 (enterprise wide)

4. Energy & Finance I
4.1. Options 1 basics
4.2. Options 2 hedging with options
4.3. Introduction to derivatives (swaps, cap, floor, collar)
4.4. Financial modelling of physical assets
4.5. Trading and hydro power
4.6. Incentive regulation

Prerequisites / notice
Handouts of the lecture
1 excursion per semester, 2 case studies, guest speakers for specific topics.
Course Moodle: https://moodle-app2.let.ethz.ch/course/view.php?id=2196

Lecture notes
Handouts of the lecture

227-0759-00L International Business Management for Engineers W 3 credits 2V W. Hofbauer
Abstract
Globalization of markets increases global competition and requires enterprises to continuously improve their performance to sustainably survive. Engineers substantially contribute to the success of an enterprise provided they understand and follow fundamental international market forces, economic basics and operational business management.

Objective
The goal of the lecture is to get a basic understanding of international market mechanisms and their consequences for a successful enterprise. Students will learn by practical examples how to analyze international markets, competition as well as customer needs and how they convert into a successful portfolio an enterprise offers to the global market. They will understand the basics of international business management, why efficient organizations and effective business processes are crucial for the successful survival of an enterprise and how all this can be implemented.

Content
The first part of the course provides an overview about the development of international markets, the expected challenges and the players in the market. The second part is focusing on the economic aspects of an enterprise, their importance for the long term success and how to effectively manage an international business. Based on these fundamentals the third part of the course explains how an innovative product portfolio of a company can be derived from considering the most important external factors and which consequences in respect of product innovation, competitive product pricing, organization and business processes emerge. Each part of the course includes practical examples to demonstrate the procedure.

Lecture notes
A script is provided for this lecture.

Prerequisites / notice
Between the blocks the students will work on specific case studies to deepen the subject matter. About two weeks after the third block a written examination will be conducted.

529-0193-00L Renewable Energy Technologies I W 4 credits 3G A. Wokaun, A. Steinfeld
Abstract
The lectures Renewable Energy Technologies I (529-0193-00L) and Renewable Energy Technologies II (529-0191-01L) can be taken independently from one another.

Objective
Scenarios for world energy demand and CO2 emissions, implications for climate. Methods for the assessment of energy chains. Potential and technology of renewable energies: Biomass (heat, electricity, biofuels), solar energy (low temp. heat, solar thermal and photovoltaic electricity, solar chemistry), Wind and ocean energy, heat pumps, geothermal energy, energy from waste. CO2 sequestration.

Content
Scenarios for the development of world primary energy consumption are introduced. Students know the potential and limitations of renewable energies for reducing CO2 emissions, and their contribution towards a future sustainable energy system that respects climate protection goals.

Lecture notes
Lecture notes will be distributed electronically during the course.

Literature

Prerequisites / notice
Fundamentals of chemistry, physics and thermodynamics are a prerequisite for this course.

Topics are available to carry out a Project Work (Semesterarbeit) on the contents of this course.

★★★ Other Elective Courses

Number Title Type ECTS Hours Lecturers
**Advanced Environmental Assessments**

Master students in Environmental Engineering choosing module Ecological Systems Design are not allowed to enrol 102-0317-00 Advanced Environmental Assessments (SKP) as already included in 102-0307-01 Advanced Environmental, Social and Economic Assessments (SKP).

**Abstract**
This course deepens students' knowledge of the environmental assessment methodologies and their various applications.

**Objective**
This course has the aim of deepening students' knowledge of the environmental assessment methodologies and their various applications. In particular, students completing the course should have the
- Ability to judge the scientific quality and reliability of environmental assessment studies, the appropriateness of inventory data and modelling, and the adequacy of life cycle impact assessment models and factors
- Knowledge about the current state of the scientific discussion and new research developments
- Ability to properly plan, conduct and interpret environmental assessment studies
- Knowledge of how to use LCA as a decision support tool for companies, public authorities, and consumers

**Content**
- Inventory developments, transparency, data quality, data completeness, and data exchange formats
- Allocation (multioutput processes and recycling)
- Hybrid LCA methods.
- Consequential and marginal analysis
- Recent development in impact assessment
- Spatial differentiation in Life Cycle Assessment
- Workplace and indoor exposure in Risk and Life Cycle Assessment
- Uncertainty analysis
- Subjectivity in environmental assessments
- Multicriteria analysis
- Case Studies

**Lecture notes**
No script. Lecture slides and literature will be made available on the lecture homepage.

**Literature**
Literature will be made available on the lecture homepage.

**Prerequisites / notice**
Basic knowledge of environmental assessment tools is a prerequisite for this class. Students that have not done classwork in this topic before are required to read an appropriate textbook before or at the beginning of this course (e.g. Jolliet, O et al. 2016: Environmental Life Cycle Assessment. CRC Press, Boca Raton - London - New York. ISBN 978-1-4398-8766-0 (Chapters 2-5.2)).

**Implementation of Environmental and other Sustainability Goals**

Master students in Environmental Engineering choosing module Ecological Systems Design are not allowed to enrol 102-0327-01 Implementation of Environmental and other Sustainability Goals (2KP) as already included in 102-0307-01 Advanced Environmental, Social and Economic Assessments (SKP).

**Abstract**
How to make sustainability operational - in industry, services and other organizations: You will learn how to put sustainability into practice by integrating environmental, social and economic aspects into organisations' management and processes. The course contains both a management view, as well as a sustainability view - and how to combine them.

**Objective**
To provide understanding of how sustainability can be made operational in an organisation. To do so, students will understand how to answer a given question with target oriented methodologies using various software programs and data sources for env. assessment

**Content**
We meet for five 3-hour-lectures, with discussions and case studies during course time. Additionally, small case studies in-between courses will be given at most course days.

Course topics are:
- Sustainable Development and its meaning for Management
- Management Standards for Sustainability (ISO and others)
- Sustainability Opportunities and Innovation
- Organisation and Implementation
- The concept of 'Continuous Improvement'
- Environmental Performance Measurement (Concepts, Standards, Methods)
- Life Cycle Costing, Life Cycle Management
- (Sustainable) Supply Chain Management
- Communication of Sustainability Issues

**Lecture notes**
Course documentation as well as case study descriptions will be provided during the course via the "ilias" repository.
The lecture deals with constitutive models that are relevant for design and calculation of structures. These include anisotropic linear continuum mechanics. Basic theories for structure integrity calculations are presented with focus on strength, stability, fatigue and elasto-plastic structural analysis. Theories and models for one dimensional and planar structures are presented based on energy theorems.

1. Basic problem of continuum mechanics and energy principles: structural theories, homogenization theories; finite elements; fracture mechanics.
2. Structural theories for planar structures and stability; plane-stress, plate theory, buckling of plates (non-linear plate theory).
3. Strength of material theories and material properties: ductile behaviour, plasticity, von Mises, Tresca, principal stress criterion; brittle behaviour; viscoplastic behaviour, creep resistance.
4. Structural design: fatigue and dynamic structural analysis.

Lecture notes

151-0360-00L Procedures for the Analysis of Structures

Abstract
Basic theories for structure integrity calculations are presented with focus on strength, stability, fatigue and elasto-plastic structural analysis. Theories and models for one dimensional and planar structures are presented based on energy theorems.

Objective
Basic principles applied in structural mechanics. Introduction to the theories of planar structures. Development of an understanding of the relationship between material properties, structural theories and design criteria.

Content
1. Basic problem of continuum mechanics and energy principles: structural theories, homogenization theories; finite elements; fracture mechanics.
2. Structural theories for planar structures and stability; plane-stress, plate theory, buckling of plates (non-linear plate theory).
3. Strength of material theories and material properties: ductile behaviour, plasticity, von Mises, Tresca, principal stress criterion; brittle behaviour; viscoplastic behaviour, creep resistance.
4. Structural design: fatigue and dynamic structural analysis.

Lecture notes

151-0524-00L System Modeling

Abstract
The lecture deals with constructive models that are relevant for design and calculation of structures. These include anisotropic linear elasticity, linear viscoelasticity, plasticity, viscoplasticity. Homogenization theories and laminate theory are presented. Theoretical models are complemented by examples of engineering applications and experiments.

Objective
Basic theories for solving continuum mechanics problems of engineering applications, with particular attention to material models.

Content

Lecture notes

151-0573-00L Embedded Control Systems

Abstract
This course provides a comprehensive overview of embedded control systems. The concepts introduced are implemented and verified on a microprocessor-controlled haptic device.

Objective
Familiarize students with main architectural principles and concepts of embedded control systems.

Content
An embedded system is a microprocessor used as a component in another piece of technology, such as cell phones or automobiles. In this intensive two-week block course the students are presented the principles of embedded digital control systems using a haptic device as an example for a mechatronic system. A haptic interface allows for a human to interact with a computer through the sense of touch.

Subjects covered in lectures and practical lab exercises include:
- The application of C-programming on a microprocessor
- Digital I/O and serial communication
- Quadrature decoding for wheel position sensing
- Queued analog-to-digital conversion to interface with the analog world
- Pulse width modulation
- Timer interrupts to create sampling time intervals
- System dynamics and virtual worlds with haptic feedback
- Introduction to rapid prototyping

Lecture notes

A list of references is included in the handouts.

151-0593-00L Rate-Controlled Separations in Fine Chemistry

Abstract
The students are supposed to obtain detailed insight into the fundamentals of separation processes that are frequently applied in modern life science processes in particular, fine chemistry and biotechnology.

Prerequisites / notice
If you have specific interests or questions, let me know at arthurb@ethz.ch. Maybe I can include your issues - or I can't :-)

Literature
There are two ways to approach the course's issues:

1. Procedures for the Analysis of Structures
2. System Modeling
3. Embedded Control Systems
4. Rate-Controlled Separations in Fine Chemistry

Lecture notes

1. Procedures for the Analysis of Structures
2. System Modeling
3. Embedded Control Systems
4. Rate-Controlled Separations in Fine Chemistry

Prerequisites / notice
If you have specific interests or questions, let me know at arthurb@ethz.ch. Maybe I can include your issues - or I can't :-)

Data: 06.03.2019 12:57
Autumn Semester 2016
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Objective: The students are supposed to obtain detailed insight into the fundamentals of separation processes that are frequently applied in modern life science processes in particular, fine chemistry and biotechnology.

Content: The class covers separation techniques that are central in the purification and downstream processing of chemicals and biopharmaceuticals. Examples from both areas illustrate the utility of the methods: 1) Liquid-liquid extraction; 2) Adsorption and chromatography; 3) Membrane processes; 4) Crystallization and precipitation.

Lecture notes: Handouts during the class

Literature: Recommendations for text books will be covered in the class.

Prerequisites / notice: Requirements: Thermal separation Processes I (151-0926-00) and Modelling and mathematical methods in process and chemical engineering (151-0940-00)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Capacity</th>
<th>Instructor(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0951-00L</td>
<td>Process Design and Safety</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>P. Rudolf von Rohr</td>
</tr>
<tr>
<td>Abstract</td>
<td>Process design and safety deals with the fundamentals of process apparatus, plant design and safety.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Objective</td>
<td>The goal of the lecture is to expound design characteristics of systems for process engineering applications.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Content</td>
<td>Fundamentals of plant and apparatus design; materials in the process industries, mechanical design and design rules of main components; pumps and fans; piping and armatures, safety in process industry</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lecture notes</td>
<td>Script is available, english slides will be distributed</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

363-0387-00L Corporate Sustainability | W | 3 credits | 2G | V. Hoffmann |

Abstract: The lectures addresses the assessment of corporate sustainability and its links to strategy, technology, and finance. Students learn why sustainability matters for managers and how businesses can act towards it. E-modules allow students to train critical thinking skills. In the 2nd half of the semester, sustainability challenges on water, energy, mobility, and food are explored in group projects.

Objective: Understand the limits and the potential of corporate sustainability for sustainable development

Content: Be able to recognize and realize opportunities for corporate sustainability in a business environment

Overview of the key concepts of corporate sustainability and topics related to Water, Energy, Mobility, and Food

Business implications of sustainable development, in particular for the assessment of sustainability performance, strategic change towards sustainability, technological innovations and sustainability, and finance and corporate sustainability.

Critical thinking skills for corporate sustainability.

In-depth case studies of corporate sustainability challenges in the track phase: How to deal with environmental pressure groups? How to use the strengths of business to solve pressing sustainability problems? How to catalyze technological innovations for sustainability? How to invest money in a sustainable way?

Lecture notes: Presentation slides will be made available on moodle prior to lectures.

Literature: Literature recommendations will be distributed during the lecture

<table>
<thead>
<tr>
<th>Course Code</th>
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<th>Credits</th>
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<th>Instructor(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-0537-00L</td>
<td>Resource and Environmental Economics</td>
<td>3 credits</td>
<td>2G</td>
<td>L. Bretschger, A. Brausmann</td>
</tr>
</tbody>
</table>
| Abstract | Relationship between economy and environment, market failure, external effects and public goods, contingent valuation, internalisation of externalities; economics of non-renewable resources, economics of renewable resources, cost-benefit analysis, sustainability, and international aspects of resource and environmental economics.

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

Topics are:

Introduction to resource and environmental economics
Importance of resource and environmental economics
Main issues of resource and environmental economics
Normative basis
Utilitarianism
Fairness according to Rawls
Economic growth and environment
Externalities in the environmental sphere
Governmental internalisation of externalities
Private internalisation of externalities: the Coase theorem
Free rider problem and public goods
Types of public policy
Efficient level of pollution
Tax vs. permits
Command and Control Instruments
Empirical data on non-renewable natural resources
Optimal price development: the Hotelling-rule
Effects of exploration and Backstop-technology
Effects of different types of markets.
Biological growth function
Optimal depletion of renewable resources
Social inefficiency as result of over-use of open-access resources
Cost-benefit analysis and the environment
Measuring environmental benefit
Measuring costs
Concept of sustainability
Technological feasibility
Conflicts sustainability / optimality
Indicators of sustainability
Problem of climate change
Cost and benefit of climate change
Climate change as international ecological externality
International climate policy: Kyoto protocol
Implementation of the Kyoto protocol in Switzerland

Data: 06.03.2019 12:57 Autumn Semester 2016 Page 547 of 1571
This course encompasses the theoretical principles of chemical process simulation, as well as its practical application in process analysis and optimization. The techniques for simulating stationary and dynamic processes are presented, and illustrated with case studies. Commercial software packages are presented as a key engineering tool for solving process flowsheeting and simulation problems.

**Objective**

This course aims to develop the competency of chemical engineers in process flowsheeting and simulation. Specifically, students will develop the following skills:

- Deep understanding of chemical engineering fundamentals: the acquisition of new concepts and the application of previous knowledge in the area of chemical process systems and their mechanisms are crucial to intelligently simulate and evaluate processes.
- Modelling of general chemical processes and systems: students have to be able to identify the boundaries of the system to be studied and develop the set of relevant mathematical relations, which describe the process behavior.
- Mathematical reasoning and computational skills: the familiarization with mathematical algorithms and computational tools is essential to be capable of achieving rapid and reliable solutions to simulation and optimization problems. Hence, students will learn the mathematical principles necessary for process simulation and optimization, as well as the structure and application of process simulation software. Thus, they will be able to develop criteria to correctly use commercial software packages and critically evaluate their results.

**Content**

Overview of process simulation and flowsheeting

- Definition and fundamentals
- Classification: stationary (steady-state) versus dynamic (transient state) systems
- Fields of application
- Case studies

Process modeling

- Modeling strategies of process systems
- Mass conservation
- Species balance
- Energy conservation
- Momentum balance
- Multiphase-systems: equilibrium & non-equilibrium models
- Process system model

Process simulation

- Process specification
- Introduction to process specification
- Classification of mathematical models: AMS, DOE, DAE, PDE
- Model validation
- Software tools
- Solution methods for process flowsheeting
- Simultaneous methods
- Sequential methods
- Dynamic simulation
- Numerical solution: explicit and implicit methods
- Continuous-discrete simulation: handling of discontinuities

Process optimization and analysis

- Classification of optimization problems
- Linear programming
- Non-linear programming
- Dynamic programming
- Optimization methods in process flowsheeting
- Sequential methods
- Simultaneous methods

Commercial software for simulation: Aspen Plus

- Thermodynamic property methods
- Reaction and reactors
- Separation / columns
- Convergence & debugging

**Prerequisites / notice**

A basic understanding of material and energy balances, thermodynamic property methods and typical unit operations (e.g., reactors, flash separations, distillation/absorption columns etc.) is required.

**Literature**

An exemplary literature list is provided below:

The 4 hour lecture covers the basics of writing & presenting a scientific text. The focus will be on the structure and elements of a scientific text.

* Topic 1: Structure of a Scientific Text (The Title, the author list, the abstract, State-of-the-Art, the "in this paper" paragraph, the scientific text and not on the language. Citation rules, good practice of scientific writing and an overview on software tools will be part of the training.

* Topic 2: Power Point Presentations.

* Topic 3: Citation Rules and Citation Software.

* Topic 4: Guidelines for Research Integrity.

The lecture will be thought on two afternoons. Some exercises will be built into the lecture.

**Objective**

Knowledge on structure and content of a scientific text. The course further is arranged to stimulate a discussion on how to properly write a legible scientific text versus writing an interesting novel. We will further discuss the practice of properly citing and critically reflect on recent plagiarism allegations.

**Content**

- Topic 1: Structure of a Scientific Text (The Title, the author list, the abstract, State-of-the-Art, the "in this paper" paragraph, the scientific part, the summary, Equations, Figures).

- Topic 2: Power Point Presentations.

- Topic 3: Citation Rules and Citation Software.

- Topic 4: Guidelines for Research Integrity.

**Literature**

ETH "Citation Etiquette", see www.plagiate.ethz.ch.


**Prerequisites / notice**

Students should already have a Bachelor degree and plan to do either a semester project or a master thesis in the immediate future.

**Multidisciplinary Courses**

With the consent of the tutor, the students are free to choose individually from the entire course offer of ETH Zürich.

**Semester Project**

The lecture Energy and Mobility imparts profound knowledge on how to reduce energy in mobility systems. Both Engineering science and social science aspects are integrated, as technological potentials, policy tools, and human decision making behaviour are combined in order to assess how to reduce energy demand for transport.

**Objective**

The main objectives of this lecture are:

(i) Students gain profound knowledge on how to frame problems related to the reduction of energy demand (or greenhouse gas emissions) of mobility (sub-)systems.

(ii) Students have an overview on the most relevant technological potentials (fuel-based and vehicle-based).

(iii) Students can assess whether a given reduction goal is ambitious or not, and whether given policy tools are adequate to reach the defined reduction goal.

**Content**

The lecture deals with the intersection of energy and transportation with focus on motorized individual transport. The lecture will be thought on two afternoons. Some exercises will be built into the lecture.

- Status quo and Scope: Definition of the system boundary (whole transport system, or only road transport) and of the status quo of that system (energy demand and energy carrier mix for this system, current technology mix, transportation services provided);

- Trends and Targets: Analysis of trend development of the mobility system under consideration, establishment of a trend scenario (baseline scenario). Definition of the reduction targets (expressed in terms of energy demand or greenhouse gas emissions; base year and target year; absolute or relative reduction target)

- Potential Analysis: Analysis of currently employed technologies and of upcoming technologies. Identification of the reduction potential of current, conventional technologies and of future, alternative technologies. Technologies cover both the fuel and the vehicle side.

- Policy Measures: Possible policy measures, direct, indirect and macro-level effects of policies, psychological aspects of decision making, elements of behavioral economics and prospect theory, combination of policies into policy mixes.

- Effects and Side Effects: Forecasting the effects of policy measures, differentiation between effects that can be quantified and those that cannot; Identification of unintended (side) counter-effects like rebound effects and perverse incentives.

**Semester Project**

Registration in mysteries required!

**Abstract**

The semester project is designed to train the students in solving specific problems from the field of Energy Science & Technology. This project uses the technical and social skills acquired during the master's program. The semester project is advised by a professor and must be approved in advance by the tutor.
Objective

see above

► Industrial Internship

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-1650-00L</td>
<td>Internship in Industry</td>
<td>O</td>
<td>8 credits</td>
<td>external organisers</td>
<td></td>
</tr>
</tbody>
</table>

Only for Energy and Technology MSc.

Abstract

The main objective of the 12-week internship is to expose master's students to the industrial work environment. During this period, students have the opportunity to be involved in on-going projects at the host institution.

Objective

see above

► GESS Science in Perspective

see GESS Science in Perspective: Type A: Enhancement of Reflection Capability

see GESS Science in Perspective: Language Courses ETH/UZH

Recommended GESS Science in Perspective (Type B) for D-ITET

► Master's Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-1101-00L</td>
<td>How to Write Scientific Texts in Engineering Sciences</td>
<td>E-</td>
<td>0 credits</td>
<td>J. Leuthold</td>
<td></td>
</tr>
</tbody>
</table>

Strongly recommended prerequisite for Semester Projects and Master Theses at D-ITET (MSc BME, MSc EEIT, MSc EST).

Abstract

The 4 hour lecture covers the basics of writing & presenting a scientific text. The focus will be on the structure and elements of a scientific text and not on the language. Citation rules, good practice of scientific writing and an overview on software tools will be part of the training. The lecture will be thought on two afternoons. Some exercises will be built into the lecture.

Objective

Knowledge on structure and content of a scientific text. The course further is arranged to stimulate a discussion on how to properly write a legible scientific text versus writing an interesting novel. We will further discuss the practice of properly citing and critically reflect on recent plagiarism allegations.

Content

* Topic 1: Structure of a Scientific Text (The Title, the author list, the abstract, State-of-the Art, the “in this paper” paragraph, the scientific part, the summary, Equations, Figures).
* Topic 2: Power Point Presentations.
* Topic 3: Citation Rules and Citation Software.
* Topic 4: Guidelines for Research Integrity.

Literature

ETH “Citation Etiquette”, see www.plagiate.ethz.ch.


Prerequisites / notice

Students should already have a Bachelor degree and plan to do either a semester project or a master thesis in the immediate future.

227-1601-00L | Master's Thesis | O | 30 credits | 40D | Supervisors |

Only students who fulfill the following criteria are allowed to enroll for and start with their master thesis:

a. successful completion of the bachelor program;

b. any additional requirements necessary to gain admission to the master program EST have been successfully completed;

c. both the semester project and the internship have been successfully completed.

Registration in mystudies required!

Abstract

The master program in Energy Science and Technology culminates in a six months research project which addresses a scientific research questions on one's chosen area of specialization. The masters thesis is supervised by a program-affiliated faculty member and the topic must be approved in advance by the tutor.

Objective

see above

Energy Science and Technology Master - Key for Type

<table>
<thead>
<tr>
<th>W</th>
<th>Dr</th>
<th>Suitable for doctorate</th>
</tr>
</thead>
<tbody>
<tr>
<td>E-</td>
<td>O</td>
<td>Compulsory</td>
</tr>
<tr>
<td>Z</td>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
</tbody>
</table>

Key for Hours

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
</tr>
</thead>
<tbody>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
</tr>
</tbody>
</table>

P | practical/laboratory course |
A | independent project |
D | diploma thesis |
R | revision course / private study |

ECTS | European Credit Transfer and Accumulation System |

Special students and auditors need special permission from the lecturers.
Earth Sciences Bachelor

Bachelor Studies (Programme Regulations 2016)

1. Semester

First Year Examinations

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-2001-02L</td>
<td>Chemistry I</td>
<td>O</td>
<td>4</td>
<td>2V+2U</td>
<td>W. Uhlig, J. E. E. Buschmann, S. Canonica, P. Funck, E. C. Meister, R. Verel</td>
</tr>
</tbody>
</table>

Abstract
General Chemistry I: Chemical bond and molecular structure, chemical thermodynamics, chemical equilibrium.

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

Content
1. Stoichiometry
2. Atoms and Elements (Quantenmechanical Model of the Atom)
3. Chemical Bonding
4. Thermodynamics
5. Chemical Kinetics
6. Chemical Equilibrium (Acids and Bases, Solubility Equilibria)

Literature
Online-Skript mit durchgerechneten Beispielen.

401-0251-00L Mathematics I

Abstract
This course covers mathematical concepts and techniques necessary to model, solve and discuss scientific problems - notably through ordinary differential equations.

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

Content
1. Single-Variable Calculus:
   - review of differentiation, linearisation, Taylor polynomials, maxima and minima, antiderivative, fundamental theorem of calculus, integration methods, improper integrals.
   - 2. Linear Algebra and Complex Numbers:
     - systems of linear equations, Gauss-Jordan elimination, matrices, determinants, eigenvalues and eigenvectors, cartesian and polar forms for complex numbers, complex powers, complex roots, fundamental theorem of algebra.
   - 3. Ordinary Differential Equations:
     - separable ordinary differential equations (ODEs), integration by substitution, 1st and 2nd order linear ODEs, homogeneous systems of linear ODEs with constant coefficients, introduction to 2-dimensional dynamical systems.

Literature
- Bretscher, O.: Linear Algebra with Applications (Pearson Prentice Hall).

Prerequisites / notice
Prerequisites: familiarity with the basic notions from Calculus, in particular those of function and derivative.

651-3001-00L Dynamic Earth I

Abstract
Provides a basic introduction into Earth Sciences, emphasizing different rock-types and the geological rock-cycle, as well as introduction into geophysics and plate tectonic theory.

Objective
Understanding basic geological and geophysical processes

Content
Overview of the Earth as a system, with emphasis on plate tectonic theory and the geological rock-cycle. Provides a basic introduction to crystals and minerals and different rock-types. Lectures include processes in the Earth's interior, physics of the earth, planetology, introduction to magmatic, metamorphic and sedimentary rocks. Exercises are conducted in small groups to provide more in depth understanding of concepts and content of the lectures.

Literature

Prerequisites / notice
Exercises and short excursions in small groups (10-15 students) will be lead by student assistants. Specific topics in earth sciences will be discussed using examples and case studies. Hand samples of the major rock types will be described and interpreted. Short excursions in the region of Zurich will permit direct experience with earth science processes (e.g. earth surface processes) and recognition of earth science problems and solutions relevant for modern society (e.g. building materials, water resources). Working in small groups will allow for discussion and examination of actual earth science themes.

First Year Additional Compulsory Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0030-00L</td>
<td>Laboratory Course: Elementary Chemical Techniques</td>
<td>O</td>
<td>3</td>
<td>6P</td>
<td>N. Kober, M. Morbidelli, M. H. Schroth, B. Wehrli</td>
</tr>
</tbody>
</table>

Autumn Semester 2016

Page 551 of 1571
Abstract
This practical course provides an introduction to elementary laboratory techniques. The experiments cover a wide range of techniques, including analytical and synthetic techniques (e.g. investigation of soil and water samples or the preparation of simple compounds). Furthermore, the handling of gaseous substances is practised.

Objective
This course is intended to provide an overview of experimental chemical methods. The handling of chemicals and proper laboratory techniques represent the main learning target. Furthermore, the description and recording of laboratory processes is an essential part of this course.

Content
The classification and analysis of natural and artificial compounds is a key subject of this course. It provides an introduction to elementary laboratory techniques, and the experiments cover a wide range of analytic and synthetic tasks:
Selected samples (e.g. soil and water) will be analysed with various methods, such as filtrations, spectroscopy or ion chromatography. The chemistry of aqueous solutions (acid-base equilibria and solvation or precipitation processes) is studied.

The synthesis of simple inorganic complexes or organic molecules is practised.
Furthermore, the preparation and handling of environmentally relevant gaseous species like carbon dioxide or nitrogen oxides is a central subject of the Praktikum.

Lecture notes
The script will be published on the web. Details will be provided on the first day of the semester.

Literature
A thorough study of all script materials is requested before the course starts.

General Courses in Earth Sciences

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>651-3301-00L</td>
<td>Crystals and Minerals</td>
<td>4 credits</td>
<td>2V+1.5U</td>
<td>P. Brack, E. Reusser</td>
<td></td>
</tr>
<tr>
<td>651-4143-00L</td>
<td>Geobiology</td>
<td>3 credits</td>
<td>2V</td>
<td>T. I. Eglinton</td>
<td></td>
</tr>
</tbody>
</table>

Objective
To understand, qualitatively and semi-quantitatively, crystal and mineral formation, the interdependence between structures, chemical composition and physical properties. This dependence is especially the case for the structural dependence of optical anisotropy and the elastic properties of the minerals as well as for the growth of crystals and their defect structures.

Content
Symmetriken und Ordnung, Punktgruppen, Translationsgruppen, Raumgruppen.

Primary references:
- P. Hanke, A. Plaut: Einführung in die Kristallographie, Universitatsverlag Göttingen.
- M. Schröder: Grundlagen von Thermodynamik und Computersimulationen in der Kristallographie.

Abstract
We will study traces in the lithosphere that have been left behind by organisms in the course of Earth history and mineral components, which were built through biological processes or used as sources of energy and nutrients. Traces of life from the past will be compared with the development of the diversity of and the disparities in today's organisms.

The course will allow students to ask questions about the origin and the evolution of life on Earth, to understand contemporary hypotheses and create new methods of developing them further. Theory is supplemented with observations in the field, exercises and the application of simple mathematical models. The course will enable students to integrate geobiological knowledge into topics that will be taught in subsequent Earth science courses and into the current understanding of Earth history. They will learn to better understand modern geological settings and, if necessary, to recommend biogeochemically well-founded and responsible interventions or protective measures.

Scientific applications of geobiological knowledge are found in fields like Microbial Ecology, Geochemistry, Palaeontology, Sedimentology, Petrology, Ocean Research, Environmental Sciences, Astrobiology and Archaeology.

Applied Case Studies, which supplement and illustrate the contents:
- Application of geological knowledge is found in fields like Microbial Ecology, Geochemistry, Palaeontology, Sedimentology, Petrology, Ocean Research, Environmental Sciences, Astrobiology and Archaeology.
- Practical applications of geological knowledge are needed in fields like environmental remediation, mineral exploration and leaching, forensic and geomedicine.

Lecture notes
Lecture slides, a list with recommended text books, scientific articles and recorded lectures to specific topics will be available in electronic form on the learning management site OLAT. Access requires that participants who are enrolled in MyStudies, will login to the course "Geobiology ETHZ" in OLAT via the switch aai authorisation system.
To understand, qualitatively and semi-quantitatively, crystal and mineral formation, the interdependence between crystals structure, chemical composition and physical properties. This dependence is especially the case for the structural dependence of optical anisotropy and the elastic properties of the minerals as well as for the growth of crystals and their defect structures.

The course builds on the contents of the natural science topics that are parts of the basics, the focus areas and the supplementary courses as required for the Swiss federal Matura (Guidelines for the Swiss Matura Exam, 2012). In order to be able to repeat some of these contents and to better prepare for the course before it starts, one can find links to preparatory material (videoclips) on the Course website on OLAT.

GMT Science in Perspective

Recommended Science in Perspective (Type B) for D-ERDW

see Science in Perspective: Type A: Enhancement of Reflection Capability

Language Courses

see Science in Perspective: Language Courses ETH/UZH

Bachelor Studies (Programme Regulations 2010)

Compulsory Basic Courses II

The general courses in Earth Sciences are offered in the 3rd and 4th semester. Out of 40 offered credits, 35 credits have to be acquired.

Laboratory Course in Physics for Students in Earth Sciences

The central aim is to provide an individual experience of the physical phenomena and the basic principles of the experiment. By conducting simple physical experiments the student will learn how to properly use physical instruments and how to evaluate the results correctly.

The course builds on the contents of the natural science topics that are parts of the basics, the focus areas and the supplementary courses as required for the Swiss federal Matura (Guidelines for the Swiss Matura Exam, 2012). In order to be able to repeat some of these contents and to better prepare for the course before it starts, one can find links to preparatory material (videoclips) on the Course website on OLAT.

Only for Earth Sciences BSc (Programme Regulations

The course builds on the contents of the natural science topics that are parts of the basics, the focus areas and the supplementary courses as required for the Swiss federal Matura (Guidelines for the Swiss Matura Exam, 2012). In order to be able to repeat some of these contents and to better prepare for the course before it starts, one can find links to preparatory material (videoclips) on the Course website on OLAT.
Abstract
Introduction to reading and construction of simple geologic maps. Construction of geological cross-sections. Introduction to Lambert projection and Schmidt net (i.e., stereoplots).

This course is mainly a hands-on-training, where students solve exercises under supervision.

Objective
To improve the ability to understand geological structures in three dimensions and visualize them.

Learn how to read and interpret geological maps, as well as drawing geological cross-sections.

Learn the handling of the Schmidt net, so that students can later plot their own field data.

Content
strike lines, symbols
true and apparent thickness of geological units
true and apparent dip
V-rule
3-Point-Problems
unconformities
faults
introduction to the Lambert projection
folds
magmatic structures

Lecture notes
Exercises and instructions are handed out and are available online in Moodle.

Literature
Semester literature can be found in the ERDW-library.

Prerequisites / notice
This course is not a prerequisite, but nevertheless extremely helpful for the Terrainkurs II.

651-3323-00L Earth and Climate History W+ 3 credits 2G G. Haug
Course will no longer take place after HS16.

Abstract
The goal of the course is to give the students a perception of the major aspects of planetary history and to add to their curiosity about methods which can be applied in the investigations of more specific problems and to planetary features.

Objective

Content
Frühe Geschichte der Erde, der Litho-, Atmo- und Biosphäre; Phanerozoische Platten und Terranes; Entwicklung des Lebens im Phanerozoikum, Mesozoische Anoxia, Kreide-Tertiär-Grenze, Tertiäre Abkühlung, Messian-Salinitätskrise, Hominidenentwicklung, Quartäre Klimaschwankungen.

Lecture notes
Unterlagen werden abgegeben.

Literature

>>> Examination Blocks

>>> Examination Block 1

Number Title Type ECTS Hours Lecturers
402-0063-00L Physics II O 5 credits 3V+1U A. Vaterlaus

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

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

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

Lecture notes
Skript wird verteilt.

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

Douglas C. Giancoli
Physik
3. erweiterte Auflage
Pearson Studium

Hans J. Paus
Physik in Experimenten und Beispielen
Carl Hanser Verlag, München, 2002, 1068 S.

Paul A. Tipler
Physik
Spektrum Akademischer Verlag, 1998, 1522 S., ca Fr. 120.-

David Halliday Robert Resnick Jearl Walker
Physik
Wiley-VCH, 2003, 1388 S., Fr. 87.- (bis 31.12.03)
dazu gratis Online Ressourcen (z.B. Simulationen): www.halliday.de

651-3341-00L Lithosphere O 3 credits 2V S. Wiemer, E. Kissling

Prerequisite: successful completion of Dynamic Earth I and II is mandatory.

Course will no longer take place after HS16.
Abstract
Comprehensive understanding of role and evolution of oceanic and continental lithosphere in global plate tectonics and evolution of earth.
Understanding principles of theoretical and experimental geothermics and fundamentals of mantle and lithosphere rheologies.

Objective
Comprehensive understanding of role and evolution of oceanic and continental lithosphere in global plate tectonics and evolution of earth.
Understanding principles of theoretical and experimental geothermics and fundamentals of mantle and lithosphere rheologies.

Content

Lecture notes
Detailed scriptum in digital form and additional learning moduls (www.lead.ethz.ch) available on intranet.

Literature
see list in scriptum.

Prerequisites / notice
PPT-files of each lecture may be played back for rehearsal on www.lead.ethz.ch.

701-0023-00L
Atmosphere
O
3 credits
2V
H. Wernli, E. M. Fischer, T. Peter

Abstract
Basic principles of the atmosphere, physical structure and chemical composition, trace gases, atmospheric cycles, circulation, stability, radiation, condensation, clouds, oxidation capacity and ozone layer.

Objective
Understanding of basic physical and chemical processes in the atmosphere. Understanding of mechanisms of and interactions between: weather - climate, atmosphere - ocean - continents, troposphere - stratosphere. Understanding of environmentally relevant structures and processes on vastly differing scales. Basis for the modelling of complex interrelations in the atmosphere.

Content
Basic principles of the atmosphere, physical structure and chemical composition, trace gases, atmospheric cycles, circulation, stability, radiation, condensation, clouds, oxidation capacity and ozone layer.

Lecture notes
Written information will be supplied.

Literature
The following methods will be discussed in detail: the radioactive-radiogenic systems Rb-Sr, Sm-Nd, U-Th-Pb and K-Ar, as well as the stable isotope systems of oxygen, carbon, nitrogen, sulfur and hydrogen.

We will discuss how these methods are used in the following research fields: geochemistry of the earth, age dating, paleotemperature reconstructions, evolution of the crust and mantle reservoirs, sediment diagenesis, fluid rock interactions, hydrothermal activity, paleoceanoigraphy, biogeochemical cycles.

**Lecture notes**
Available

**Literature**
- Dickin A. P., Radiogenic Isotope Geology, (2005), Cambridge University Press

William White (2011) Geochemistry
http://www.geo.cornell.edu/geology/classes/geo455/Chapters.HTML

**Prerequisites**

Geochemie I: (Bachelor course)

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### 651-3503-00L Metamorphism

**Abstract**
Understanding of the principles governing (chemical) reactions in metamorphic processes and resulting (physical) properties of metamorphic rocks s.l.; Recognition of metamorphic minerals and rocks (e.g. Gesteinsbestimmung)

**W+** 3 credits 3G M. W. Schmidt

### 651-3505-00L Mineral Resources

**Abstract**
Overview of the geological formation processes and the global distribution of mineral resources (metals, energy resources, bulk materials and industrial minerals), their economic importance, as well as the political and environmental aspects of responsible resource extraction and site rehabilitation.

**Objective**

**Content**
- Vorstellung der Dozierenden mit Fallstudie aus der persönlichen Berufspraxis (CH, RK, WL, FS)
- Ressourcen der Welt und Bedeutung für die Schweiz (RK)  
- Metalliche Erzlagerstätten - Einführung (CH)  
- Metalliche Erzlagerstätten - Magmatische Prozesse (CH)  
- Geothermische Systeme, Oberflächenerzen und Atmosphärentechnologie (CH)  
- Metalliche Erzlagerstätten - Magmatisch-hydrothermale Systeme (CH)  
- Ubricht Rohstoffe - Einführung; Bildungsprozesse Petroleum und Erdgas (WL)  
- Ubricht Rohstoffe - Oel und Gas (WL)  
- Ubricht Rohstoffe - Kohle und CO2-Entsorgung Test 3 (WL/ RK)  
- nichtmetallische Rohstoffe - Baustoffe (RK)  
- nichtmetallische Rohstoffe - Erden (RK/ FS)  
- nichtmetallische Rohstoffe - Industrimaterialien Test 4 (FS)  
- Industriematerialien und nachhaltige Nutzung von Rohstoffen der Erde (FS)

**Lecture notes**
Kursnotizen werden in den Stunden verteilt

**Literature**
- W. Pohl u. a. (2005): Mineralische und Energie-Rohstoffe, Schweizerbart'sche Verlagsbuchhandlung
- Senatskommission für Geowissenschaftliche Gemeinschaftsforschung 2010: Dynamische Erde - Zukunftsaufgaben der Geowissenschaften - Strategie: online to be based on http://www.geokommission.de/Dynamische_Erde.html

**Prerequisites**


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### 651-3521-00L Tectonics

**Abstract**
Comprehensive understanding of evolution, mechanics, and rheology of divergent, convergent and wrenching tectonic systems from the lithospheric scale to local shallow crustal and outcrop-scales. Evaluation of plate tectonic and other orogenic processes through the study of reference examples of taken in Alps-Himalaya orogenic system.

**W+** 3 credits 2V J.P. Burg, E. Kissling

**Objective**
Comprehensive understanding of evolution, mechanics, and rheology of divergent, convergent and wrenching tectonic systems from the lithospheric scale to local shallow crustal and outcrop-scales. Assessment of mechanisms responsible for plate movements (the Earth as a heat transfer machine, dynamics of earth mantle, plate driving forces) and subsequent large-scale structures (oceanic basins and cycle of the oceanic lithosphere, convergence and mountain systems and continental growth, etc) through theoretical and experimental information. Evaluation of plate tectonic and other orogenic processes through the study of reference examples of taken in Alps-Himalaya orogenic system.

**Content**
- Plate tectonic frame work: earth cooling and mantle-plate interaction, three kinds of plate boundaries and their roles and characteristics, cycle of oceanic lithosphere, longevity and growth of continents, supercontinents. 
- Rheology of layered lithosphere and upper mantle. 
- Obduction systems 
- Collisions systems 
- Extensional systems 
- Basin evolution 
- Passive and active continental margin evolution

**Lecture notes**
Detailed scriptum in digital form and additional learning module (www.lead.ethz.ch) available on the intranet.

**Literature**
This course provides the basics of quaternary geology and an overview of the aspects of the hydrogeology of quaternary sediments and karst within Switzerland.

- Become familiar with the processes that formed the landscapes during the last 2 Mio. years.
- Understanding the types of landscape and the forming quaternary sediments.
- Get insight into the role of the quaternary aquifers and apply fundamental hydrogeological techniques.
- Learn about the risk exposure of aquifers and ways to protect
- Familiarize with the concepts for characterization of fractured and karst aquifers

During the Vorlesung will be important data and facts be given and available for download.

- Familiarize with the processes that formed the landscapes during the last 2 Mio. years.
- Understanding the types of landscape and the forming quaternary sediments.
- Get insight into the role of the quaternary aquifers and apply fundamental hydrogeological techniques.
- Learn about the risk exposure of aquifers and ways to protect
- Familiarize with the concepts for characterization of fractured and karst aquifers

Additional material will be provided by the lecturers.
General knowledge of seismology.

These practical courses are mandatory for the BSc specializations "geology" and "geophysics".

Major in Geology: Electives

From the offered elective courses in autumn and spring semester 8 credits must be acquired. Primarily courses from the core courses of BSc Earth Sciences have to be selected. Other elective courses from the ETH and University of Zurich are possible, however they must be granted by the advisor of geology (Professor Stefano Bernasconi). Courses of the paleontology of the University of Zurich (further offer under www.palinst.uzh.ch).

Bachelor's Seminar I
Introduction into different aspects of scientific work. Literature search, structure and content of scientific publications, presentation of scientific findings in talks and posters

Isotope Geochemistry and Isotope Geology
The course focuses on the most important systems of radioactive and stable isotopes used in geochemistry and geology. Applications of isotope geochemistry for solving fundamental geological problems are discussed on the basis of case studies.

Geochemistry I: (Bachelor course)
Understanding of the principles governing (chemical) reactions in metamorphic processes and resulting (physical) properties of metamorphic rocks s.l.. Recognition of metamorphic minerals and rocks (e.g. Gesteinsbestimmung).

Hydrogeology and Quaternary Geology
Understanding of the processes that formed the landscapes during the last 2 Mio. years.

Prozesse während Kaltzeiten (Eisvorstösse, glaziale Erosion) und während Warmzeiten (Sedimentation, fluviatile Erosion) (mit Übungen).

Entwicklungsgeschichte der Täler in den Alpen und im Alpenvorland (mit Übungen).

Altersbestimmungen, Quartärstratigraphische Methoden. Striatgrafie der Tailfyllungen.

Wiederholung Hydrogeologischer Grundlagen.

Grundwasservorkommen der Schweiz (mit Übungen).

Hydrogeologie und Quaternäre Ablagerungen (namentlich fluvio-glaziale Schotter).

Nutzung und Bewirtschaftung der Grundwasservorkommen in quartären Ablagerungen (mit Übungen).

Grundwassernutzung im Hauptsiedlungsraum der Schweiz.

Gefährdung und Schutz der Grundwasservorkommen in quartären Lockergesteinen (mit Übungen).

Einführung in die Hydrogeologie von Kluff- und Karstgrundwasserleitern (mit Übung).

Literature

3G - Become familiar with the processes that formed the landscapes during the last 2 Mio. years.

585-3543-00L Seismology W+ 3 credits 2G D. Giardini, D. Fäh

651-3597-00L Bachelor’s Seminar I W+ 2 credits 2S W. Schatz, J. D. Rickli

651-3501-00L Isotope Geochemistry and Isotope Geology W 3 credits 2G S. Bernasconi, D. Vance

651-3503-00L Metamorphism W 3 credits 3G M. W. Schmidt

651-3523-00L Hydrogeology and Quaternary Geology W 3 credits 2G M. Kleipikova, P. Haldimann, S. Ivy Ochs
3G Advanced analysis of geological maps and construction of geological sections. Special points: normal faults of the Rheintal graben, Bull
Exercises and instructions are handed out. Students are able
Reading and interpretation of geological and climatological maps.
handouts will be distributed during the teaching semester
W
Exploration and Environmental Geophysics
Hours
2P
This course introduces the different parts of the cryosphere - snow, glaciers, sea ice, permafrost - and their role in the climate system. A
A significant physical aspect is the focus in each part. Those completing the course are able to describe the dynamics of cryosphere
components both formally and using examples. Students are able
- to qualitatively describe the main components of the cryosphere and their role in the climate system
- to formally describe the relevant physical processes which determine the state of cryosphere components
Content
Introduction into the different components of the Cryosphere: Snow, glaciers, sea ice and permafrost, and their roles in the climate system.
Each part is used to emphasize on one specific physical aspect: material qualities of ice, mass balance and dynamics of glaciers and energy
balance of sea ice.
Lecture notes
handouts will be distributed during the teaching semester
651-3561-00L Cryosphere
W 3 credits 2V M. Funk, M. Huss, K. Steffen
Abstract
This course introduces the different parts of the cryosphere - snow, glaciers, sea ice, permafrost - and their role in the climate system. A
significant physical aspect is the focus in each part. Those completing the course are able to describe the dynamics of cryosphere
components both formally and using examples. Students are able
- to qualitatively describe the main components of the cryosphere and their role in the climate system
- to formally describe the relevant physical processes which determine the state of cryosphere components
Content
Introduction into the different components of the Cryosphere: Snow, glaciers, sea ice and permafrost, and their roles in the climate system.
Each part is used to emphasize on one specific physical aspect: material qualities of ice, mass balance and dynamics of glaciers and energy
balance of sea ice.
Lecture notes
handouts will be distributed during the teaching semester
651-3527-00L Earth Science Mapping Exercises II
W 2 credits 2P J.P. Burg
Abstract
Reading and interpretation of geological and climatological maps.
Objective
Reading and interpretation of geological and climatological maps.
Content
Advanced analysis of geological maps and construction of geological sections. Special points: normal faults of the Rheintal graben, Bull
Lake West (USA), Val de Ruz, Helvetic nappes of the Säntis area. Reconstruction of the geological history of the map areas. References to
the Geology of Switzerland.
Introduction to generation of climatological maps. Analysis of synoptic scale patterns of air pressure and temperature advection on the
surface and one upper air level. (Hydrostatic) Conclusions about vertical stratification of the atmosphere. Elementary prognostic
interpretation. Inclusion of special actually weather phenomenon.
Lecture notes
Exercises and instructions are handed out.
Literature
Written course documentation available under "Kursunterlagen".
Prerequisites /
requirement: Earth science mapping exercises I
651-3525-00L Introduction to Engineering Geology
W 3 credits 3G S. Löw
Abstract
This introductory course starts from a descriptions of the behavior and phenomena of soils and rocks under near surface loading conditions
and their key geotechnical properties. Lab and field methods for the characterization of soils, rocks and rock masses are introduced. Finally
practical aspects of ground engineering, including tunneling and landslide hazards are presented.
Objective
Understanding the basic geotechnical and geometrical properties and processes of rocks and soils. Understanding the interaction of
rock and soil masses with technical systems. Understanding the fundamentals of geological hazards.
Content
Rock, soil and rock mass: scale effects and fundamental geotechnical properties. Soil mechanical properties and their determination. Rock
mechanical properties and their determination. Fractures: geotechnical properties and their determination. Geotechnical classification of
intact rock, soils and rock masses. Natural and induced stresses in rock and soil. Interaction of soil masses with surface loads, water and
excavations. Slope instability mechanisms and stability analyses. Underground excavation instability mechanisms and rock deformation.
Geological mass wasting processes.
Lecture notes
Written course documentation available under "Kursunterlagen".
Literature

Major in Geophysics
Advisor of the major geophysics is Prof. Taras Gerya.

Major in Geophysics: Core Courses
From the offered core courses in autumn and spring semester, 27 credits have to be acquired.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>651-3541-00L</td>
<td>Exploration and Environmental Geophysics</td>
<td>W+</td>
<td>4</td>
<td>3V</td>
<td>F. Brogini, J. Doetsch</td>
</tr>
</tbody>
</table>

Overview and understanding of the most important geophysical methods: Potential field methods (Gravimetrics and Magnetics), Electrical and electromagnetic methods, Refraction and reflection seismics, Georadar. Discussion of survey design, sources and receivers and data processing.
Objective
Overview and understanding of the most important geophysical methods. Proposed solutions to assess and observe problems relevant to
exploration and environmental geophysics in soil, ice and lithosphere at different scales. Getting familiar with measuring- and interpretation
procedures. Pointing out the possibilities and limitations of geophysical methods.
Content
651-3543-00L  Seismology 3 credits 2G  D. Giardini, D. Fäh
Abstract
Reading and interpretation of geological and climatological maps. Additional material will be provided by the lecturers.

651-3527-00L  Earth Science Mapping Exercises II 2 credits 2P  J.P. Burg
Abstract
Reading and interpretation of geological and climatological maps. Advanced analysis of geological maps and construction of geological sections. Special points: normal faults of the Rheintal graben, Bull Lake West (USA), Val de Ruz, Helvetic nappes of the Säntis area. Reconstruction of the geological history of the map areas. References to the Geology of Switzerland.

651-3525-00L  Introduction to Engineering Geology 3 credits 3G  S. Löw
Abstract
This introductory course starts from a description of the behavior and phenomena of soils and rocks under near surface loading conditions and their key geotechnical properties. Lab and field methods for the characterization of soils, rocks and rock masses are introduced. Finally practical aspects of ground engineering, including tunneling and landslides hazards are presented.

651-3523-00L  Hydrogeology and Quaternary Geology 3 credits 2G  M. Klepikova, P. Haldimann, S. Ivy Ochs
Abstract
This course provides the basics of quaternary geology and an overview of the aspects of the hydrogeology of quaternary sediments and karst within Switzerland.

651-3521-00L  Tectonics 3 credits 2V  J.P. Burg, E. Kissling
Abstract
Comprehensive understanding of evolution, mechanics, and rheology of divergent, convergent and wrenching tectonic systems from the lithospheric scale to local shallow crustal and outcrop-scales. Evaluation of plate tectonic and other orogenic processes through the study of reference examples of taken in Alps-Himalaya orogenic system.
Objective

Comprehensive understanding of evolution, mechanics, and rheology of divergent, convergent and wrenching tectonic systems from the lithospheric scale to local shallow crustal and outcrop-scales. Assessment of mechanisms responsible for plate movements (the Earth as a heat transfer machine, dynamics of earth mantle, plate driving forces) and subsequent large-scale structures (oceanic basins and cycle of the oceanic lithosphere, convergence and mountain systems, and continental growth, etc) through theoretical and experimental information.

Evaluation of plate tectonic and other orogenic processes through the study of reference examples of taken in Alps-Himalaya orogenic system.

Content

Plate tectonic frame work: earth cooling and mantle-plate interaction, three kinds of plate boundaries and their roles and characteristics, cycle of oceanic lithosphere, longevity and growth of continents, supercontinents.

Rheology of layered lithosphere and upper mantle.

Oduction systems

Collisions systems

Extensional systems

Basin evolution

Passive and active continental margin evolution

Lecture notes

Detailed scriptum in digital form and additional learning moduls (www.lead.ethz.ch) available on the intranet.

Literature


651-3505-00L

Mineral Resources

W+ 3 credits 2V C. A. Heinrich, R. Kündig, W. Leu, F. Schenkner

Abstract

Overview of the geological formation processes and the global distribution of mineral resources (metals, energy resources, bulk materials and industrial minerals), their economic importance, as well as the political and environmental aspects of responsible resource extraction and site rehabilitation.

Objective


Literature


Prerequisites / notice

Geochemie I: (Bachelor course)
### Major in Geophysics: Electives

From all elective courses offered in the autumn and spring semester, 12 credits have to be acquired.

<table>
<thead>
<tr>
<th>Number</th>
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<th>Hours</th>
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</thead>
<tbody>
<tr>
<td>651-3597-00L</td>
<td>Bachelor's Seminar I</td>
<td>W+</td>
<td>2 credits</td>
<td>2S</td>
<td>W. Schatz, J. D. Rickli</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>Introduction into different aspects of scientific work. Literature search, structure and content of scientific publications, presentation of scientific findings in talks and posters</td>
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<tr>
<td><strong>Objective</strong></td>
<td>Students are able to hold scientific presentations. Students can plan and present a scientific poster. Students can search scientific publications in an effective and efficient manner.</td>
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### Major in Climate and Water: Compulsory Laboratory Courses

This practical course is compulsory for the BSc-specialization "geophysics".

### Major in Climate and Water: Electives

Advisor of the BSc-major "Climate and Water" is Dr. Erich Fischer, Institute for climate and atmosphere (IAC).

### Major in Climate and Water: Core Courses

14 credits have to be acquired of the offered core courses from autumn and spring semester.

<table>
<thead>
<tr>
<th>Number</th>
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</thead>
<tbody>
<tr>
<td>651-3597-00L</td>
<td>Cryosphere</td>
<td>W</td>
<td>3 credits</td>
<td>2V</td>
<td>M. Funk, M. Huss, K. Steffen</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>This course introduces the different parts of the cryosphere - snow, glaciers, sea ice, permafrost - and their role in the climate system. A significant physical aspect is the focus in each part. Those completing the course are able to describe the dynamics of cryosphere components both formally and using examples.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>Students are able - to qualitatively describe the main components of the cryosphere and their role in the climate system - to formally describe the relevant physical processes which determine the state of cryosphere components</td>
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<tr>
<td><strong>Content</strong></td>
<td>Introduction into the different components of the Cryosphere: Snow, glaciers, sea ice and permafrost, and their roles in the climate system. Each part is use to emphasized on one specific physical aspect: material qualities of ice, mass balance and dynamics of glaciers and energy balance of sea ice.</td>
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<tr>
<td><strong>Lecture notes</strong></td>
<td>Handouts will be distributed during the teaching semester</td>
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</table>

### Major in Climate and Water: Electives

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>701-0471-00L</td>
<td>Atmospheric Chemistry</td>
<td>W+</td>
<td>3 credits</td>
<td>2G</td>
<td>M. Ammann, D. W. Brunner</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>The lecture provides an introduction to atmospheric chemistry at bachelor level. It introduces the kinetics of gas phase and heterogeneous reactions on aerosols and in clouds and explains the chemical and physical mechanisms responsible for global (e.g. stratospheric ozone depletion) as well as regional (e.g. urban air pollution) environmental problems.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>The students will understand the basics of gas phase and heterogeneous reactions and will know the most relevant atmospheric chemical processes taking place in the gas phase as well as between different phases including aerosols and clouds. The students will also acquire a good understanding of atmospheric environmental problems including air pollution, stratospheric ozone destruction and changes in the oxidative capacity of the global atmosphere.</td>
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<tr>
<td><strong>Content</strong></td>
<td>Origin and properties of the atmosphere: structure, large scale dynamics, UV radiation Thermodynamics and kinetics of gas phase reactions: enthalpy and free energy of reactions, rate laws, mechanisms of bimolecular and termolecular reactions. Tropospheric photochemistry: Photolysis reactions, photochemical O3 formation, role and budget of HOx, dry and wet deposition Aerosols and clouds: chemical properties, primary and secondary aerosol sources Multiphase chemistry: heterogeneous reactions, solubility and hygroscopicity, N2O5 chemistry, SO2 oxidation, secondary organic aerosols Air quality: role of planetary boundary layer, summer- versus winter-smog, environmental problems, legislation, long-term trends Stratospheric chemistry: Chapman cycle, Brewer-Dobson circulation, catalytic ozone destruction cycles, polar ozone hole, Montreal protocol Global aspects: global budgets of ozone, methane, CO and NOx, air quality - climate interactions</td>
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<tr>
<td><strong>Lecture notes</strong></td>
<td>Handouts will be distributed during the teaching semester</td>
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Atmospheric Physics  
W+ 3 credits  2G  U. Lohmann, A. A. Mensah

Abstract
This course covers the basics of atmospheric physics, which consist of: cloud and precipitation formation, thermodynamics, aerosol physics, radiation as well as the impact of aerosols and clouds on climate and artificial weather modification.

Objective
Students are able
- to explain the mechanisms of cloud and precipitation formation using knowledge of humidity processes and thermodynamics.
- to evaluate the significance of clouds and aerosol particles for climate and artificial weather modification.

Content
Moist processes/thermodynamics; aerosol physics; cloud formation; precipitation processes, storms; importance of aerosols and clouds for climate and weather modification, clouds and precipitation

Lecture notes
Powerpoint slides and script will be made available

Literature

Prerequisites / notice
50% of the time we use the concept of "flipped classroom" (en.wikipedia.org/wiki/Flipped_classroom), which we introduce at the beginning.

We offer a lab tour, in which we demonstrate with some instruments how some of the processes, that are discussed in the lectures, are measured.

There is a additional tutorial right after each lecture to give you the chance to ask further questions and discuss the exercises. The participation is recommended but voluntary.

Numerical Methods in Environmental Sciences  
W+ 3 credits  2G  C. Schär, O. Fuhrer

Abstract
This lecture imparts the mathematical basis necessary for the development and application of numerical models in the field of Environmental Science. The lecture material includes an introduction into numerical techniques for solving ordinary and partial differential equations, as well as exercises aimed at the realization of simple models.

Objective
This lecture imparts the mathematical basis necessary for the development and application of numerical models in the field of Environmental Science. The lecture material includes an introduction into numerical techniques for solving ordinary and partial differential equations, as well as exercises aimed at the realization of simple models.

Content
Classification of numerical problems, introduction to finite-difference methods, time integration schemes, non-linearity, conservative numerical techniques, an overview of spectral and finite-element methods. Examples and exercises from a diverse cross-section of Environmental Science.

Lecture notes
Is provided (CHF 10.- per copy).

Literature
List of literature is provided.

Weather Systems  
W+ 3 credits  2G  M. A. Sprenger, C. Grams

Abstract
This lecture introduces the theoretical principles and the observational and analytical methods of atmospheric dynamics. Based on these principles, the following aspects are discussed: the energetics of the global circulation, the basic synoptic- and meso-scale flow phenomena, in particular the dynamics of extratropical cyclones, and the influence of mountains on the atmospheric flow.

Objective
The students are able to
- explain up-to-date meteorological observation techniques and the basic methods of theoretical atmospheric dynamics
- to discuss the mathematical basis of atmospheric dynamics, based on selected atmospheric flow phenomena
- to explain the basic dynamics of the global circulation and of synoptic- and meso-scale flow features
- to explain up-to-date meteorological observation techniques and the basic methods of theoretical atmospheric dynamics
- to explain how mountains influence the atmospheric flow on different scales

Content
Satellite observations; analysis of vertical soundings; geostrophic and thermal wind; cyclones at mid-latitude; global circulation; north-atlantic oscillation; atmospheric blocking situtations; Eulerian and Lagrangian perspective; potential vorticity; Alpine dynamics (storms, orographic wind); planetary boundary layer

Lecture notes
Lecture notes and slides

Literature
Atmospheric Science, An Introductory Survey
John M. Wallace and Peter V. Hobbs, Academic Press

Major in Climate and Water: Electives

In addition to the mandatory seminar for Bachelor Students: Atmosphere and Climate (course nr. 701-0459-00 in autumn semester) another 22 credits must be acquired from the offered elective courses during the 5th and 6th semester. The choice of other courses has to be granted by the advisor (Dr. Erich Fischer).

<table>
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<th>Number</th>
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<tbody>
<tr>
<td>701-0459-00L</td>
<td>Seminar for Bachelor Students: Atmosphere and Climate</td>
<td>O</td>
<td>2 credits</td>
<td>2S</td>
<td>R. Knutti, H. Joos, O. Stebler</td>
</tr>
<tr>
<td>102-0635-01L</td>
<td>Air Pollution Control</td>
<td>W</td>
<td>6 credits</td>
<td>4G</td>
<td>B. Buchmann, P. Hofer</td>
</tr>
</tbody>
</table>

Abstract
The lecture provides in the first part an introduction to the formation of air pollutants by technical processes, the emission of these chemicals into the atmosphere and their in-pact on air quality. The second part covers different strategies and techniques for emis-sion reduction. The basic knowledge is deepened by the discussion of specific air pollution problems of today's society.

Objective
The students gain general knowledge of the factors resulting in air pollution and the techniques used for air pollution control. The students can identify major air pollution sources and understand the methods for measurement, data collection and analysis. The students can evaluate possible control methods and equipment, design a control system and estimate the efficiency and cost.

The students know the different techniques of air pollution control and their scientific basements. They are able to incorporate goals concerning the air quality into their engineering work.
Content
Part 1 Emission, Immission, Transmission
- Fluxes of pollutants and their environmental impact
- physical and chemical processes leading to emission of pollutants
- mass and energy of processes
- Emission measurement techniques and concepts
- quantification of emissions from individual and aggregated sources
- extent and development of the emissions (Switzerland and global)
- propagation and transport of pollutants (transmission)
- meteorological parameters influencing air pollution dispersion
- deterministic and stochastic models, describing the air pollution dispersion
- dispersion models (Gaussian model, box model, receptor model)
- measurement concepts for ambient air (immission level)
- extent and development of ambient air mixing ratios
- goal and instrument of air pollution control

Part 2 Air Pollution Control Technologies
- The reduction of the formation of pollutants is done by modifying the processes (pro-cess-integrated measures) and by different engineering operations for the cleaning of waste gas (downstream pollution control). It will be demonstrated, that the variety of these procedures can be traced back on the application of a few basic principles of physical chemistry.
- Procedures for the removal of particles (inertial separator, filtration, electrostatic pre-cipitators, scrubbers) with their different mechanisms (field forces, impaction and diffusion processes) and the modelling of these mechanisms.
- Procedures for the removal of gaseous pollutants and the description of the driving forces involved, as well as the equilibrium and the kinetics of the relevant processes (absorption, adsorption as well as thermal, catalytic and biological conversions).
- Discussion of the technical possibilities to solve the actual air pollution problems.

Lecture notes
- Brigitte Buchmann, Air pollution control, Part I
- Peter Hofer, Air pollution control, Part II
- Lecture slides and exercises

Literature
List of literature included in scrip

Prerequisites / notice
College lectures on basic physics, chemistry and mathematics

401-0649-00L Applied Statistical Regression
W 5 credits 2V+1U M. Dettling

Abstract
This course offers a practically oriented introduction into regression modeling methods. The basic concepts and some mathematical background are included, with the emphasis lying in learning "good" work life. A special focus will be laid in the use of the statistical software package R for regression analysis.

Objective
The students acquire advanced practical skills in linear regression analysis and are also familiar with its extensions to generalized linear modeling.

Content
The course starts with the basics of linear modeling, and then proceeds to parameter estimation, tests, confidence intervals, residual analysis, model choice, and prediction. More rarely touched but practically relevant topics that will be covered include variable transformations, multicollinearity problems and model interpretation, as well as general modeling strategies.

The last third of the course is dedicated to an introduction to generalized linear models: this includes the generalized additive model, logistic regression for binary response variables, binomial regression for grouped data and poisson regression for count data.

Lecture notes
A script will be available.

Literature
Faraway (2006); Linear Models with R
Faraway (2006); Extending the Linear Model with R
Draper & Smith (1998); Applied Regression Analysis
Fox (2008); Applied Regression Analysis and GLMs
Montgomery (2009); Introduction to Linear Regression Analysis

Prerequisites / notice
The exercises, but also the classes will be based on procedures from the freely available, open-source statistical software package R, for which an introduction will be held.

In the Mathematics Bachelor and Master programmes, the two course units 401-0649-00L "Applied Statistical Regression" and 401-3622-00L "Regression" are mutually exclusive. Registration for the examination of one of these two course units is only allowed if you have not registered for the examination of the other course unit.

401-6215-00L Using R for Data Analysis and Graphics (Part I)
W 1 credit 1G A. Drewek, A. J. Papritz

Abstract
The course provides the first part an introduction to the statistical software R for scientists. Topics covered are data generation and selection, graphical and basic statistical functions, creating simple functions, basic types of objects.

Objective
The students will be able to use the software R for simple data analysis.

Content
The course provides the first part of an introduction to the statistical software R for scientists. R is free software that contains a huge collection of functions with focus on statistics and graphics. If one wants to use R one has to learn the programming language R - on very rudimentary level. The course aims to facilitate this by providing a basic introduction to R.

Part I of the course covers the following topics:
- What is R?
- R Basics: reading and writing data from/to files, creating vectors & matrices, selecting elements of dataframes, vectors and matrices, arithmetics;
- Types of data: numeric, character, logical and categorical data, missing values;
- Simple (statistical) functions: summary, mean, var, etc., simple statistical tests;
- Writing simple functions;
- Introduction to graphics: scatter-, boxplots and other high-level plotting functions, embellishing plots by title, axis labels, etc., adding elements (lines, points) to existing plots.

The course focuses on practical work at the computer. We will make use of the graphical user interface RStudio: www.rstudio.org

Lecture notes

Prerequisites / notice
The course resources will be provided via the Moodle web learning platform
Please login (with your ETH (or other University) username+password) at https://moodle-app2.let.ethz.ch/enrol/users.php?id=1145
Choose the course “Using R for Data Analysis and Graphics” and follow the instructions for registration.

701-0535-00L Environmental Soil Physics/Vadose Zone Hydrology
W 3 credits 2G+2U D. Or
The course provides theoretical and practical foundations for understanding and characterizing physical and transport properties of soils/near-surface earth materials, and quantifying hydrological processes and fluxes of mass and energy at multiple scales. Emphasis is given to land-atmosphere interactions, the role of plants on hydrological cycles, and biophysical processes in soils.

Students are able to:
- characterize quantitative knowledge needed to measure and parameterize structural, flow and transport properties of partially-saturated porous media,
- quantify driving forces and resulting fluxes of water, solute, and heat in soils,
- apply modern measurement methods and analytical tools for hydrological data collection,
- conduct and interpret a limited number of experimental studies
- explain links between physical processes in the vadose-zone and major societal and environmental challenges

Weeks 1 to 3: Physical Properties of Soils and Other Porous Media. Units and dimensions, definitions and basic mass-volume relationships between the solid, liquid and gaseous phases; soil texture; particle size distributions; surface area; soil structure. Soil colloids and clay behavior.

Soil Water Content and its Measurement - Definitions; measurement methods - gravimetric, neutron scattering, gamma attenuation; and time domain reflectometry; soil water storage and water balance.

Weeks 4 to 5: Soil Water Retention and Potential (Hydrostatics) - The energy state of soil water; total water potential and its components; properties of water (molecular, surface tension, and capillary rise); modern aspects of capillarity in porous media; units and calculations and measurement of equilibrium soil water potential components; soil water characteristic curves definitions and measurements; parametric models; hysteresis. Modern aspects of capillarity

Demo-Lab: Laboratory methods for determination of soil water characteristic curve (SWC), sensor pairing

Weeks 6 to 9: Water Flow in Soil - Hydrodynamics:
- Lamellar flow in tubes (Poiseuille's Law); Darcy's Law, conditions and states of flow; saturated flow; hydraulic conductivity and its measurement.

Lab #1: Measurement of saturated hydraulic conductivity in uniform and layered soil columns using the constant head method.

Part 2 - Unsaturated steady state flow; unsaturated hydraulic conductivity models and applications; non-steady flow and Richards Eq.; approximate solutions to infiltration (Green-Ampt, Philip); field methods for estimating soil hydraulic properties.

Midterm exam

Lab #2: Measurement of vertical infiltration into dry soil column - Green-Ampt, and Philip's approximations; infiltration rates and wetting front propagation.

Part 3 - Use of Hydrus model for simulation of unsaturated flow.

Week 10 to 11: Energy Balance and Land Atmosphere Interactions - Radiation and energy balance; evapotranspiration definitions and estimation; transpiration, plant development and transpiration coefficients small and large scale influences on hydrological cycle; surface evaporation.

Week 12 to 13: Solute Transport in Soils. Transport mechanisms of solutes in porous media; breakthrough curves; convection-dispersion Eq.; solutions for pulse and step solute application; parameter estimation; salt balance.

Lab #3: Miscible displacement and breakthrough curves for a conservative tracer through a column; data analysis and transport parameter estimation.

Additional topics:
- Temperature and Heat Flow in Porous Media - Soil thermal properties; steady state heat flow; nonsteady heat flow; estimation of thermal properties; engineering applications.
- Biological Processes in the Vadose Zone An overview of below-ground biological activity (plant roots, microbial, etc.); interplay between physical and biological processes. Focus on soil-atmosphere gaseous exchange; and challenges for bio- and phytoremediation.

Classnotes on website: Vadose Zone Hydrology, by Or D., J.M. Wraith, and M. Tuller (available at the beginning of the semester)
http://www.step.ethz.ch/education/active-courses/vadose-zone-hydrology

701-0479-00L Environmental Fluid Dynamics W 3 credits 2G H. Wernli, M. Croci-Maspolli

Abstract
This course covers the basic physical concepts and mathematical equations used to describe environmental fluid systems on the rotating Earth. Fundamental concepts (e.g. vorticity dynamics and waves) are formally introduced, applied quantitatively and illustrated using examples. Exercises help to deepen knowledge of the material.

Objective
Students are able to:
- to name the bases, concepts and methods of environmental fluid dynamics.
- to understand and discuss the components of the basic physical equations in fluid dynamics
- to apply basic mathematical equations to simple problems of environmental fluid dynamics

Content
Basic physical terminology and mathematical laws:
- Continuum hypothesis, forces, constitutive laws, state equations and basic principles of thermodynamics, kinematics, laws of mass and momentum on rotating earth.
- Concepts and illustrative flow systems: vorticity dynamics, boundary layers, instability, turbulence - with respect to environmental fluid systems.
- Scale analysis: dimensionless variables and dynamical similarity, simplification of the fluid system, e.g. shallow water assumption, geostrophic flow.

Waves in environmental fluid systems.

Lecture notes
In english language

Literature
Will be presented in class.
See also: web-site.

702-4055-01L Groundwater I W 3 credits 2G M. Willmann

Abstract
The course provides an introduction into quantitative analysis of groundwater flow and transport. It is focussed on formulating flow and transport problems in groundwater, which are to be solved analytically or numerically.
Objective

a) Students understand the basic concepts of flow and contaminant transport processes and boundary conditions in groundwater.

b) Students are able to formulate simple practical flow and transport problems.

c) Students are able to understand and apply simple analytical solutions to simple flow and transport problems.

d) Students are able to use simple numerical codes to adequately solve simple flow (and transport) problems.

Content

Properties of porous media.
Exercises: Groundwater use, porosity, grain size analysis.

Flow properties, Darcy's law, filter.

Flow equations, stream function.
Exercises: Darcy's law.

Analytical solutions, confined aquifers, steady-state flow.
Exercises: Head isolines.

Use of superposition principles, transient flow, free surface flow.
Exercises: Analytical solutions to flow problems.

Finite difference solutions to flow problems I.
Exercises: Analytical solutions to flow problems.

Finite difference solutions to flow problems II.
Exercises: Finite difference formulations to flow problems.

Transport processes.
Exercises: Computer workshop using PMWIN.

Analytical solutions to transport problems I.
Exercises: Computer workshop using PMWIN.

Analytical solutions to transport problems II.
Exercises: Analytical solutions to transport problems.

Path lines, groundwater protection.
Exercises: Analytical solutions to transport problems.

Groundwater remediation, groundwater management.
Exercises: Groundwater remediation.

Lecture notes

Folien auf Internet unter www.ihw.ethz.ch/GWH/education/index

Altes Skript auf Internet www.ihw.ethz.ch/GWH/education/index

Weitere Texte auf Internet www.ihw.ethz.ch/GWH/education/index

Didaktische Software auf Internet unter www.ihw.ethz.ch/GWH/education/index


W. Kinzelbach, R. Rausch, Grundwassermodellierung, Gebrüder Bornträger, Stuttgart, 1995

Krusemann, de Ridder, Untersuchung und Anwendung von Pumpversuchen, Verl. R. Müller, Köln, 1970

G. de Marsily, Quantitative Hydrogeology, Academic Press, 1986

651-3561-00L Cryosphere 3 credits 2V M. Funk, M. Huss, K. Steffen

Abstract

This course introduces the different parts of the cryosphere - snow, glaciers, sea ice, permafrost - and their role in the climate system. A significant physical aspect is the focus in each part. Those completing the course are able to describe the dynamics of cryosphere components both formally and using examples.

Objective

Students are able
- to qualitatively describe the main components of the cryosphere and their role in the climate system
- to formally describe the relevant physical processes which determine the state of cryosphere components

Content

Introduction into the different components of the Cryosphere: Snow, glaciers, sea ice and permafrost, and their roles in the climate system.

Each part is use to emphasized on one specific physical aspect: material qualities of ice, mass balance and dynamics of glaciers and energy balance of sea ice.

Lecture notes

handouts will be distributed during the teaching semester

Field Trips, Laboratory and Block Courses

The Practical Training in Atmosphere and Climate takes place in Spring Semester.

Electives

Courses can be chosen from the complete offerings of the ETH Zurich and University of Zurich.

Number Title Type ECTS Hours Lecturers

701-0565-00L Fundamentals of Natural Hazards Management W 3 credits 3G H. R. Heinimann, B. Krummenacher, S. Löw

Abstract

Risks to life and human assets result when settlement areas and infrastructure overlap regions where natural hazard processes occur. This course utilizes case studies to teach how a future natural hazards-specialist should analyze, assess and manage risks.
Objective

Concepts will be explained step-by-step through a set of case studies, and applied in lab by the students. The following principal steps are used when coping with natural hazard-risks. At each step, students will learn and apply the following skills:

Risk analysis - What can happen?
- Characterize the processes and environmental measures that lead to a natural hazard and integrate modeling results of these processes.
- Identify threats to human life and assets exposed to natural hazards and estimate possible drawbacks or damages.
Risk assessment - What are the acceptable levels of risk?
- Apply principles to determine acceptable risks to human life and assets in order to identify locations which should receive added protection.
- Explain causes for conflicts between risk perception and risk analysis.
Risk management - What steps should be taken to manage risks?
- Explain how various hazard mitigation approaches reduce risk.
- Describe hazard scenarios as a base for adequate dimensioning of control measures.
- Identify the best alternative from a set of thinkable measures based on an evaluation scheme.
- Explain the principles of risk-governance.

Content

Die Vorlesung besteht aus folgenden Blöcken:
1) Einführung ins Vorgehenskonzept (1W)
2) Risikoanalyse (6W + Exkursion) mit:
   - Systemabgrenzung
   - Gefahrenbeurteilung
   - Expositions- und Folgenanalyse
3) Risikobewertung (2W)
4) Risikomanagement (2W + Exkursion)
5) Abschlussbesprechung (1W)

Choice of courses from the complete offerings of ETH and UZH.

► Social Sciences

Recommended Science in Perspective (Type B) for D-ERDW.

see Science in Perspective: Type A: Enhancement of Reflection Capability

see Science in Perspective: Language Courses ETH/UZH

► Bachelor’s Seminar

The Bachelor Seminar (651-3698-00L) takes place in spring semester.

► Bachelor’s Thesis

The Bachelor Thesis and Bachelor-Seminar are offered once per year in the 6th semester, in the spring.

► Complementary Courses

The Complementary Courses take place in Spring Semester.

Earth Sciences Bachelor - Key for Type

| W+ | Eligible for credits and recommended |
| W  | Eligible for credits               |
| E- | Recommended, not eligible for credits |
| Z  | Courses outside the curriculum     |
| Dr | Suitable for doctorate             |
| O  | Compulsory                         |

Key for Hours

| V  | lecture          |
| G  | lecture with exercise |
| U  | exercise         |
| S  | seminar          |
| K  | colloquium       |
| P  | practical/laboratory course |
| A  | independent project |
| D  | diploma thesis   |
| R  | revision course / private study   |

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
### Microscopy Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>651-4045-00L</td>
<td>Microscopy of Metamorphic Rocks</td>
<td>W+</td>
<td>2</td>
<td>2G</td>
<td>P. Nievergelt</td>
</tr>
</tbody>
</table>
| Objective     | - Advanced knowledge in optical mineralogy  
- Application of methods to determine minerals in thin sections  
- Identification and characterisation of metamorphic minerals  
- Description of rocks. Derive correct petrographic rock name, based on modal abundance and microstructure/texture  
- Interpretation of rock fabric/microstructure, parageneses and mineral reactions |
| Content       | - Repetition of principal optical properties and of microscopic methods to identify minerals. Emphasis on interpretation of interference figures.  
- Study typical metamorphic rocks in thin sections  
- Description and interpretation of parageneses and texture/microstructures. Study the age relationship of crystallisation and deformation.  
- Estimation of metamorphic grade  
- Quantitative determination of rock components  
- Scientific documentation: Descriptions, drawings, photomicrography using different kinds of illumination and using plane- or circular-polarised light. |
| Literature    | To brush up knowledge in optical mineralogy read the relevant chapters in the book of W.D. Nesse (2004); - Nesse, W.D.: Introduction to optical mineralogy. 3. Ed. (2004). Figures from this book will be used in lectures. Besides the theory, this book describes all optical properties of important minerals. Petrographers working on varying types of silicate rocks should have a look at this book.  
| Prerequisites / notice | Participants should have basic knowledge in crystallography, mineralogy and petrology, and have taken practical courses in microscopy of thin sections, as well as lectures in metamorphic petrology and structural geology! |

Other microscopy courses at department D-ERDW are on:  
- magmatic rocks, following this course in second half of semester (P. Ulmer, IGP; Inst. for Geochemistry and Petrology)  
- sedimentary rocks (Geol. Institute)  
- ore minerals (reflected light microscopy, Th. Driesner, IGP)  
- microstructures, deformed rocks (Geol. Institute)

| 651-4047-00L  | Microscopy of Magmatic Rocks         | W+   | 2    | 2G    | P. Ulmer          |
| Abstract      | This course provides basic knowledge in microscopy of igneous rocks. Apart from the identification of common igneous minerals in thin sections, mineral assemblages, textures and structures will be investigated and the results of microscopy will be combined with igneous phase equilibria to understand generation, differentiation and emplacement of igneous rocks. |
| Objective     | The principal goal of this course is to acquire expertise in:  
(1) optical determination of minerals in igneous rocks using the polarizing microscope  
(2) Identification of igneous rocks basing on modal mineralogy, structure and texture;  
(3) Interpretation of textures and structures and associated igneous processes;  
(4) Application of igneous phase diagrams to natural rocks. |
| Content       | This practical course bases on the course 'Microscopy of metamorphic rocks' (P. Nievergelt), that is taught immediately before this course, where basic knowledge in optical mineralogy and the use of the polarizing microscope is acquired. In this course, the most important (common) igneous minerals and rocks are studied in thin sections under the polarizing microscope. Mineral assemblages, textures, structures and crystalization sequences are determined and utilized to understand the generation, differentiation and emplacement of igneous rocks. In addition, we will apply igneous phase equilibria that have been introduced in other lectures (such as magmatism and volcanism at ETH/Uni Zurich or an equivalent igneous petrology course) to natural rock samples in order to constrain quantitatively parental magma compositions and crystallization conditions. The range of investigated rocks encompasses mantle rocks, tholeiitic, calc-alkaline and alkaline plutonic and volcanic rocks that contain the most common igneous minerals. |
| Lecture notes | Basis of the optical determinations of (igneous) minerals using the polarizing microscope are the tables of Tröger (‘Optische Bestimmung der gesteinsbildenden Mineralien’, Optical determination of rock-forming minerals, 1982) that are available in sufficient volumes in the class room.  
Some loose sheets will be distributed during the lecture providing additional information and templates for thin section descriptions.  
Additionally, I recommend the lecture notes of H.-G. Stosch (University of Karlsruhe, in German) that can be provided in printed form upon request. |
| Literature    | There are several good textbooks on the subject of ‘mineralogy in thin sections’ that I can suggest upon request. |
| Prerequisites / notice | This course does not include an introduction in optical mineralogy and the use of a polarizing microscope and, therefore, bases on the course ‘Microscopy of metamorphic rocks’ taught by P. Nievergelt immediately before this course where these basic principles are provided. Alternatively, e.g. for external students, an equivalent course is required to follow this practical course. |

Other microscopy courses taught at ETH Zurich at the D-ERDW are:  
- Microscopy of metamorphic rocks (P. Nievergelt, required for this course)  
- Microscopy of sedimentary rocks (W. Winkler & Blaesi)  
- Reflected light microscopy and ore deposits practical (T. Driesner)  
- Microstructures (deformation structures, B. Cordonnier)

| 651-4051-00L  | Reflected Light Microscopy and Ore Deposits Practical | W+   | 2    | 2P    | T. Driesner        |
Analytical Methods in Petrology and Geology

Abstract
The course offers a series of basic methods useful for the analysis of sediments. It is also offered to apply these methods on material collected for the students Master or PhD projects.

Objective
Practical work in analytical chemistry for Earth science students.

Content
Knowledge of some analytical methods used in Earth sciences.

Literature
English textbooks recommended

Prerequisites / notice
It is desirable but not excluding that the students bring their own material (Master or PhD project) for some of the analytical methods.

Part B: Methods

<table>
<thead>
<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
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</thead>
<tbody>
<tr>
<td>651-4055-00L</td>
<td>Analytical Methods in Petrology and Geology</td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>E. Reuss, S. Bernasconi, L. Zehnder</td>
</tr>
<tr>
<td>651-4113-00L</td>
<td>Sedimentary Petrography and Microscopy</td>
<td>W+</td>
<td>2</td>
<td>2G</td>
<td>V. Picotti, M. G. Fellin</td>
</tr>
<tr>
<td>651-4031-00L</td>
<td>Geographic Information Systems</td>
<td>W+</td>
<td>3</td>
<td>4G</td>
<td>A. Baltensweiler, M. Hägeli-Golay</td>
</tr>
<tr>
<td>651-4063-00L</td>
<td>X-ray Powder Diffraction</td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>L. M. Plötze</td>
</tr>
</tbody>
</table>

Analytical Methods in Petrology and Geology

Abstract
Introduction to the architecture and data processing capabilities of geographic information systems (GIS). Practical application of spatial data modeling and geoprocessing functions to a selected project from the earth sciences.

Objective
Knowledge of the basic architecture and spatial data handling capabilities of geographic information systems.

Content
Theoretical introduction to the architecture, modules, spatial data types and spatial data handling functions of geographic information systems (GIS). Application of data modeling principles and geoprocessing capabilities using ArcGIS: Data design and modeling, data acquisition, data integration, spatial analysis of vector and raster data, particular functions for digital terrain modeling and hydrology, map generation and 3D-visualization.

Literature

Literature


Prerequisites / notice

The course includes a high portion of practical exercises in sample preparation as well as measurement and evaluation of X-ray powder diffraction data. Own sample will be analysed qualitatively and quantitatively. Knowledge in mineralogy of this system is essential.

The lecture course is limited to 12 participants.

Restricted Choice Modules Geology

A minimum of two restricted choice modules must be completed for the major Geology.

Palaeoclimatology: Compulsory Courses

<table>
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<tr>
<th>Number</th>
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</thead>
<tbody>
<tr>
<td>651-4057-00L</td>
<td>Climate History and Palaeoclimatology</td>
<td>W+</td>
<td>3 credits</td>
<td>2G</td>
<td>S. Bernasconi, B. Ausin Gonzalez, A. Fernandez Bremer, A. Gilli</td>
</tr>
</tbody>
</table>

Abstract

The course “Climate history and paleoclimatology gives an overview on climate through geological time and it provides insight into methods and tools used in paleoclimatological research.

Objective

The student will have an understanding of evolution of climate and its major forcing factors -orbital, atmosphere chemistry, tectonics-through geological time. He or she will understand interaction between life and climate and he or she will be familiar with the use of most common geochronological paleoclimatological proxies. The student will be able to estimate rates of changes in climate history and to recognize feedbacks between the biosphere and climate.

Content

Geological time, stratigraphy, geological archives, climate archives, palaeoclimatic archives

Climate through geological time: "lessons from the past"

Cretaceous greenhouse climate

The Late Paleocene Thermal Maximum (PETM)

Cenozoic Cooling

Onset and Intensification of Southern Hemisphere Glaciation

Onset and Intensification of Northern Hemisphere Glaciation

Pliocene warmth

Glacial and Interglacials

Millennial-scale climate variability during glaciations

The last deglaciation(s)

The Younger Dryas

Holocene climate - climate and societies

Palaeoclimatology: Courses of Choice

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<tr>
<th>Number</th>
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<th>ECTS</th>
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<tbody>
<tr>
<td>651-4043-00L</td>
<td>Sedimentology II: Biological and Chemical Processes in Lacustrine and Marine Systems</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>V. Picotti, A. Gilli</td>
</tr>
</tbody>
</table>

Abstract

The course will focus on biological and chemical aspects of sedimentation in marine environments. Marine sedimentation will be traced from coast to deep-sea. The use of stable isotopes palaeoceanography will be discussed. Neritic, hemipelagic and pelagic sediments will be used as proxies for environmental change during times of major perturbations of climate and oceanography.

Objective

-You will understand chemistry and biology of the marine carbonate system
-You will be able to relate carbonate mineralogy with facies and environmental conditions
-You will be familiar with cool-water and warm-water carbonates
-You will see carbonate and organic-carbon rich sediments as part of the global carbon cycle
-You will be able to recognize links between climate and marine carbonate systems (e.g. acidification of oceans and reef growth)
-You will be able to use geological archives as source of information on global change
-You will have an overview of marine sedimentation through time

Content

-carbonates: chemistry, mineralogy, biology
-carbonate sedimentation from the shelf to the deep sea
-carbonate facies
-cool-water and warm-water carbonates
-organic-carbon and black shales
-C-cycle, carbonates, Corg : CO2 sources and sink
-carbonates: their geochemical proxies for environmental change: stable isotopes, Mg/Ca, Sr
-marine sediments through geological time
-carbonates and evaporites
-lacustrine carbonates
-economic aspects of limestone

Lecture notes

no script. Scientific articles will be distributed during the course

Literature

We will read and critically discuss scientific articles relevant for "biological and chemical processes in marine and lacustrine systems"
Quaternary Dating Methods
Details on the program will be handed out during the first lecture.

L. M. Plötze
Lecturers
Type

V. Picotti
Students will be made familiar with the details of the six dating methods through lectures on basic principles, analysis of case studies, and critical reading and evaluation of scientific publications. In particular, we pay attention to introducing the importance of considering entire sediment routing systems and understanding their functioning.

Content Details on the program will be handed out during the first lecture. We will attribute the papers for presentation on the 26th, so please be here on that day!

Literature The sedimentary record of sea-level change
Angela Coe, the Open University.
Cambridge University Press
Prerequisites / notice The grading of students is based on in-class exercises and end-semester examination.

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<tbody>
<tr>
<td>651-4041-00L</td>
<td>Sedimentology I: Physical Processes and</td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>V. Picotti</td>
</tr>
<tr>
<td></td>
<td>Sedimentary Systems</td>
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<tr>
<td>Abstract</td>
<td>Sediments preserved a record of past landscapes. This courses focuses on understanding the processes that modify sedimentary landscapes with time and how we can read this changes in the sedimentary record.</td>
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<tr>
<td>Objective</td>
<td>The students learn basic concepts of modern sedimentology and stratigraphy in the context of sequence stratigraphy and sea level change. They discuss the advantages and pitfalls of the method and look beyond. In particular we pay attention to introducing the importance of considering entire sediment routing systems and understanding their functioning.</td>
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<tr>
<td>Content</td>
<td>Details on the program will be handed out during the first lecture.</td>
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<td>Sedimentology II: Biological and Chemical Processes</td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>V. Picotti, A. Gill</td>
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<tr>
<td></td>
<td>in Lacustrine and Marine Systems</td>
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<tr>
<td>Prerequisite</td>
<td>Successful completion of the MSc-course &quot;Sedimentology I&quot; (651-4041-00L).</td>
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<tr>
<td>Abstract</td>
<td>The course will focus on biological and chemical aspects of sedimentation in marine environments. Marine sedimentation will be traced from coast to deep-sea. The use of stable isotopes and palaeoceanography will be discussed. Nertic, hemipelagic and pelagic sediments will be used as proxies for environmental changes through times of major perturbations of climate and oceanography.</td>
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</tbody>
</table>
| Objective    | - You will understand chemistry and biology of the marine carbonate system  
- You will be able to calculate carbonate mineralogy with facies and environmental conditions  
- You will be familiar with cool-water and warm-water carbonates  
- You will see carbonate and organic-carbon rich sediments as part of the global carbon cycle  
- You will be able to recognize links between climate and marine carbonate systems (e.g. acidification of oceans and reef growth)  
- You will be able to use geological archives as source of information on global change  
- You will have an overview of marine sedimentation through time |
| Content      | - carbonates, chemistry, mineralogy, biology  
- carbonate sedimentation from the shelf to the deep sea  
- carbonate facies  
- cool-water and warm-water carbonates  
- organic-carbon and black shales  
- C-cycle, carbonates, Corg : CO2 sources and sink  
- Carbonates: their geochemical proxies for environmental change: stable isotopes, Mg/Ca, Sr  
- marine sediments through geological time  
- carbonates and evaporites  
- lacustrine carbonates  
- economic aspects of limestone |

Lecture notes no script. scientific articles will be distributed during the course
Literature We will read and critically discuss scientific articles relevant for "biological and chemical processes in marine and lacustrine systems" in the context of sequence stratigraphy and sea level change.
Prerequisites / notice The grading of students is based on in-class exercises and end-semester examination.

Sedimentology: Courses of Choice

<table>
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<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
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</thead>
<tbody>
<tr>
<td>651-4901-00L</td>
<td>Quaternary Dating Methods</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>I. Hajdas, S. Ivy Ochs</td>
</tr>
<tr>
<td>Abstract</td>
<td>Reconstruction of time scales is critical for all Quaternary studies in both Geology and Archeology. Various methods are applied depending on the time range of interest and the archive studied. In this lecture we focus on the six methods that are most frequently used for dating Quaternary sediments and landforms.</td>
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</tbody>
</table>
| Objective    | Students will be made familiar with the details of the six dating methods through lectures on basic principles, analysis of case studies, solving of problem sets for age calculation and visits to dating laboratories. At the end of the course students will:  
1. understand the fundamental principles of the most frequently used dating methods for Quaternary studies.  
2. be able to calculate an age based on data of the six methods studied.  
3. be able to calculate an age based on data of the six methods studied.  
4. critically read and evaluate the application of dating methods in scientific publications. |
| Content      | 1. Introduction: Time scales for the Quaternary, Isotopes and decay  
2. Radiocarbon dating: principles and applications  
3. Cosmogenic nuclides: 3He,10Be, 14C, 21Ne, 26Cl, 36Cl  
4. U-series disequilibrium dating  
5. Luminescence dating  
6. K/Ar and Ar/Ar dating of lava flows and ash layers  
7. Summary and comparison of results from several dating methods at specific sites |
| Prerequisites / notice | Visit to radiocarbon lab, cosmogenic nuclide lab, noble gas lab, accelerator (AMS) facility. |

Required attending the lecture, visiting laboratories, handing back solutions for problem sets (Exercises)

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<td>651-4063-00L</td>
<td>X-ray Powder Diffraction</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>L. M. Plötze</td>
</tr>
<tr>
<td>Number of participants limited to 12.</td>
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<tr>
<td>Abstract</td>
<td>In the course the students learn to measure X-ray diffraction patterns of minerals and to evaluate these using different software for qualitative and quantitative mineral composition as well as crystallographic parameters.</td>
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</tbody>
</table>
Upon successful completion of this course students are able to:
- describe the principle of X-ray diffraction analysis
- carry out a qualitative and quantitative mineralogical analysis independently,
- critically assess the data,
- communicate the results in a scientific report.

The course includes a high portion of practical exercises in sample preparation as well as measurement and evaluation of X-ray powder diffraction data.

Own sample will be analysed qualitatively and quantitatively. Knowledge in mineralogy of this system is essential.

The lecture course is limited to 12 participants.

充当：结构性地质

temp：结构性地质：必修课程

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>651-4132-00L</td>
<td>Field Course IV: Non Alpine Field Course</td>
<td>W+</td>
<td>6P</td>
<td>3</td>
<td>J.P. Burg</td>
</tr>
</tbody>
</table>

Field Course to Oman. The students will produce a geological map write and a complementing field report.

成功完成此课程的学生能够做到:
- 理解和使用连续力学方程描述岩层变形。
- 学习岩层流体力学：弹性 + 黏性。
- 在2D中使用有限元方法来建模岩层变形。
- 岩石和材料的黏性 + 流变学。
- 结果的科学报告。

有以下软技能将被要求和培训，如:
- 自我评估和评估。
- 向同事提供客观的反馈。
- 诚实的自我评估和自我评级。

文献

A good knowledge of linear algebra is expected.

The used software is Matlab. So, knowledge of Matlab is advantageous. Students may bring their own laptop with a pre-installed copy of Matlab.
The modern discipline of Rock Physics serves as a bridge between traditional Rock Mechanics and traditional Rock Physical Property measurement. Through understanding the physics of the process, we strive to better understand other related fields such as structural geology and geophysics.

The course will consist of regular classes, with a small number of laboratory demonstrations made on an ad-hoc basis (depending on equipment and research objective schedules at the Rock Deformation Laboratory). The course will cover measurements of physical properties of rock such as density, porosity, permeability and elastic wave velocity, and will introduce the concept of seismic anisotropy etc. Later we will cover rock deformation in the brittle field, earthquake physics and triggering. Finally we will discuss scale effects as we move from small scale laboratory environment to the scale of the geophysical investigation.

Undergraduate courses in the following subjects are highly recommended in order to get the most out of this specialist course:
- Basic structural Geology
- Geophysics

Comprehensive understanding of evolution, mechanics, and rheology of divergent, convergent and wrenching tectonic systems from the lithospheric scale to local shallow crustal and outcrop-scales. Evaluation of plate tectonic and other orogenic processes through the study of reference examples of taken in Alps-Himalaya orogenic system.

Comprehensive understanding of evolution, mechanics, and rheology of divergent, convergent and wrenching tectonic systems from the lithospheric scale to local shallow crustal and outcrop-scales. Assessment of mechanisms responsible for plate movements (the Earth as a heat transfer machine, dynamics of earth mantle, plate driving forces) and subsequent large-scale structures (oceanic basins and cycle of the oceanic lithosphere, convergence and mountain systems and continental growth, etc) through theoretical and experimental information.

Evaluation of plate tectonic and other orogenic processes through the study of reference examples of taken in Alps-Himalaya orogenic system.

Plate tectonic frame work: earth cooling and mantle-plate interaction, three kinds of plate boundaries and their roles and characteristics, cycle of oceanic lithosphere, longevity and growth of continents, supercontinents.

Rheology of layered lithosphere and upper mantle.

Obduction systems

Collisions systems

Extensional systems

Basin evolution

Passive and active continental margin evolution

The course "Basics in Palaeobotany" gives an overview on the evolution and palaeobiology of plants and their relevance for the reconstruction of past environments.

On successful completion of the module, the students should be able to explain how plants are preserved in the fossil record, to describe the morphology of plant mega fossils, and of spores and pollen. They can describe how plant fossils can be used for reconstructing palaeoenvironments. Students should be able to explain the interactions between evolution of plants, climate and physical environment and they will be able to integrate the dimension of geological time into their understanding of biological events.

- Preservation of plants in the fossil record.
- First evidence for plants on Earth.
- The conquest of the continents by plants.
- Major adaptation and innovations leading to the present plant diversity.
- The evolution and morphology of the major plant groups.
- Plant associations through geological time and their palaeogeographic and stratigraphic relevance.
- Mass extinctions and the fossil plant record.
- Interaction between past vegetation and climate.
- The relevance of plant microfossils for reconstruction of palaeoclimate and palaeoecology.
Objective
- You will understand chemistry and biology of the marine carbonate system
- You will be able to relate carbonate mineralogy with facies and environmental conditions
- You will be familiar with cool-water and warm-water carbonates
- You will see carbonate and organic-carbon rich sediments as part of the global carbon cycle
- You will be able to recognize links between climate and marine carbonate systems (e.g., acidification of oceans and reef growth)
- You will be able to use geological archives as source of information on global change
- You will have an overview of marine sedimentation through time

Content
- carbonates: chemistry, mineralogy, biology
- carbonate sedimentation from the shelf to the deep sea
- carbonate facies
- cool-water and warm-water carbonates
- organic-carbon and black shales
- C-cycle, carbonates, Corg : CO2 sources and sink
- Carbonates: their geochemical proxies for environmental change: stable isotopes, Mg/Ca, Sr
- marine sediments thorough geological time
- carbonates and evaporites
- lacustrine carbonates
- economic aspects of limestone

Lecture notes
no script. scientific articles will be distributed during the course

Literature
We will read and critically discuss scientific articles relevant for "biological and chemical processes in marine and lacustrine systems"

Prerequisites / notice
The grading of students is based on in-class exercises and end-semester examination.

651-4057-00L Climate History and Palaeoclimatology  W  3 credits  2G  S. Bernasconi, B. Ausin Gonzalez, A. Fernandez Bremer, A. Gilli

Abstract
The course "Climate history and paleoclimatology gives an overview on climate through geological time and it provides insight into methods and tools used in paleoclimatic research.

Objective
The student will have an understanding of evolution of climate and its major forcing factors -orbital, atmosphere chemistry, tectonics-through geological time. He or she will understand interaction between life and climate and he or she will be familiar with the use of most common geochemical climate "proxies", he or she will be able to evaluate quality of marine and terrestrial sedimentary paleoclimate archives. The student will be able to estimate rates of changes in climate history and to recognize feedbacks between the biosphere and climate.

Content
Climate system and earth history - climate forcing factors and feedback mechanisms of the geosphere, biosphere, and hydrosphere.

Geological time, stratigraphy, geological archives, climate archives, paleoclimate proxies

Climate through geological time: "lessons from the past"

Cretaceous greenhouse climate
The Late Paleocene Thermal Maximum (PETM)

Cenozoic Cooling
Onset and Intensification of Southern Hemisphere Glaciation
Onset and Intensification of Northern Hemisphere Glaciation

Pliocene warmth
Glacial and Interglacials

Millennial-scale climate variability during glaciations
The last deglaciation(s)
The Younger Dryas

Holocene climate - climate and societies

Open Choice Modules Geology

Basin Analysis

Basin Analysis: Compulsory Courses

Number  Title  Type  ECTS  Hours  Lecturers
651-4231-00L  Basin Analysis  W+  3 credits  2G  S. Willett, T. I. Eglinton, M. Lupker

Abstract
The course discusses the formation and development of different basin types as part of lithosphere geodynamics. It introduces conceptual models and governing physics, with practical application to the study of basin evolution. Techniques for the analysis of subsidence and thermal history are demonstrated. Organic matter, petroleum play, and their biogeochemical investigation are examined.

Objective
Based on the introductory education and practical training during this course, each participant should be able to choose and apply approaches and techniques to own problems of basin analysis, and should be versed to expand their knowledge independently.

In particular, each participant should:
- Develop an intuitive understanding for origin, dynamics, and temporal evolution of basins in a geological / geodynamic context;
- Acquire the necessary theoretical foundation to describe basin evolution quantitatively;
- Be familiar with geological and geophysical methods that are applied to obtain information about rock properties, structural geometry, and thermal and subsidence history of basins;
- Understand the burial and maturation of organic matter in basins, the development of petroleum play, and be acquainted with geochemical methods to study the evolution of biogenic carbon.
The following topics are covered:

- Introduction; classification schemes and types of basins; heat conduction; geotherms;
- The lithosphere; isostasy; rifts and basins due to lithospheric stretching; uniform extension model; modifications to the uniform stretching model; dynamics of rifting.
- Elasticity of the lithosphere; flexural compensation; geometry and analytical description of loads and the resulting deflection; foreland basins; their anatomy;
- Reconstruction of basin evolution; borehole data; porosity loss and decompaction; backstripping; subsidence curves; thermal history and its reconstruction;
- Petroleum play concept; organic production; source rock prediction and depositional environment; petroleum generation, expulsion, migration, alteration; reservoir and traps;
- Carbon cycle; maturation of organic matter; geochemistry of biogenic carbon; biomarkers; analytical techniques
- Overview of other basin types: effects of mantle dynamics, strike-slip basins.

Each week of the course is split in lectures and corresponding practicals, in which the concepts are applied to simplified problems.

Grading of the semester performance is based on submitted practicals (50%) and a final exam (50%). The exam will take place in the time slot of the last practical (18.12.).

Lecture notes
Lecture notes are provided online during the course. They summarize the current subjects week by week, and provide the essential theoretical background.

Literature
Main reference:
ISBN 978-0-470-67376-8

Recommended, but not required (available in library).

Supplementary:


Prerequisites / notice
Familiarity with MATLAB is advantageous, but not required.

Basin Analysis: Courses of Choice

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</thead>
<tbody>
<tr>
<td>651-4243-00L</td>
<td>Seismic Stratigraphy and Facies</td>
<td>W</td>
<td>2</td>
<td>3G</td>
<td>G. Eberli</td>
</tr>
</tbody>
</table>

Abstract
Introduction into seismic interpretation for solving geological and environmental problems. A special focus is given to the seismic facies analysis and seismic sequence stratigraphy. In addition, the seismic attributes are explained, which are important for the analysis of paleo-geomorphology and structural deformation.

Objective
1. Acquire techniques for a comprehensive interpretation of seismic sections for solving geologic, tectonic, stratigraphic and environmental problems
2. Correlation of seismic facies to lithologic facies in different sedimentary systems
3. Recognition of structural elements and faults on seismic sections.
4. Learning the techniques of 3D seismic data interpretation
5. Reconstruction of sedimentary history using seismic stratigraphy and facies analysis and core information.
The four day course consists of lectures that are accompanied by a variety of exercises.

Day 1:
Introduction seismic facies analysis with exercise
Seismic resolution
Factors controlling sedimentation
Exercise: Seismic section in Straits of Florida

Day 2:
Seismic attributes and seismic geomorphology
Siliciclastic deltas, shelves and turbidite systems, 2D-3D
Exercise: Seismic section Tarragon Basin
Seismic facies carbonates
Exercise: Seismic section platform margin Great Bahama Bank
Deepwater environments, including cold-water coral habitats

Day 3:
Seismic facies of mixed systems with exercises
Faults and structures on seismic sections
Exercise: Seismic section Golf von Mexiko

Day 4:
Telling ages on seismic section
Seismic stratigraphy and sequence stratigraphy
Exercise: Sequence analysis Straits of Andros
Final discussion

Lecture notes
An original script (110 pages) designed for the class will be distributed at the beginning of the course.

Literature
Books Seismic Facies:

Books Seismic Stratigraphy:
Schlager, W., 1992, Sedimentology and sequence stratigraphy of reefs and carbonate platforms: AAPG Cont. Education course notes #34, pp71.

Basic knowledge in sedimentology and stratigraphy

Prerequisites / notice
Basic knowledge in sedimentology and stratigraphy

Earthquake Seismology

Earthquake Seismology: Compulsory Courses

<table>
<thead>
<tr>
<th>Number</th>
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</thead>
<tbody>
<tr>
<td>651-4021-00L</td>
<td>Engineering Seismology</td>
<td>W+</td>
<td>3 credits</td>
<td>2G</td>
<td>D. Fäh, M. Pilz</td>
</tr>
</tbody>
</table>

Data: 06.03.2019 12:57  Autumn Semester 2016  Page 576 of 1571
This course is a general introduction to the methods of seismic hazard analysis. It provides an overview of the input data and the tools in deterministic and probabilistic seismic hazard assessment, and discusses the related uncertainties.

**Objective**

This course is a general introduction to the methods of seismic hazard analysis.

**Content**

In the course it is explained how the disciplines of seismology, geology, strong-motion geophysics, and earthquake engineering contribute to the evaluation of seismic hazard. It provides an overview of the input data and the tools in deterministic and probabilistic seismic hazard assessment, and discusses the related uncertainties. The course includes the discussion related to Intensity and macroseismic scales, historical seismicity and earthquake catalogues, ground motion parameters used in earthquake engineering, definitions of the seismic source, ground motion attenuation, site effects and microzonation, and the use of numerical tools to estimate ground motion parameters, both in a deterministic and probabilistic sense.

During the course recent earthquakes and their impacts are discussed and related to existing hazard assessments for the areas of interest.

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**651-4016-00L Geophysical Geodesy**

**W+ 3 credits  2G  S. Houlié**

**Abstract**

The course is an introduction to the concepts of geodesy applied to the seismic cycle and to the monitoring of ground deformation. The aim of the course is to gain a thorough understanding of the physical processes leading to and governing earthquake source ruptures. To achieve this, students are introduced to various geodetic techniques and to their most famous applications in Earth Sciences: a) Students are introduced to seismological techniques and to their most famous applications in Earth Sciences; b) Students are able to independently conceptualize 1) the inter seismic strain accumulation for an earthquake and 2) inflation of a spherical reservoir (i.e. magma chamber of a volcano) or 3) water level change within aquifer. c) Students are then introduced to news techniques linking seismology and geodesy.

**Objective**

1. Plate Tectonics before Space Geodesy.
2. Geophysical Geodesy
3. GPS and deformation related to volcanoes (Practical on Muni source)
4. GPS, Strain, Stress and Plate motion.
5. InSAR applied to submarine and land deformation.
6. Troposphere sounding. Accuracies of GPS and InSAR.
7. Future of GPS. Future of InSAR.
8. GPS and geodynamics
9. GPS and normal modes?

**Lecture notes**

Slides. Script in English is planned. PDF of articles cited.

**Literature**

See webpage

**Pre-requisites / notice**

Geology and Geophysics equivalent to Bachelor program at ETH
Math of Bachelor program at ETH

---

**651-4103-00L Earthquakes Source Physics**

**W+ 3 credits  2G  S. Wiemer**

**Abstract**

The course teaches the fundamental principles to understand physical processes leading to and governing earthquake source ruptures. To obtain that understanding we cover topics ranging from friction and fault mechanics up to earthquake source descriptions. The acquired understanding will be applied to a topic of choice to practice research skills.

**Objective**

The aim of the course is to gain a thorough understanding of the physical processes leading to and governing earthquake source ruptures. This understanding will be applied to a topic of choice to practice research skills.

**Content**

We will cover a range of topics, including:
- Earthquake basics: definitions, faults, elastic rebound theory, and source parameters.
- Introduction to elastodynamics: strain, stress, equation of motion.
- Mathematical description of the source:
  - Representation theorem, point and extended sources, source spectra.
- Energy partitioning
- Source dynamics: Linear Elastic Fracture Mechanics
- Fault mechanics and friction
- Seismic cycle: inter-, co-, and post-seismic processes
- Aseismic creep and slow slip transients
- Earthquake source inversion and data assimilation
- Recurrence models
- Modeling of dynamic ruptures and seismic cycles

After a theoretical understanding has been acquired, we invite students to apply this knowledge to their topic of preference by presenting a group of state-of-the-art and/or classical papers as a final project. This will require them to understand and evaluate current challenges and state-of-the-art practices in earthquake physics. Additionally, this stimulates participants to improve their skills to:
- critically analyze (to be) published papers
- disseminate knowledge within their own and neighboring research fields
- formulate their opinion, new ideas and broader implications
- present their findings to an audience
- ask questions and actively participate in discussions on new scientific ideas

**Lecture notes**

Course notes will be available on a designated course web site. An overview of the discussed principles are available in the three books mentioned below.

**Literature**

This concerns a bi-yearly course that will be taught again in Fall 2017.

The course will be evaluated in 2 parts:
- a two hours final exam at the end of the course,
- a presentation discussing a topic of choice based on a group of suggested papers

The course is worth 3 credit points, and a satisfactory total grade (4 or better) is needed to obtain 3 ECTS. The final writing exam has a weight of 70% and the presentation weighs for 30%.

The course will be given in English.

Earthquake Seismology: Compulsory Courses

One additional elective course of at least 3KP has to be completed for this Module according to prior agreement with the Subject Advisor (Autumn or Spring Semester).

Geographic Information Systems

The courses of this module are offered by UZH and must be registered at UZH.

Geographic Information Systems: Compulsory Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>651-4267-00L</td>
<td>Specializing in Geographic Information Science V</td>
<td>W+</td>
<td>5 credits</td>
<td>2V+2U</td>
<td>University lecturers</td>
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<tr>
<td></td>
<td>(University of Zurich)</td>
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<tr>
<td></td>
<td>*No enrolment to this course at ETH Zurich. Book the</td>
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<td></td>
<td>corresponding module directly at UZH.</td>
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<tr>
<td></td>
<td>UZH Module Code: GEO372</td>
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Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

Geographic Information Systems: Courses of Choice

The Courses of Choice are offered by UZH and must be approved by the subject advisor.

Geomagnetics

Geomagnetics: Compulsory Courses

<table>
<thead>
<tr>
<th>Number</th>
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<tbody>
<tr>
<td>651-4107-00L</td>
<td>Rock and Environmental Magnetism</td>
<td>W+</td>
<td>3 credits</td>
<td>2G</td>
<td>A. M. Hirt</td>
</tr>
</tbody>
</table>

Abstract
Does not take place this semester.

Objective
There are two objectives in this course: (1) to acquire an understanding of the physical theory behind the origin of magnetism in a mineral or rock; and (2) to learn how material magnetic properties can be used to study environmental and geologic systems and processes.

Content
1. Fundamentals of magnetism
2. Magnetic mineralogy
3. Measurement techniques
4. Time
5. Special Topics: Magnetoclimatology, mass transport, pollution monitoring, biophysics, magnetic properties of nanoscale materials

Lecture notes
Available on-line

Geomagnetics: Courses of Choice

One additional elective course of at least 3KP has to be completed for this Module according to prior agreement with the Subject Advisor (Autumn or Spring Semester).

Glaciology

Glaciology: Compulsory Courses

<table>
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<tr>
<th>Number</th>
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</thead>
<tbody>
<tr>
<td>651-3561-00L</td>
<td>Cryosphere</td>
<td>W+</td>
<td>3 credits</td>
<td>2V</td>
<td>M. Funk, M. Huss, K. Steffen</td>
</tr>
</tbody>
</table>

Abstract
This course introduces the different parts of the cryosphere - snow, glaciers, sea ice, permafrost - and their role in the climate system. A significant physical aspect is the focus in each part. Those completing the course are able to describe the dynamics of cryosphere components both formally and using examples.

Objective
Students are able
- to qualitatively describe the main components of the cryosphere and their role in the climate system
- to formally describe the relevant physical processes which determine the state of cryosphere components

Content
Introduction into the different components of the Cryosphere: Snow, glaciers, sea ice and permafrost, and their roles in the climate system. Each part is use to emphasized on one specific physical aspect: material qualities of ice, mass balance and dynamics of glaciers and energy balance of sea ice.

Lecture notes
Handouts will be distributed during the teaching semester

Glaciology: Courses of Choice

One additional elective course of at least 3KP has to be completed for this Module according to prior agreement with the Subject Advisor (Autumn or Spring Semester).

Glaciology

Glaciology: Compulsory Courses

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Lecture notes
Handouts will be distributed during the teaching semester

Glaciology: Courses of Choice

One additional elective course of at least 3KP has to be completed for this Module according to prior agreement with the Subject Advisor (Autumn or Spring Semester).
Seismic tomography is the science of interpreting seismic measurements (seismograms) to derive information about the structure of the Earth. The subject of this course is the formal relationship existing between a seismic measurement and the nature of the Earth, or of certain regions of the Earth, and the ways to use it, to gain information about the Earth.

Abstract
Seismic tomography is the science of interpreting seismic measurements (seismograms) to derive information about the structure of the Earth. The subject of this course is the formal relationship existing between a seismic measurement and the nature of the Earth, or of certain regions of the Earth, and the ways to use it, to gain information about the Earth.

Objective
Comprehensiv understanding of evolution, mechanics, and rheology of divergent, convergent and wrenching tectonic systems from the lithospheric scale to local shallow crustal and outcrop-scales. Evaluation of plate tectonic and other orogenic processes through the study of reference examples of taken in Alps-Himalaya orogenic system.

Content
Comprehensiv understanding of evolution, mechanics, and rheology of divergent, convergent and wrenching tectonic systems from the lithospheric scale to local shallow crustal and outcrop-scales. Evaluation of plate tectonic and other orogenic processes through the study of reference examples of taken in Alps-Himalaya orogenic system.

Lecture notes
Basic knowledge about geomorphology and glaciers/permafrost from corresponding courses at ETH/UZH or from the related lecture notes

Literature
References in script

Prerequisites / notice
Basic knowledge about geomorphology and glaciers/permafrost from corresponding courses at ETH/UZH or from the related lecture notes

Prerequisites / notice
Physics of Glaciers

Lithosphere Structure and Tectonics

<table>
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<tr>
<th>Number</th>
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</thead>
<tbody>
<tr>
<td>651-4014-00L</td>
<td>Seismic Tomography</td>
<td>W+</td>
<td>3 credits</td>
<td>2G</td>
<td>E. Kissling, T. Diehl</td>
</tr>
</tbody>
</table>

Lithosphere Structure and Tectonics

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<tr>
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</thead>
<tbody>
<tr>
<td>651-3521-00L</td>
<td>Tectonics</td>
<td>W+</td>
<td>3 credits</td>
<td>2V</td>
<td>J.P. Burg, E. Kissling</td>
</tr>
</tbody>
</table>

Lithosphere Structure and Tectonics
Content

Plate tectonic frame work: earth cooling and mantle-plate interaction, three kinds of plate boundaries and their roles and characteristics, cycle of oceanic lithosphere, longfidelity and growth of continents, supercontinents.
Rheology of layered lithosphere and upper mantle.
Obduction systems
Collisions systems
Extensional systems
Basin evolution

ECTS

Erosion and sedimentation by glaciers as a function of topography, englacial temperature, sediment balance, sliding and melt water runoff.

University lecturers

ECTS

Type

Title

Knowledge of the most prominent climate-related geomorphological processes and phenomena in high-mountain regions, understanding of primary research challenges.

Hours

1P

Detailed scriptum in digital form and additional learning moduls (www.lead.ethz.ch) available on the intranet.

Paleontological Excursions (University of Zürich)

Reconstruction of time scales is critical for all Quaternary studies in both Geology and Archeology. Various methods are applied depending on the time range of interest and the archive studied. In this lecture we focus on the six methods that are most frequently used for dating Quaternary sediments and landforms.

I. Hajdas


Mind the enrolment deadlines at UZH:

http://www.uzh.ch/studies/application/mobilitaet_en.html

Prerequisites / notice

Visit to radiocarbon lab, cosmogenic nuclide lab, noble gas lab, accelerator (AMS) facility.

At the end of the course students will:
1. understand the fundamental principles of the most frequently used dating methods for Quaternary studies.
2. be able to calculate an age based on data of the six methods studied.
3. choose which dating method (or combination of methods) is suitable for a certain field problem.
4. critically read and evaluate the application of dating methods in scientific publications.

Content

1. Introduction: Time scales for the Quaternary, Isotopes and decay
2. Radiocarbon dating: principles and applications
3. Cosmogenic nuclides: 3He,10Be, 14C, 21Ne, 26Cl, 36Cl
4. U-series disequilibrium dating
5. Luminescence dating
6. K/Ar and Ar/Ar dating of lava flows and ash layers
7. Cs-137 and Pb-210 (soil, sediments, ice core)
8. Summary and comparison of results from several dating methods at specific sites

Quaternary Dating Methods

Students will be made familiar with the details of the six dating methods through lectures on basic principles, analysis of case studies, solving of problem sets for age calculation and visits to dating laboratories.

At the end of the course students will:
1. understand the fundamental principles of the most frequently used dating methods for Quaternary studies.
2. be able to calculate an age based on data of the six methods studied.
3. choose which dating method (or combination of methods) is suitable for a certain field problem.
4. critically read and evaluate the application of dating methods in scientific publications.

Content

1. Introduction: Time scales for the Quaternary, Isotopes and decay
2. Radiocarbon dating: principles and applications
3. Cosmogenic nuclides: 3He,10Be, 14C, 21Ne, 26Cl, 36Cl
4. U-series disequilibrium dating
5. Luminescence dating
6. K/Ar and Ar/Ar dating of lava flows and ash layers
7. Cs-137 and Pb-210 (soil, sediments, ice core)
8. Summary and comparison of results from several dating methods at specific sites

Quaternary sediments and landforms.

Quaternary Dating Methods

Students will be made familiar with the details of the six dating methods through lectures on basic principles, analysis of case studies, solving of problem sets for age calculation and visits to dating laboratories.

At the end of the course students will:
1. understand the fundamental principles of the most frequently used dating methods for Quaternary studies.
2. be able to calculate an age based on data of the six methods studied.
3. choose which dating method (or combination of methods) is suitable for a certain field problem.
4. critically read and evaluate the application of dating methods in scientific publications.

Prerequisites / notice

Visit to radiocarbon lab, cosmogenic nuclide lab, noble gas lab, accelerator (AMS) facility.

At the end of the course students will:
1. understand the fundamental principles of the most frequently used dating methods for Quaternary studies.
2. be able to calculate an age based on data of the six methods studied.
3. choose which dating method (or combination of methods) is suitable for a certain field problem.
4. critically read and evaluate the application of dating methods in scientific publications.
Remote Sensing

The courses of this module are offered by UZH and must be registered at UZH.

Remote Sensing: Compulsory Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>651-4263-00L</td>
<td>Remote Sensing and Geographic Information Science V (University of Zürich)</td>
<td>W+</td>
<td>5 credits</td>
<td>2V+2U</td>
<td>University lecturers</td>
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<tr>
<td></td>
<td>No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: GEO371</td>
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<td>Mind the enrolment deadlines at UZH: <a href="http://www.uzh.ch/studies/application/mobilitaet_en.html">http://www.uzh.ch/studies/application/mobilitaet_en.html</a></td>
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Remote Sensing: Courses of Choice

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<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
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<tbody>
<tr>
<td>651-4269-00L</td>
<td>Specialisation in Remote Sensing: Spectroscopy of the Earth System (University of Zurich)</td>
<td>W</td>
<td>6 credits</td>
<td>2V+2U</td>
<td>University lecturers</td>
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<td></td>
<td>No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: GEO442</td>
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<td></td>
<td>Prerequisite: Remote Sensing Methods (UZH Module Code: GEO371)</td>
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<tbody>
<tr>
<td>651-4257-00L</td>
<td>Specialisation in Remote Sensing: SAR and Lidar (University of Zurich)</td>
<td>W</td>
<td>6 credits</td>
<td>2V+2U</td>
<td>University lecturers</td>
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<td></td>
<td>No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: GEO443</td>
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<td></td>
<td>Prerequisite: Remote Sensing Methods (UZH Module Code: GEO371)</td>
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Shallow Earth Geophysics

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<tbody>
<tr>
<td>651-4109-00L</td>
<td>Geothermal Energy</td>
<td>W+</td>
<td>3 credits</td>
<td>3G</td>
<td>K. F. Evans, P. Bayer, D. Karvounis, M. O. Saar, F. Samrock</td>
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</table>

Abstract
The course will introduce students to the general principles of Geothermics and is suitable for students who have a basic knowledge of Geoscience or Environmental Science (equivalent of a Bachelor degree).

Objective
To provide students with a broad understanding of the systems used to exploit geothermal energy in diverse settings.

Content
The course will begin with an overview of heat generation and the thermal structure of the Earth. The basic theory describing the flow of heat in the shallow crust will be covered, as will be the methods used to measure it. Petrophysical parameters of relevance to Geothermics, such as thermal conductivity, heat capacity and radiogenic heat productivity, are described together with the laboratory and borehole measurement techniques used to estimate their values. The focus will then shift towards the exploitation of geothermal heat at various depths and temperatures, ranging from electricity and heat production in various types of deep geothermal systems (including high and medium temperature hydrothermal systems, and Engineered Geothermal Systems at depths of 5 km or more), to ground-source heat pumps installed in boreholes at depths of a few tens to hundreds of meters for heating domestic houses. The subjects covered are as follows:

- Week 1: Introduction. Earth's thermal structure. Conductive heat flow
- Week 3: Temperature measurement. Hydrothermal reservoirs & well productivity
- Week 4: Hydrological characterisation of reservoirs. Drilling. Optimized systems
- Week 5: Petrothermal or Engineered Geothermal Systems
- Week 6: Low-enthalpy systems
- Week 7: Low-enthalpy systems
- Week 8: Low-enthalpy systems

Lecture notes
The script for each class will be available for download from the Ilias website no later than 1 day before the class.

Modules from the Engineering Geology Major
Choice from Engineering Geology Required Modules

Modules from the Geophysics Major
Choice from Geophysics Compulsory Modules
Choice from Geophysics Restricted Choice Modules

Modules from the Mineralogy and Geochemistry Major
Choice from the Mineralogy and Geochemistry Restricted Choice Modules

Modules from the Major Geology Restricted Choice Modules
Choice from the Geology Restricted Choice Modules

Major in Engineering Geology

Compulsory Modules Engineering Geology

Engineering Geology: Fundamentals

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<th>Number</th>
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<tr>
<td>651-4025-00L</td>
<td>Rock Mechanics and Rock Engineering</td>
<td>W+</td>
<td>4 credits</td>
<td>4V+2U</td>
<td>F. Amann, R. Jalali, K. Leith, M. Perras</td>
</tr>
</tbody>
</table>

Abstract
This course focusses on the principles (fundamentals) and basic concepts of rock mechanics and rock engineering (e.g. tunnelling, rock slope stability).

Objective
The course aims to introduce the fundamentals and basic concepts of rock mechanics and generic rock engineering. The student shall understand how rocks behave at different scales, under various artificial loads and in the shallow subsurface (a few km below ground). The link between rock mechanics, geology, hydrogeology and tectonics (i.e. the conditions under which the rock formed) will be clearly established.

The student shall understand basic principles of rock mechanics and rock engineering. In addition, the student shall learn how to carry out laboratory tests, to interpret these tests and to apply the results from lab and field investigations to simple engineering problems. This knowledge is required for subsequent integration courses (Landslide Analysis and Hazard Mitigation; Engineering Geology of Underground Excavations).

Content
This course focusses on the principles (fundamentals) and basic concepts of rock mechanics and generic rock engineering. The behavior of different rock types is studied with laboratory investigations which are linked to the theoretical aspects discussed in lectures and applied in exercises. The course is compulsory for the MSc Eng Geol. The applications of rock mechanical principles and rock engineering methods are extensively covered in subsequent courses.

Lecture notes
Written course documentation available on our homepage: www.engineeringgeology.ethz.ch

651-4033-00L Soil Mechanics and Foundation Engineering

Abstract
The course presents the principles of soil mechanics and soil behaviour characteristics and its applications in geotechnical structures and systems. It is based on more descriptive courses on Engineering Geology within the BSc Geol. Program and is a compulsory prerequisite for other courses within the MSc Eng. Geol. program.

Objective
Understanding the principles of soil behaviour and the fundamentals of geotechnical practices in soils. Ability to communicate with geotechnical engineers.

Content
Soil Mechanics:
Fundamental concepts of strength and deformation of different soils. Introduction to geotechnical calculations
Significance of (ground)water
Geotechnical Engineering in Soils:
Evaluation of geotechnical scenarios, handling of forecast uncertainties, relation of soil properties and soil composition, interactions between soil and building,
standard construction methods in soils (foundations, slopes, dams and levees),
requirements for the geotechnical prognosis

Lecture notes
This lecture is supported by the textbook: "Geotechnical Engineering" by Donald P. Coduto, 2nd edition, 2011; ISBN-13: 978-0-13-135425-8

Prerequisites / notice
Courses must be completed:
Introduction to Engineering Geology (BSc level)
Introduction to Groundwater
Sedimentology and Quaternary deposits
Principles of Physics

Courses recommended:
Eng Geol Site Investigations
Eng Geol Field Course I (soils)
Clay Mineralogy

651-4023-00L Groundwater

Abstract
The course provides an introduction into quantitative analysis of groundwater flow and solute/heat transport. It is focussed on understanding, formulating, and solving groundwater flow and solute/heat transport problems.

Objective
a) Students understand the basic concepts of groundwater flow and solute/heat transport processes and boundary conditions.
b) Students are able to formulate simple, practical groundwater flow and solute/heat transport problems.
c) Students are able to understand and apply simple analytical and/or numerical solutions to fluid flow and solute/heat transport problems.
Content

1. Introduction to groundwater problems. Concepts to quantify properties of aquifers.
2. Flow equation. The generalised Darcy law.
3. The water balance equation.
5. Analytical solutions to flow problems I
6. Analytical solutions to flow problems II
7. Finite difference solution to flow problems.
12. Analytical solutions to transport problems I.
13. Analytical solutions to transport problems II

Lecture notes

Handouts of slides.

Literature

de Marsily G., Quantitative Hydrogeology, Academic Press, 1986

Engineering Geology: Methods

Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
651-4065-00L | Geological Site Investigations | W+ | 3 credits | 3G | M. Ziegler, A. Manconi

Abstract
This course introduces students to the methods used in characterising, developing or monitoring geotechnical engineering project sites. Measurements, tools and analyses are described that are relevant to determining the geologic conditions at a site as well as deformations that occur under natural or construction conditions.

Objective
This course aims to introduce the general procedures taken during a engineering geological site investigation. Students who complete the course should be able to design a site investigation program of measurements based on information from initial desk studies, and to analyse, integrate and interpret data from the measurement program.

Content
The methods that are routinely employed in site investigations will be described focusing on their applicability in different geologic environments. The limitations of the data in constraining the parameters of interest will be addressed together with problems of interpretation and cost-versus-information value. Specific topics addressed include drilling, coring, sampling, borehole testing, geophysical methods used in engineering geology, satellite, air- and ground-based surface and displacement monitoring (photogrammetry, LIDAR and Radar), and in-situ deformation measurement methods.

Lecture notes
Lecture notes will be available for download 1-2 days before each class.

Literature
Online (ETH): http://www.icevirtuallibrary.com/content/book/100017

Supplemental literature will be suggested and made available during the course.

Engineering Geology: Integration

Courses for this Module take place in spring semester.

Engineering Geology: Industrial Internship

Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
651-4071-00L | Industrial Internship | W+ | 12 credits | 32P | B. Oddsson, E. Kreuzer

Prerequisites: successful participation in all 3 compulsory modules of the Major in Engineering Geology (Fundamentals, Methods and Integration).

The Industrial Internship of the Eng Geol Major should take place in the second MSc year after consultation with Dr. Ernst Kreuzer. Detailed regulations of this practical are published on the Eng Geol Website.
The industry practical is supervised both from the industry partner and ETH and consists of technically and/or scientifically challenging work in the engineering geology domain. The regular duration of the practical is 2.5 month. The practical is pre-defined in a work plan and concluded with a report written by the student.

The goals of the industry practical are to become familiar with technical, economic, legal and communication issues of real-life work in private industry or technical administration.

**Major in Geophysics**

**Compulsory Modules Geophysics**

**Geophysical Data Processing**

**Number** 651-4005-00L

**Title** Geophysical Data Processing

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<tbody>
<tr>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>C. V. Cauzzi</td>
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</table>

**Abstract**

This course presents fundamental digital signal processing and filter theory with a focus on geophysical applications.

**Objective**

The goal of the course is to provide an understanding of the principles of digital signal processing and filter theory. Form: two hours lecture with two hours of computer based exercises per week over 7 weeks.

**Content**

Analog-digital conversion: dynamic range and resolution; Dirac-impulse, step function; Laplace transformation; Z-transformation; Differential equations of linear time-invariant systems; Examples: seisometer and RC-filter; Impulse response and transfer function; Frequency selective filters: example Butterworth filters; Digital filters: impulse invariance and bilinear transformation; Inverse filters; Response spectra.

**Lecture notes**

Lecture notes will be made available for download from the website of the course.

**Literature**

The class follows no single book. A list of relevant texts will be given in class.

**Prerequisites / notice**

Students must bring their own laptop in class for Matlab exercises.

**Numerical Modelling I and II: Theory and Applications**

**Number** 651-4241-00L

**Title** Numerical Modelling I and II: Theory and Applications

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<th>Type</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>W+</td>
<td>6</td>
<td>4G</td>
<td>T. Gerya</td>
</tr>
</tbody>
</table>

**Abstract**

In this 13-week sequence, students learn how to write programs from scratch to solve partial differential equations that are useful for Earth science applications. Programming will be done in MATLAB and will use the finite-difference method and marker-in-cell technique. The course will emphasise a hands-on learning approach rather than extensive theory.

**Objective**

The goal of this course is for students to learn how to program numerical applications from scratch. By the end of the course, students should be able to write state-of-the-art MATLAB codes that solve systems of partial-differential equations relevant to Earth and Planetary Science applications using finite-difference method and marker-in-cell technique. Applications include Poisson equation, buoyancy driven variable viscosity flow, heat diffusion and advection, and state-of-the-art thermomechanical code programming. The emphasis will be on commonality, i.e., using a similar approach to solve different applications, and modularity, i.e., re-use of code in different programs. The course will emphasise a hands-on learning approach rather than extensive theory, and will begin with an introduction to programming in MATLAB.

**Content**

A provisional week-by-week schedule (subject to change) is as follows:

- **Week 1:** Introduction to the finite difference approximation to differential equations. Introduction to programming in Matlab. Solving of 1D Poisson equation.
- **Week 2:** Direct and iterative methods for obtaining numerical solutions. Solving of 2D Poisson equation with direct method. Solving of 2D Poisson equation with Gauss-Seidel and Jacobi iterative methods.
- **Week 3:** Solving momentum and continuity equations in case of constant viscosity with stream function/vorticity formulation. Weeks 4-5: Staggered grid for formulating momentum and continuity equations. Indexing of unknowns. Solving momentum and continuity equations in case of constant viscosity using pressure-velocity formulation with staggered grid.
- **Week 5:** Conservative finite differences for the momentum equation. "Free slip" and "no slip" boundary conditions. Solving momentum and continuity equations in case of variable viscosity using pressure-velocity formulation with staggered grid.
- **Week 6:** Advection in 1-D. Eulerian methods. Marker-in-cell method. Comparison of different advection methods and their accuracy.
- **Week 7:** Advection in 2-D with Marker-in-cell method. Combining flow calculation and advection for buoyancy driven flow.
- **Week 8:** "Free surface" boundary condition and "sticky air" approach. Free surface stabilization. Runge-Kutta schemes.
- **Week 9:** Solving 2D heat conservation equation in case of constant thermal conductivity with explicit and implicit approaches. Temperature advection with markers. Creating thermomechanical code by combining mechanical solution for 2D buoyancy driven flow with heat diffusion and advection based on marker-in-cell approach.
- **Week 10:** Subgrid diffusion of temperature. Implementing subgrid diffusion to the thermomechanical code.
- **Week 12:** Implementation of radioactive, adiabatic and shear heating to the thermomechanical code.
- **Week 13:** Implementation of temperature-, pressure- and strain rate-dependent viscosity, temperature- and pressure-dependent density and temperature-dependent thermal conductivity to the thermomechanical code. Final project description.

**Literature**

Taras Gerya, Introduction to Numerical Geodynamic Modelling, Cambridge University Press 2010

**Geophysical Fluid Dynamics**

**Number** 651-4001-00L

**Title** Geophysical Fluid Dynamics

<table>
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<tr>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>J. A. R. Noir</td>
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</table>

**Abstract**

Fluid mechanics is one of the fundamental building blocks of modern geophysics. This course aims to provide the students with the basics tools used in fluid dynamics studies of geophysical-astrophysical problems. The course is a combination of lectures, exercises and demo experiments to present the same concepts in various forms.

**Objective**

The goal of this course is to develop familiarity with basic fluid dynamical concepts relevant to geophysical and astrophysical problems.

**Content**

(i) Basic concepts.
(ii) Conservation Laws.
(iii) Dynamical similarity and scale analysis.
(iv) The inviscid approximation.
(v) Streamlines-Streamfunctions.
(vi) Elements of boundary layer theory - Application to viscous boundary layer.
(vii) Vorticity-Concept and Examples.
(viii) Introduction to rotating fluid.
(ix) Viscous boundary layer in rotating fluid.
(x) Non-rotating thermal convection.
(xi) Introduction to rotating thermal convection.

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Data: 06.03.2019 12:57  Autumn Semester 2016  Page 584 of 1571
Lecture notes  Primary Text: Tritton, Physical Fluid Dynamics (OUP)

651-4007-00L  Continuum Mechanics  W+  3 credits  2V  T. Gerya

Abstract  In this course, students learn crucial partial differential equations (conservation laws) that are applicable to any continuum including the Earth's mantle, core, atmosphere and ocean. The course will provide step-by-step introduction into the mathematical structure, physical meaning and analytical solutions of the equations. The course has a particular focus on solid Earth applications.

Objective  The goal of this course is to learn and understand few principal partial differential equations (conservation laws) that are applicable for analysing and modelling of any continuum including the Earth's mantle, core, atmosphere and ocean. By the end of the course, students should be able to write, explain and analyse the equations and apply them for simple analytical cases. Numerical solving of these equations will be discussed in the Numerical Modelling I and II course running in parallel.

Content  A provisional week-by-week schedule (subject to change) is as follows:

Week 1: The continuity equation
Theory: Definition of a geological media as a continuum. Field variables used for the representation of a continuum. Methods for definition of the field variables. Eulerian and Lagrangian points of view. Continuity equation in Eulerian and Lagrangian forms and their derivation.
Exercise: Computing the divergence of velocity field.

Week 2: Density and gravity
Exercise: Computing density, thermal expansion and compressibility from an equation of state.

Week 3: Stress and strain
Exercise: Analysing strain rate tensor for solid body rotation.

Week 4: The momentum equation
Exercise: Computing velocity for magma flow in a channel.

Week 5: Viscous rheology of rocks
Theory: Solid-state creep of minerals and rocks as themajor mechanism of deformation of the Earths interior. Dislocation and diffusion creep mechanisms. Rheological equations for minerals and rocks. Effective viscosity and its dependence on temperature, pressure and strain rate. Formulation of the effective viscosity from empirical flow laws.
Exercise: Deriving viscous rheological equations for computing effective viscosities from empirical flow laws.

Week 6: The heat conservation equation
Exercise: steady temperature profile in case of channel flow.

Week 7: Elasticity and plasticity

GRADING will be based on homeworks (30%) and oral exams (70%).

Lecture notes  Script is available by request to taras.gerya@erdw.ethz.ch
Exam questions: http://www.erdw.ethz.ch/people/geophysics/tgerya/EXAM_QUESTIONS

Literature  Taras Gerya Introduction to Numerical Geodynamic Modelling Cambridge University Press, 2010

651-4130-00L  Mathematical Methods  W+  3 credits  2G  A. Kuvshinov, A. Grayver

Abstract  The course will guide students in learning about solutions of partial differential equations arising in connection with various physical problems. Special attention will be paid to the solutions of Laplace's equation in spherical and cylindrical polars. In addition the basics of vector calculus will be discussed in order to support Geophysical Fluid Dynamics and Potential Field Theory courses.

Objective  The course will guide students in learning about solutions of partial differential equations arising in connection with various physical problems. Special attention will be paid to the solutions of Laplace's equation in spherical and cylindrical polars. In addition the basics of vector calculus will be discussed in order to support Geophysical Fluid Dynamics, Potential Field Theory and Earth's Core and the Geodynamo courses.

Content  Introduction to partial differential equations, Sturm-Liouville problem, eigenvalues and eigenfunctions, orthogonality, orthogonal expansion, method of separation of variables, solution of 1-D heat equation, basics of vector algebra, vector calculus, curvilinear coordinates, differential operations in curvilinear coordinates, solution of Laplace's equation in spherical polar coordinates, Legendre and associated Legendre polynomials, spherical harmonics, solution of Laplace's equation in cylindrical polar coordinates, Bessel functions, integral theorems, solution of Maxwell's equations in spherically uniform Earth, delta and Green's functions, integral equation concept, basics of tensor analysis.

Lecture notes  Current lecture notes and homeworks will be found during the course at www.polybox.ethz.ch

1. E. Kreyszig, *Advanced engineering mathematics*
2. M. Boas, *Mathematical methods in the physical science*
4. R. Snieder, "A guided tour of mathematical methods for the physical sciences"

Restricted Choice Modules Geophysics

Seismology

Number  Title  Type  ECTS  Hours  Lecturers
651-4019-00L  Wave Propagation  W+  3 credits  2G  D. Fäh, W. Imperatori

Abstract  The course is a general introduction to the theory of seismic wave propagation. It explains the principles and assumptions used in seismology. It provides the tools to solve basic seismological problems.

Objective  The course is a general introduction to the theory of seismic wave propagation.
The course explains the principles and assumptions used in seismology. It provides the tools to solve basic seismological problems. The course includes the theorems in dynamic elasticity, the formulation with potentials, Greens function, elastic waves from point dislocation sources, moment tensors, 1D, 2D, and 3D wave propagation problems, reflection and transmission at plane boundaries, and surface waves in a vertically heterogeneous medium.

If you're interested in knowing more about the relationship between seismicity and plate tectonics, this is the course for you. (If you're not that interested, but yr program of study requires that you complete this course, this is also the course for you.)

To begin our series of 14 meetings, we will review fundamentals of continuum mechanics and tensor analysis; our goal is to help you understand deformation from the scale of consturnach to the scale of plate tectonics. We will tell you about several ways to approximately represent an earthquake source; we'll present these in order of increasing sophistication. We'll discuss a currently-popular theory to explain earthquake triggering. We'll talk about the conceptual connections between earthquakes and tectonic deformation. You will enjoy (at least) two computer exercises.

Discussed: stress and deformation in the Earth; stress and strain tensors; rheology and failure criteria; fault stresses, friction and effects of fluids; stable and unstable sliding; earthquake focal mechanisms; relationship between stress fields and focal mechanisms; seismic moment and moment tensors; relationship between moment- and deformation tensors; crustal deformation from seismic, geologic, and geodetic observations; earthquake stress drop, scaling, and source parameters; earthquake induced stress changes; global earthquake distribution; current global earthquake activity; different seismotectonic regions; examples of earthquake activity in different tectonic settings, such as in subduction zones, California, the Mediterranean, and in Switzerland.

You should have at least a foggy recollection of calculus.

This course is a general introduction to the methods of seismic hazard analysis. It provides an overview of the input data and the tools in deterministic and probabilistic seismic hazard assessment, and discusses the related uncertainties.

This course is a general introduction to the methods of seismic hazard analysis.

In the course it is explained how the disciplines of seismology, geodynamics, strong-motion geophysics, and earthquake engineering contribute to the evaluation of seismic hazard. It provides an overview of the input data and the tools in deterministic and probabilistic seismic hazard assessment, and discusses the related uncertainties. The course includes the discussion related to Intensity and macroseismic scales, historical seismicity and earthquake catalogues, ground motion parameters used in earthquake engineering, definitions of the seismic source, ground motion attenuation, site effects and microzoning, and the use of numerical tools to estimate ground motion parameters, both in a deterministic and probabilistic sense.

During the course recent earthquakes and their impacts are discussed and related to existing hazard assessments for the areas of interest.

This course aims to give a physical understanding of the formation, structure, dynamics and evolution of planetary bodies in our solar system and also apply it to ongoing discoveries regarding planets around other stars.

The goal of this course is to enable students to understand current knowledge and uncertainties regarding the formation, structure, dynamics and evolution of planets and moons in our solar system, as well as ongoing discoveries regarding planets around other stars. Students will practice making quantitative calculations relevant to various aspects of these topics through weekly homeworks.

The following gives an overview of the course content and approximate schedule (subject to change).

- Introduction
- Orbital dynamics and Tides
- Solar heating and Energy transport
- Planetary atmospheres
- Planetary surfaces
- Planetary interiors
- Asteroids and Meteorites
- Comets
- Planetary rings
- Magnetic fields and Magnetospheres
- The Sun and Stars
- Planetary formation
- Exoplanets and Exobiology
- Review

It is recommended but not mandatory to buy one of these books:

Fundamental Planetary Science, by Jack J. Lissauer & Imke de Pater (paperback), Cambridge University Press, 2013. (books.ch Fr64.90, amazon.co.uk £35.00, amazon.de €38.81, amazon.com $49.26).

The compulsory courses take place in spring semester.

►►► Applied Geophysics: Courses of Choice
The compulsory Courses for the Module Applied Geophysics take place in Spring Semester. One additional elective course of at least 3KP has to be completed for this Module according to prior agreement with the Subject Advisor of the Geophysics Major (Autumn or Spring Semester).

► Major in Mineralogy and Geochemistry

►► Compulsory Module in Analytical Methods in Earth Sciences
Students have to complete 6 credits in part A (microscopy courses), and 6 credits in part B (methods).

►► Microscopy Courses
Compulsory Module in Analytical Methods in Earth Sciences: Microscopy Courses

►► Analytical Methods Courses
Compulsory Module in Analytical Methods in Earth Sciences: Analytical Methods Courses

►► Restricted Choice Modules Mineralogy and Geochemistry
A minimum of two restricted choice modules must be completed in the major Mineralogy and Geochemistry.

►►► Mineralogy and Petrology

►►► Mineralogy and Petrology: Compulsory Courses

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>651-4028-00L</td>
<td>Physical Properties of Minerals</td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>E. Reusser</td>
</tr>
<tr>
<td>Abstract</td>
<td>Physical properties of minerals, e.g. electrical properties, elastic properties are discussed. The effect of the crystal symmetry on the symmetry of physical properties as well as the mathematical formulation of the physical properties are major topics.</td>
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<tbody>
<tr>
<td>651-4039-00L</td>
<td>Thermodynamics Applied to Earth Materials</td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>J. Connolly</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course develops the thermodynamic concepts necessary to predict phase equilibria and to compute physical properties from thermodynamic data.</td>
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<tr>
<td>Objective</td>
<td>To provide students with the conceptual and practical skills necessary to implement thermodynamic models and data as provided in the earth science literature. The computer software package Maple is relied upon to allow students to solve realistic problems without the distraction of mathematical details.</td>
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<tr>
<td>Content</td>
<td>Elementary concepts (1st and 2nd Laws; composition, state and extent); stability criteria; Legendre transforms; Maxwell relations and other manipulations of thermodynamic functions; calculation of Gibbs energy for a pure solid; simple solution models; order-disorder solution models; reciprocal solution models; equations of state for molecular fluids; free energy minimization.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>The course is neither an introduction to computer methods for calculating petrological phase equilibria nor an introduction to phase diagram methods. Some familiarity with elementary thermodynamics (phase rule, reactions) and mathematics (differentiation, integration) is assumed. Experience with Maple or comparable programs such as Mathematica is helpful.</td>
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►►► Mineralogy and Petrology: Courses of Choice

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<tbody>
<tr>
<td>651-4063-00L</td>
<td>X-ray Powder Diffraction</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>L. M. Plötze</td>
</tr>
<tr>
<td>Number of participants limited to 12.</td>
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<tr>
<td>Abstract</td>
<td>In the course the students learn to measure X-ray diffraction patterns of minerals and to evaluate these using different software for qualitative and quantitative mineral composition as well as crystallographic parameters.</td>
<td></td>
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<tr>
<td>Objective</td>
<td>Upon successful completion of this course students are able to:</td>
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<tr>
<td>Content</td>
<td>- describe the principle of X-ray diffraction analysis</td>
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</tr>
<tr>
<td>Literature</td>
<td>Selected handouts will be made available in the lecture</td>
<td></td>
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<tr>
<td>Prerequisites / notice</td>
<td>The course includes a high portion of practical exercises in sample preparation as well as measurement and evaluation of X-ray powder diffraction data. Own sample will be analysed qualitatively and quantitatively. Knowledge in mineralogy of this system is essential. The lecture course is limited to 12 participants.</td>
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<tbody>
<tr>
<td>651-4223-00L</td>
<td>Phase Petrology</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>L. Tajcmanová</td>
</tr>
<tr>
<td>Abstract</td>
<td>A comprehensive introduction to heterogeneous phase equilibria in the geosciences.</td>
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<tr>
<td>Objective</td>
<td>The aim of the course is to give insight into processes that lead to the formation of magmatic and metamorphic rocks.</td>
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</table>
The specific topics will involve:
Mineral reactions and chemical equilibrium in metamorphic and magmatic rocks, recalculation of rock and mineral analyses, mineral modes, P-T-X relations.

Literature
1) the blue book by F Spear 1993 Metamorphic phase equilibria and pressure-temperature-time paths. MSA Mongraph
2) Principles of Metamorphic Petrology; Ron H. Vernon, Geoffrey Clarke

**Petrology and Volcanology**

**Petrology and Volcanology: Compulsory Courses**

*The compulsory courses take place in spring semester.*

**Petrology and Volcanology: Courses of Choice**

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<td>651-4063-00L</td>
<td>X-ray Powder Diffraction</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>L. M. Plötzé</td>
</tr>
</tbody>
</table>

Number of participants limited to 12.

In the course the students learn to measure X-ray diffraction patterns of minerals and to evaluate these using different software for qualitative and quantitative mineral composition as well as crystallographic parameters.

Upon successful completion of this course students are able to:
- describe the principle of X-ray diffraction analysis
- carry out a qualitative and quantitative mineralogical analysis independently,
- critically assess the data,
- communicate the results in a scientific report.

Fundamental principles of X-ray diffraction
Setup and operation of X-ray diffractometers

Interpretation of powder diffraction data

Qualitative and quantitative phase analysis of crystalline powders (e.g. with Rietveld analysis)

Selected handouts will be made available in the lecture


The course includes a high portion of practical exercises in sample preparation as well as measurement and evaluation of X-ray powder diffraction data.

Own sample will be analysed qualitatively and quantitatively. Knowledge in mineralogy of this system is essential.

The lecture course is limited to 12 participants.

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</thead>
<tbody>
<tr>
<td>651-4233-00L</td>
<td>Geotectonic Environments and Deep Global Cycles</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>M. W. Schmidt, P. Ulmer</td>
</tr>
</tbody>
</table>

This course addresses master students interested in in integral view of processes operating in various tectonic environments, most specifically divergent and convergent plate margins

Number of participants limited to 12.

In the course the students learn to measure X-ray diffraction patterns of minerals and to evaluate these using different software for qualitative and quantitative mineral composition as well as crystallographic parameters.

Upon successful completion of this course students are able to:
- communicate the results in a scientific report.
- carry out a qualitative and quantitative mineralogical analysis independently,
- critically assess the data,
- describe the principle of X-ray diffraction analysis

Fundamental principles of X-ray diffraction
Setup and operation of X-ray diffractometers

Interpretation of powder diffraction data

Qualitative and quantitative phase analysis of crystalline powders (e.g. with Rietveld analysis)

Selected handouts will be made available in the lecture


The course includes a high portion of practical exercises in sample preparation as well as measurement and evaluation of X-ray powder diffraction data.

Own sample will be analysed qualitatively and quantitatively. Knowledge in mineralogy of this system is essential.

The lecture course is limited to 12 participants.
### Mineral Resources: Compulsory Courses

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<tbody>
<tr>
<td>651-4097-00L</td>
<td>Applied Mineralogy and Non-Metallic Resources I</td>
<td>W+</td>
<td>3 credits</td>
<td>2G</td>
<td>R. Kündig, C. Bühler</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>Geological and mineralogical aspects to important non-metallic mineral resources. Industrial use of specific mineral resources as well as economic, strategic and environmental aspects are discussed. Examples from all over the world with a specific focus on the non-mineral mineral resources potential in Switzerland.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>Students will learn to understand the use of non-metallic mineral resources from a geological and mineralogical point of view as well as from an industrial, technical and strategic (political) point of view. Environmental aspects on the worldwide use of non-metallic mineral resources are discussed. A special focus will be given on the situation in Switzerland.</td>
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<tr>
<td><strong>Content</strong></td>
<td>Teaching, case-studies and excursions (e.g. raw-material industry).</td>
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<tr>
<td><strong>Course “Applied mineralogy and non-metallic resources I”</strong> (autumn/winter semester):</td>
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<tr>
<td>Non-metallic resources. Occurrences, geology, extraction, properties, fabrication and use. Industrial aspects, (new) technologies, market, stock, situation, reserves &amp; resources, trends and development, environmental aspects, law.</td>
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<tr>
<td>Chapters: e.g. coal/carbon (coal, graphite, diamond, fullerene); oil/gas (oil- and tarsands, oil-shists); phosphates/nitrates; aluminum (bauxite, corundum); salt; carbonates; titanium; clay and clay minerals; sulphur; gypsum/anhydrite; fluoriges; asbestos; talc; micas; rare earth elements.</td>
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<tr>
<td><strong>Course “Applied mineralogy and non-metallic resources II”</strong> (fall/summer semester):</td>
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<td>Chapters: e.g. Stone industry - technical aspects of building stones, properties, weathering, treatment, quarries, products. Crushed stones - quarries, products, planning, environment. Gravel an sand - resources/reserves, environment (protection/law), alternative products (substitution). Cement and concrete (geological resources, prospection, fabrication, environment).</td>
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<tr>
<td><strong>Lecture notes</strong></td>
<td>Will be given according to the lessons. Partially integration of e-learning tools.</td>
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### Mineral Resources: Courses of Choice

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<tr>
<td>651-4037-00L</td>
<td>Ore Deposits I</td>
<td>W+</td>
<td>3 credits</td>
<td>2G</td>
<td>C. A. Heinrich</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>Principles of hydrothermal ore formation, using base metal deposits (Cu, Pb, Zn) in sedimentary basins to explain the interplay of geological, chemical and physical factors from global scale to sample scale. Introduction to orthomagmatic ore formation (mostly Cr, Ni, PGE).</td>
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<tr>
<td><strong>Objective</strong></td>
<td>Understanding the fundamental processes of hydrothermal and magmatic ore formation, recognising and interpreting mineralised rocks in geological context</td>
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<tr>
<td><strong>Content</strong></td>
<td>(a) Principles of hydrothermal ore formation: base metal deposits in sedimentary basins. Practical classification of sample suites by genetic ore deposit types</td>
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<tr>
<td>- Mineral solubility and ore deposition, principles &amp; thermodynamic prediction using activity diagrams. Stable isotopes in ore-forming hydrothermal systems (O, H, C, S) Driving forces and structural focussing of hydrothermal fluid flow</td>
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<tr>
<td>(b) Introduction to orthomagmatic ore formation. Chromite, Ni-Cu sulphides and PGE in layered mafic intrusions. Distribution coefficients between silicate and sulphide melts. Carbonatites and pegmatite deposits.</td>
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<tr>
<td><strong>Lecture notes</strong></td>
<td>Notes handed out during lectures</td>
<td></td>
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</tr>
<tr>
<td><strong>Literature</strong></td>
<td>Extensive literature list distributed in course</td>
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<tr>
<td><strong>Prerequisites / notice</strong></td>
<td>2 contact hours per lecture / week including lectures, exercises and practical study of samples, and small literature-based student presentations. Supplementary contact for sample practicals and exercises as required. Credits and mark based on participation in course (exercises, 50%) and 1h written exam in the last lecture of the semester (50%).</td>
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### Mineral Resources: Courses of Choice

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<tbody>
<tr>
<td>651-4069-00L</td>
<td>Fluid and Melt Inclusions: Theory and Practice</td>
<td>W</td>
<td>3 credits</td>
<td>3P</td>
<td>C. A. Heinrich, T. Driesner, O. Laurent</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>Block course involving lectures, exercises and practical application of inclusion petrography, microthermometry, Raman and LA-ICPMS microanalysis</td>
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<tr>
<td><strong>Objective</strong></td>
<td>Practical ability to carry out a meaningful fluid or melt inclusion study in the fields of geochemistry, petrology or resource geology, involving problem definition, research planning, quantitative measurements using a combination of techniques, critical interpretation and correct documentation of results.</td>
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<tr>
<td><strong>Lecture notes</strong></td>
<td>Goldstein and Reynolds (1994): CD available for in-house use</td>
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<tr>
<td>651-4221-00L</td>
<td>Numerical Modelling of Ore Forming Hydrothermal Processes</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>T. Driesner</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>Introduction to computer tools for the simulation of hydrothermal processes. This includes fluid flow modelling and thermodynamic modelling of hydrothermal reactions. The computer programs are handed out to the students and can be run on normal PCs. No programming knowledge is necessary.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>Learn how to use the simulation programs HYDROTHERM and HCh to explore how hydrothermal systems work.</td>
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Autumn Semester 2016
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Introduction to computer tools for the simulation of hydrothermal processes: HYDROTHERM for fluid flow simulations, HCH for thermodynamic modeling. While learning the respective computer programs is an essential part of the course, the emphasis will be on using these tools to learn how the physics and chemistry of hydrothermal system actually work.

Lecturers: S. Bernasconi

Abstract: Global mineral economics and the strategies of mineral exploration -- including geological, geochemical and geophysical methods, but also non-geological factors such as organisational, political and environmental aspects. Changing external lecturers.

Objective: Practical understanding of the procedure of exploring a mineral prospect, based on geological analysis, exploration by drilling, resource calculation of tonnage and grade as a basis for economic evaluation for reporting to investors.

Content: This block course in will comprise 4 half-day lectures and a series of practical exercises from selection of a mineral property to discovery of mineral resources and their valuation. Teams are formed as Limited Partnership companies that have to select and bid for a mineral property offered during an auction. Each company has the same nominal budget. The highest bidder purchases the selected property, others need to purchase the remaining properties during an auction. Justification for selecting the property is justified in a report. The companies must interpret the geology of their mineral property to prepare a diamond drill program to discover and, eventually, delineate the mineral resources. This drill program is presented in a report prior to drilling. Drilling in the tri-dimensional matrix of the property is simulated using the software FOREUR, until budget lapse. The companies must select drill intervals for chemical analysis to document the extent and composition of the discovered mineralization. Portions of the mineral rights can be traded for capital between the companies. An estimate of the tonnage and grade of the discovered resource is prepared using geometric methods and GIS software (ex. Arc GIS). The ground value of the resource is estimated by a computation of the Net Smelter Return at current metal prices. The results of the exploration program are presented in a comprehensive report.

Lecturers: O. Bachmann, B. Ausin Gonzalez, H. Busemann, M. W. Schmidt, M. Schönbächler

Prerequisites / notice: Pre-requisites: Knowledge of mineral deposit-type characteristics is useful (orogenic gold, Cu-Zn VMS, Ni-Cu-PGE); at least "Ressourcen der Erde", or adequate knowledge of mineral deposits acquired by preparatory reading. Basic knowledge of ArcGIS software is important to produce maps and sections required in reports. Training exercises and tutorials will be provided in advance to prepare for the course. Taught biennially in collaboration with University of Geneva.

This course is co-organised by ETH Zurich (Prof. C. Heinrich) and University of Geneva (Prof. L. Fontbote)

Geochemistry

Geochemistry: Compulsory Courses

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<tr>
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<tbody>
<tr>
<td>651-4049-00L</td>
<td>Conceptual and Quantitative Methods in Geochemistry</td>
<td>W+</td>
<td>3 credits</td>
<td>2G</td>
<td>O. Bachmann, M. Schönbächler, D. Vance</td>
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</table>

Geochemistry: Courses of Choice

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<tr>
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<tr>
<td>651-4049-00L</td>
<td>Geotectonic Environments and Deep Global Cycles</td>
<td>W</td>
<td>3 credits</td>
<td>2V</td>
<td>M. W. Schmidt, P. Ulmer</td>
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Climate and Palaeoclimatology

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<th>Lecturers</th>
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<tbody>
<tr>
<td>651-4057-00L</td>
<td>Climate History and Palaeoclimatology</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>S. Bernasconi, B. Ausin Gonzalez, A. Fernandez Bremer, A. Gilli</td>
</tr>
</tbody>
</table>
Objective

The student will have an understanding of evolution of climate and its major forcing factors - orbital, atmosphere chemistry, tectonics - through geological time. He or she will understand interaction between life and climate and he or she will be familiar with the use of most common geochemical climate "proxies", he or she will be able to evaluate quality of marine and terrestrial sedimentary paleoclimate archives. The student will be able to estimate rates of changes in climate history and to recognize feedbacks between the biosphere and climate.

Content

Climate system and earth history - climate forcing factors and feedback mechanisms of the geosphere, biosphere, and hydrosphere.

Geological time, stratigraphy, geological archives, climate archives, paleoclimate proxies

Climate through geological time: "lessons from the past"

Cretaceous greenhouse climate

The Late Paleocene Thermal Maximum (PETM)

Cenozoic Cooling

Onset and Intensification of Southern Hemisphere Glaciation

Onset and Intensification of Northern Hemisphere Glaciation

Pliocene warmth

Glacial and Interglacials

Millennial-scale climate variability during glaciations

The last deglaciation(s)

The Younger Dryas

Holocene climate - climate and societies

651-4225-00L  Topics in Geochemistry  W  3 credits  2G  S. Bernasconi, G. Bernasconi-Green

Abstract

This course aims to present and discuss advanced topics in geochemistry based on the critical reading of research papers. Themes will vary from year to year and suggestions from students are welcome. The format of the course will be: one or more lectures introducing a theme, followed by a presentation of one or more papers by a student or group of students.

Objective

The goal of the course is discuss topics in advanced geochemistry which were not covered in other general and specialized geochemistry courses. In addition, we aim at training the student's ability to critically evaluate research papers and to summarize the findings concisely in an oral presentation.

Content

Themes will vary from year to year and suggestions from students are welcome. Some possible topics are:

- Organic geochemistry.
- Isotope geochemistry of organic matter: carbon, hydrogen and nitrogen.
- Multiply-substituted isotopologues.
- Mass-independent fractionations.
- Mass transfer and isotopes in modern and ancient ocean-floor hydrothermal systems and subduction zone environments.
- Noble gas geochemistry: terrestrial and extraterrestrial applications

Lecture notes

None

Literature

Will be identified based on the chosen topic.

651-4010-00L  Planetary Physics and Chemistry  W  3 credits  2G  P. Tackley

Abstract

This course aims to give a physical understanding of the formation, structure, dynamics and evolution of planetary bodies in our solar system and also apply it to ongoing discoveries regarding planets around other stars.

Objective

The goal of this course is to enable students to understand current knowledge and uncertainties regarding the formation, structure, dynamics and evolution of planets and moons in our solar system, as well as ongoing discoveries regarding planets around other stars. Students will practice making quantitative calculations relevant to various aspects of these topics through weekly homeworks.

The following gives an overview of the course content and approximate schedule (subject to change).

Hours    Topics
1-2            Introduction
3-4           Orbital dynamics and Tides
5-6            Solar heating and Energy transport
7-8            Planetary atmospheres
9-10           Planetary surfaces
11-12          Planetary interiors
13-14          Asteroids and Meteors
15-16          Comets
17-18          Planetary rings
19-20          Magnetic fields and Magnetospheres
21-22          The Sun and Stars
23-24          Planetary formation
25-26          Exoplanets and Exobiology
27-28          Review

Lecture notes

Slides and scripts will be posted at the moodle site: https://moodle-app2.let.ethz.ch/course/view.php?id=2559

Literature

It is recommended but not mandatory to buy one of these books:

Fundamental Planetary Science, by Jack J. Lissauer & Imke de Pater (paperback), Cambridge University Press, 2013. (books.ch Fr64.90, amazon.co.uk £35.00, amazon.de €39.81, amazon.com $49.26).


651-4235-00L  Marine Geology and Geochemistry  W  3 credits  2G  G. Bernasconi-Green

Does not take place this semester.
Abstract
Introduction to oceanographic methods and international research programs in marine geology and an overview of physical, chemical and biological processes in modern marine environments.

Objective
This course aims at giving an overview of oceanographic methods and an understanding of physical, chemical and biological processes in modern marine environments. This course will combine lectures and student participation. Student presentations are based on critical reading of research papers and integration of data and results from international oceanographic programs and ocean drilling.

Content
Specific topics will be chosen to examine processes of crustal formation, alteration, mass transfer and biological activity in mid-ocean ridge, continental margin and subduction zone settings, with consideration of data and new results obtained from international oceanographic programs and from DSDP, ODP and IODP drilling.

Student participation and discussions are based on critical reading of research papers, use of internet-based data, and web-based cruise results. Requirements to obtain credit points are oral or poster presentations and a short written summary of selected themes.

Lecture notes
No formal script will be distributed. Handouts will be given, where necessary. These will consist of the most important diagrams presented in the lectures. The students are expected to take their own notes and consult the literature for more details.

Literature
Lists of literature relevant to the selected topics will be handed out in the course.

Prerequisites / notice
This course is offered every 2 years.

651-4229-00L Advanced Geochronology W 3 credits 2G A. Quad Wykraud-Hüchtenbruck, H. Busemann, B. Ellis, M. Guillong, A. Liati

Objective
The purpose of this lecture is to provide a comprehensive overview of: a) the different radiometric methods in Geology, the different dating tasks and the constraints put by the complexity of natural systems, including dating by cosogenic nuclides, b) the various analytical tools available today for radiometric dating, their advantages and disadvantages, c) the use of noble gases in Geochemistry and d) detailed description of case studies, as examples of approach of a number of geological problems and interpretation of the data.

Content
The content of this lecture is summarised as follows:

Anthi Liati:
- Ion microprobes - U-Pb SHRIMP dating (zircon, sphene, rutile, monazite)
- Dating metamorphic rocks
- Combined geochronology and petrology subduction and exhumation rates
- Tracing the timing of mantle and crustal events via zircon-dating in mantle xenoliths: Two case studies: South Namibia, Kilbourne Hole (New Mexico)

Henner Busemann:
- Noble gas geo- and cosmochemistry
- Surface exposure dating with cosmogenic nuclides
- carbon-14 dating and U-Th-He thermochronology
- Visit of the radiogenic and noble gas isotope laboratories of IGMR

Albrecht von Quad:
- Analytical tools and applications to radiogenic isotopes (basics about TIMS, LA-ICP-MS-MC)
- Dating magmatic rocks and ore deposits (porphyry, epithermal Cu-Au-(Mo) deposits)
- U-Pb, Re-Os, Pb-Pb methods - Hf tracing of zircons
- Geochronology and geochemistry of magmatic systems

Marcel Guillong:
- LA-ICP-MS as the method of choice for dating, in comparison to other methods (Ion-probe, TIMS, ...)
- Data reduction in LA-ICP-MS; from measured counts per seconds to the final age of a sample, with hands on example.
- The challenge to date very young Zircons, with an example from Kos.

Ben Ellis:
- Ar-Ar dating techniques
- Ar-Ar dating of volcanic rocks

Lecture notes
Script (for part of the lecture), partly power point presentations (in the web) and partly copies of power point transparencies.

Literature
http://www.elementsmagazine.org/archives/index.html; see February 2013

Open Choice Modules Mineralogy and Geochemistry

Modules from the Geology Major
Choice from the Geology Restricted Choice Modules
Choice from the Geology Open Choice Modules

Modules from the Engineering Geology Major
Modules from the Engineering Geology Compulsory Modules

Modules from the Geophysics Major
Modules from the Geophysics Compulsory Modules

Modules from the Geophysics Restricted Choice Modules

Restricted Choice Module of Mineralogy and Geochemistry
Choice from Mineralogy and Geochemistry Restricted Choice Modules

Electives
Courses can be chosen from the complete offerings of the ETH Zurich and University of Zurich (according to prior agreement with the subject advisor).

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>651-1615-00L</td>
<td>Colloquium Geophysics</td>
<td>W</td>
<td>1</td>
<td>1K</td>
<td>A. Obermann</td>
</tr>
</tbody>
</table>

Data: 06.03.2019 12:57 Autumn Semester 2016 Page 592 of 1571
Abstract
This colloquium comprises geophysical research presentations by invited leading scientists from Europe and overseas, advanced ETH Ph.D. students, new and established ETH scientists with specific new work to be shared with the institute. Topics cover the field of geophysics and related disciplines, to be delivered at the level of a well-informed M.Sc. graduate/early Ph.D. student.

Objective
Attendants of this colloquium obtain a broad overview over active and frontier research areas in geophysics as well as opened questions. Invited speakers typically present recent work: Attendants following this colloquium for multiple terms will thus be able to trace new research directions, trends, potentially diminishing research areas, controversies and resolutions thereof, and thus build a solid overview of state and direction of geophysical research. Moreover, the diverse content and delivery style shall help attendants in gaining experience in how to successfully present research results.

651-1851-00L
Introduction to Scanning Electron Microscopy
W 1 credit 2G K. Kunze, L. Martin

Does not take place this semester.

Objective
Introduction in scanning electron microscopy and microanalysis. Obtain practical experience in operating a SEM.

Content
Functional principles and operation modes of a scanning electron microscope. Methods and application fields for
- imaging (SE, BSE, FSE, AE, CL),
- X-ray spectrosopy (EDX)
- Electron diffraction (EBSD, Channeling, Orientation Imaging).
Methods for sample preparation
Practical exercises.

Lecture notes
Scripts and operation manuals are provided during the course.

Literature

Prerequisites / notice
Full day block course after the end of HS

651-0048-00L
Electron Microprobe Course
W 3 credits 4G E. Reusser

Objective

Content
Physical principles of electron optics, interaction of electrons with matter, production of X-rays, interaction of X-rays with matter. Detection of X-rays. Laboratory work in the field of Earth sciences.

Lecture notes
Kursunterlagen

Literature

Prerequisites / notice
7 full days.

Prerequisite: Analytical methods in Petrology and Geology (651-4055-00L).

Max. 8 participants (incl. PhD students and external participants).

-> Restricted attendance. Register with E. Reusser.

327-0703-00L
Electron Microscopy in Material Science
W 4 credits 2V+2U K. Kunze, R. Erni, S. Gerstl, F. Gramm, F. Krumeich

Objective

Content
Physical principles of electron optics, interaction of electrons with matter, production of X-rays, interaction of X-rays with matter. Detection of X-rays. Laboratory work in the field of Earth sciences.

Lecture notes
Englisch

Literature

651-3541-00L
Exploration and Environmental Geophysics
W 4 credits 3V F. Broggin, J. Doetsch

Objective
Overview and understanding of the most important geophysical methods: Potential field methods (Gravimetrics and Magnetics), Electrical and electromagnetic methods, Refraction and reflection seisms, Georadar. Discussion of survey design, sources and receivers and data processing.

Content
Overview and understanding of the most important geophysical methods. Proposed solutions to assess and observe problems relevant to exploration and environmental geophysics in soil, ice and lithosphere at different scales. Getting familiar with measuring- and interpretation procedures. Pointing out the possibilities and limitations of geophysical methods.

Lecture notes
Available through eDoz/ILIAS.

Literature

651-4086-00L
Experimental Methods in Petrology
W 3 credits 2P C. Liebske

Abstract
Overview of the most common experimental methods employed in petrology to determine thermodynamic and physical properties and phase equilibria of minerals, mineral assemblages, magmas and fluids. The basic principals of low, moderate, high and ultrahigh pressure devices are discussed combined with an introduction into the synthesis of starting materials and the evaluation of run products.
We offer the opportunity to develop drawing skills which can be applied for scientific studies and publications. We emphasize the hands-on approach will be emphasized rather than abstract concepts, using example scientific problems relevant to Earth science.

This course gives an introduction to programming in FORTRAN95, and is suitable for students who have only minimal programming experience. The focus will be on Fortran 95, but Fortran 77 will also be covered for those working with already-existing codes. A hands-on approach will be emphasized rather than abstract concepts.

FORTRAN 95 is a modern programming language that is specifically designed for scientific and engineering applications. This course gives an introduction to programming in this language, and is suitable for students who have only minimal programming experience, for example with MATLAB scripts. The focus will be on Fortran 95, but Fortran 77 will also be covered for those working with already-existing codes. A hands-on approach will be emphasized rather than abstract concepts, using example scientific problems relevant to Earth science.

FORTRAN 95 is a modern programming language that is specifically designed for scientific and engineering applications. This course gives an introduction to programming in this language, and is suitable for students who have only minimal programming experience, for example with MATLAB scripts. The focus will be on Fortran 95, but Fortran 77 will also be covered for those working with already-existing codes. A hands-on approach will be emphasized rather than abstract concepts, using example scientific problems relevant to Earth science.

The practical work in the laboratories are conducted (with the exception of exercise #1) on a small research project where the various techniques and equipment are demonstrated and the practical use is trained.

The course 'Experimental methods in petrology' covers the following subjects:

1. Introduction and historical survey of experimental petrology
2. Experimental methods at ambient pressure (1 bar) with practical exercise to determine the free energy of formation of wustite (FeO)
3. Experimental buffering techniques (phase rule, buffering of partial pressures of gases and supercritical fluids, buffering of mixed volatile phases at elevated pressures, buffering of activities and solid-solid solutions in solid phases
4. Experimental methods at moderate pressures: externally (cold seal) and internally (IHPV) heated gas-pressure apparatus with practical demonstration/exercise
5. High-pressure solid-media experimental techniques (piston cylinders)
6. Ultra-high-pressure experimental techniques (multi-anvil apparatus, diamond-anvil-cells (DAC)
7. Evaluation of petrologic experiments (preparation of run products, analytical and spectroscopic methods of examination and quantification)

The course addresses to a public (master and PhD students) that is interested in an introduction to experimental research in petrology, but does not require basic knowledge in experimental methods. However, basic knowledge in petrology and physical chemistry (thermodynamics) is required to follow the course.

The project consists of writing a Fortran program to solve a problem agreed upon between the instructor and student; the topic is often related to (and helps to advance) the student’s Masters or PhD research. The project is typically started towards the end of the end of the main Fortran class when the student has acquired sufficient programming skills, and is due by the end of Semesterprüfung week.
Wöchentliches Seminar mit Fachvorträgen eingeladener oder interner Wissenschafter, vornehmlich zu Themen der Geochemie,
Invited speakers from the entire range of Earth Sciences.

651-1392-00L  Palaeontological Colloquium (University of Zurich) E- 0 credits 1K University lecturers
Abstract: Mind the enrolment deadlines at UZH: http://www.uzh.ch/studies/application/mobilitaet_en.html
Objective: Spezielle Vertiefung paläontologischer Kenntnisse.
Content: Vorträge von Institutsangehörigen und eingeladenen Gästen aus dem In- und Ausland über aktuelle Themen aus dem Gesamtgebiet der Paläontologie (Paläobotanik, Paläozoologie und Mikropaläontologie) mit anschliessender Diskussion.

Abstract: Understanding glaciers and ice sheets with simple physical concepts. Topics include the reaction of glaciers to the climate, ice rheology, temperature in glaciers and ice sheets, glacier hydrology, glacier seismology, basal motion and calving glaciers. A special focus is the current development of Greenland and Antarctica.
Objective: After the course the students are able understand and interpret measurements of ice flow, subglacial water pressure and ice temperature. They will have an understanding of glaciology-related physical concepts sufficient to understand most of the contemporary literature on the topic. The students will be well equipped to work on glacier-related problems by numerical modeling, remote sensing, and field work.
Content: The dynamics of glaciers and polar ice sheets is the key requisite to understand their history and their future evolution. We will take a closer look at ice deformation, basal motion, heat flow and glacier hydraulics. The specific dynamics of tide water and calving glaciers is investigated, as is the reaction of glaciers to changes in mass balance (and therefore climate).
Lecture notes: http://people.ee.ethz.ch/~luethim/teaching.html
Literature: A list of relevant literature is available on the class web site.
Prerequisites / notice: Good high school mathematics and physics knowledge required.

651-4249-00L  Semester Paper in Paleontology (University of Zürich) W 3 credits 7A University lecturers
Abstract: Paläontologie (Paläobotanik, Paläozoologie und Mikropaläontologie) mit anschliessender Diskussion.
Objective: Erweiterte Vertiefung paläontologischer Kenntnisse.
Content: Seminar series with both internal and external speakers on current topics in Structural Geology, Tectonics and Rock Physics. The current program is available at: http://www.geology.ethz.ch/sgt/seminar/sgt_seminar.htm
Lecture notes: http://www.uzh.ch/studies/application/mobilitaet_en.html
Prerequisites / notice: Good high school mathematics and physics knowledge required.

651-0254-00L  Seminar Geochemistry and Petrology E- 0 credits 2S O. Bachmann, M. Schönbächler, C. A. Heinrich, M. W. Schmidt, D. Vance
Abstract: Seminar series with external and occasional internal speakers addressing current research topics. Changing programs announced via D-ERDW homepage (Veranstaltungskalender)
Objective: Presentations on isotope geochemistry, cosmochemistry, fluid processes, economic geology, petrology, mineralogy and experimental studies. Mostly international speakers provide students, department members and interested guests with insight into current research topics in these fields.
Content: Wöchentliches Seminar mit Fachvorträgen eingeladener oder interner Wissenschafter, vornehmlich zu Themen der Geochemie, isotopengeologie, Hydrothermalgeochemie, Lagerstättenbildung, Petrologie, Mineralogie und experimentelle Studien.

651-1692-00L  Seminar in Applied and Environmental Geophysics E- 0 credits 1S H. Maurer, J. Robertsson

651-2915-00L  Seminar in Hydrology E- 0 credits 1S P. Burlando, J. W. Kirchner, S. Löw, D. Or, C. Schär, M. Schirmer, S. I. Seneviratne, M. Stähli, C. H. Stamm, University lecturers

651-1694-00L  Seminar in Seismology E- 0 credits 1S S. Wiemer, D. Fäh, D. Giardini
Abstract: Short seminars on a variety of popular topics in Seismology. The seminars present current problems and research activities in the seismological community.
Objective: Understanding of a broad scope of current problems and state-of-the-art practice in seismology.

651-1180-00L  Research Seminar Structural Geology and Tectonics E- Dr 0 credits 1S N. Mancktelow, J.P. Burg, M. Frehner
Abstract: A seminar series with both invited speakers from both inside and outside the ETH. The seminar series provides an opportunity to convey the latest research results to students and staff. Informal seminars with both internal and external speakers on current topics in Structural Geology, Tectonics and Rock Physics. The current program is available at: http://www.geology.ethz.ch/sgt/seminar/sgt_seminar.htm

101-0317-00L  Tunnelling I W 3 credits 2G G. Anagnostou, E. Pimentel
Objective: Basic aspects of design and analysis of underground structures. Conventional tunnel construction methods. Auxiliary measures (ground improvement and drainage, forepoling, face reinforcement). Numerical analysis methods.
Content: Numerical analysis methods in tunnelling. Conventional excavation methods (full face, top heading and bench, side drift method, ...). Auxiliary measures: - Injections - Jet grouting - Ground freezing - Drainage - Forepoling - Face reinforcement
Lecture notes: Autographieblätter
Literature: Empfehlungen

651-1091-00L  Colloquium Department Earth Sciences E- Dr 0 credits 1K T. I. Eglinton
Abstract: Invited speakers from the entire range of Earth Sciences.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Lecture Hours</th>
<th>University Lecturers</th>
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<tbody>
<tr>
<td>651-2613-00L</td>
<td>Humangeography III (Geographies of Difference) (Universität Zürich)</td>
<td>W</td>
<td>5</td>
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<tr>
<td>651-2601-00L</td>
<td>Human Geography I: One Earth - Many Worlds (University of Zurich)</td>
<td>W</td>
<td>5</td>
<td>2V+2U</td>
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<tr>
<td>651-4088-03L</td>
<td>Physical Geography III (Geomorphology and Glaciology) (University of Zurich)</td>
<td>W</td>
<td>5</td>
<td>1V+1U</td>
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<tr>
<td>651-4088-01L</td>
<td>Physical Geography I (Fundamentals and Spheres) (University of Zürich)</td>
<td>W</td>
<td>5</td>
<td>2V+2U</td>
</tr>
<tr>
<td>651-1617-00L</td>
<td>Geophysical Fluid Dynamics and Numerical Modelling Seminar</td>
<td>E-Dr</td>
<td>0</td>
<td>1S</td>
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<tr>
<td>651-4931-00L</td>
<td>Heat and Mass Transfers in Magmatology</td>
<td>W Dr</td>
<td>1</td>
<td>1S</td>
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</tbody>
</table>
HEAT AND MASS TRANSFERS IN THE CRUST

**Abstract**

Heat and mass transfers in the crust control many aspects of the differentiation of our planet, including (1) type of volcanic eruptions we should expect at the surface of our planet, (2) the volcanic/plutonic ratio in the crust, and (3) how volcanic degassing occurs, with important consequences on the climate response following volcanic eruptions.

**Objective**

The goal of this class is to learn about the modern methods and ideas on heat and mass transfers in magmatology through recently published papers and computer softwares. The class will allow students to explore some of the most challenging concepts in this field, and become familiar with state-of-the-art techniques to model these processes.

**Content**

The class will focus mostly on reading recent literature on topics of interests, and will contain some computer exercises to allow students to work by themselves on some well-defined problems.

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<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
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<tr>
<td>651-1091-02L</td>
<td>Geological Colloquium</td>
<td>E-Dr</td>
<td>0</td>
<td>2K</td>
<td>J.P. Burg, P. Nievergelt</td>
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<td>Invited speakers from the entire range of Earth Sciences.</td>
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<td>Objective</td>
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<td>Selected themes in sedimentology, tectonics, paläontology, geophysics, mineralogy, paleoclimate and engineering geology on a regional and global scale.</td>
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<td>Content</td>
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<td>Literature</td>
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<td>Prerequisites / notice</td>
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<tr>
<td>651-3280-00L</td>
<td>Earth Science Excursions</td>
<td>W</td>
<td>1</td>
<td>2P</td>
<td>P. Brack</td>
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<td>Only for MSc and doctorate students of D-ERDW. Only for excursions that are not part of the BSc excursion program 2.-6. semester.</td>
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<tr>
<td>651-2001-00L</td>
<td>Semester Research Project</td>
<td>W</td>
<td>3</td>
<td>6A</td>
<td>Lecturers</td>
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<td>Small individual research project done by a student and supervised by a Professor/Dozent/Oberassistent of D-ERDW. The content of each project is unique and is defined by the supervisor. The project consists of research activity aimed at producing new scientific results and/or data. Short scientific report/paper is written by the student, which serves as a basis for project grading.</td>
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<td>Abstract</td>
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<td></td>
<td>Objective</td>
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<td>To learn logic, content and methodology of research aimed at producing new scientific results and/or data.</td>
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<td>Content</td>
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<td>To familiarize with research procedures in a selected scientific area.</td>
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<td>Literature</td>
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<td>To obtain experience in writing scientific reports/papers.</td>
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<td>Prerequisites / notice</td>
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<td>To get prepared for a MSc project.</td>
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</table>

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**GESS Science in Perspective**

Recommended Science in Perspective (Type B) for D-ERDW.

- see Science in Perspective: Type A: Enhancement of Reflection Capability
- see Science in Perspective: Language Courses ETH/UZH

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**Master’s Project Proposal**

**Number** | **Title** | **Type** | **ECTS** | **Hours** | **Lecturers**
---|---|---|---|---|---
651-4060-00L | MSc Project Proposal | O | 10 | 21A | S. Löw, Lecturers
The MSc Project Proposal is only offered in autumn semester. A registration in spring semester is subject to special approval by the study director.

The introductory lecture for all majors on "Conduct as a Scientist" will be taught at the beginning of spring semester 2017 on Tuesday February 21, 2017 at 16:15 during the Engineering Geology Seminar.

**Abstract**

The main purpose of the Master Project Proposal is to help students organize ideas, material and objectives for their Master Thesis, and to develop development of communication skills.

**Objective**

The main objectives of the Master Project Proposal are to demonstrate the following abilities:
- To formulate a scientific question
- To present scientific approach to solve the problem
- To interpret, discuss and communicate scientific results in written form
- To gain experience in writing a scientific proposal

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**Master’s Thesis**

**Number** | **Title** | **Type** | **ECTS** | **Hours** | **Lecturers**
---|---|---|---|---|---
651-4062-00L | Master’s Thesis | O | 30 | 64D | Lecturers
Only students who fulfill the following criteria are allowed to begin with their master thesis:
- a. successful completion of the bachelor programme;
- b. fulfilling of any additional requirements necessary to gain admission to the master programme;
- c. have successfully completed the MSc Project Proposal.
<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>651-3001-AAL</td>
<td>Dynamic Earth I and II</td>
<td>E-</td>
<td>11</td>
<td>24R</td>
<td>E. Kissling, M. Schönbächer</td>
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<tr>
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<td>Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement. Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.</td>
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<td></td>
<td>Abstract</td>
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<td></td>
<td>Provides a basic introduction into Earth Sciences, emphasizing different rock-types and the geological rock-cycle, as well as introduction into geophysics and plate tectonic theory.</td>
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<td>Objective</td>
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<td></td>
<td>Understanding basic geological and geophysical processes</td>
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<td>Content</td>
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<td>Overview of the Earth as a system, with emphasis on plate tectonic theory and the geological rock-cycle. Provides a basic introduction to crystals and minerals and different rock-types. Lectures include processes in the Earth's interior, physics of the earth, planetology, introduction to magmatic, metamorphic and sedimentary rocks. Exercises are conducted in small groups to provide more in depth understanding of concepts and content of the lectures.</td>
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<td>Lecture notes</td>
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<td>Literature</td>
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<td>Prerequisites / notice</td>
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<td>Exercises and short excursions in small groups (10-15 students) will be lead by student assistants. Specific topics in earth sciences will be discussed using examples and case studies. Hand samples of the major rock types will be described and interpreted. Short excursions in the region of Zurich will permit direct experience with earth science processes (e.g. earth surface processes) and recognition of earth science problems and solutions relevant for modern society (e.g. building materials, water resources). Working in small groups will allow for discussion and examination of actual earth science themes.</td>
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<td>Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement. Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.</td>
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<tr>
<td>651-3400-AAL</td>
<td>Fundamentals of Geochemistry</td>
<td>E-</td>
<td>6</td>
<td>21R</td>
<td>T. Driesner, O. Bachmann</td>
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<tr>
<td>406-0243-AAL</td>
<td>Analysis I and II</td>
<td>E-</td>
<td>14</td>
<td>30R</td>
<td>M. Akveld, C. Busch</td>
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<td>Mathematical tools for the engineer</td>
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<td>Objective</td>
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<td>Mathematical formulation of technical and scientific problems.</td>
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<td>Content</td>
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<td>- M. Akveld, R. Sperl: Analysis I, vdf</td>
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<td>- M. Akveld, R. Sperl: Analysis II, vdf</td>
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<td></td>
<td>- L. Papula: Mathematik für Ingenieure und Naturwissenschaftler, Vieweg Verlag</td>
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<td></td>
<td>- L. Papula: Mathematik für Ingenieure 2, Vieweg Verlag</td>
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<td>406-0062-AAL</td>
<td>Physics I</td>
<td>E-</td>
<td>5</td>
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<td>A. Vaterlaus</td>
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<td></td>
<td>Abstract</td>
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<td></td>
<td>Introduction to the concepts and tools in physics: mechanics of point-like and rigid bodies, elasticity theory, elements of hydrostatics and hydrodynamics, periodic motion and mechanical waves.</td>
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<td></td>
<td>Objective</td>
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<td></td>
<td>Introduction to the scientific methodology. The student should develop his/her capability to turn physical observations into mathematical models, and to solve the latter. The student should acquire an overview over the basic concepts in mechanics.</td>
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</tbody>
</table>
Content


Chapters:
1, 2, 3, 4, 5, 6 (without: 6-5, 6-6, 6-8), 7, 8 (without 8-9), 9, 10 (without 10-10), 11 (without 11-7), 13 (without 13-13, 13-14), 14 (without 14-6), 15 (without 15-3, 15-5)

Literature
see "Content"

651-3521-AAL Tectonics E- 3 credits 6R T. Gerya, E. Kissling
Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Abstract
Comprehensive understanding of role and evolution of oceanic and continental lithosphere in global plate tectonics and evolution of earth.

Objective
Understanding principles of theoretical and experimental geothermics and fundamentals of mantle and lithosphere rheologies.

Content

Lecture notes
Detailed scriptum in digital form and additional learning moduls (www.lead.ethz.ch) available on intranet.

Literature
see list in scriptum.

Prerequisites / notice
PPT-files of each lecture may be played back for rehearsal on www.lead.ethz.ch.

529-2001-AAL Chemistry I and II E- 9 credits 19R H. Grützmacher, W. Uhlig
Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Abstract
General Chemistry I and II: Chemical bond and molecular structure, chemical thermodynamics, chemical equilibrium, kinetics, acids and bases, electrochemistry

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

Content
1. Stoichiometry
2. Atoms and Elements (Quantenmechanical Model of the Atom)
3. Chemical Bonding
4. Thermodynamics
5. Chemical Kinetics
6. Chemical Equilibrium (Acids and Bases, Solubility Equilibria)
7. Electrochemistry

Lecture notes
Nivaldo J. Tro Chemistry - A molecular Approach (Pearson), Chapter 1-18

Literature
Housecroft and Constable, CHEMISTRY
Oxtoby, Gillis, Nachtrieb, MODERN CHEMISTRY

406-0603-AAL Stochastics (Probability and Statistics) E- 4 credits 9R M. Kalisch
Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Abstract
Introduction to basic methods and fundamental concepts of statistics and probability theory for non-mathematicians. The concepts are presented on the basis of some descriptive examples. Learning the statistical program R for applying the acquired concepts will be a central theme.

Objective
The objective of this course is to build a solid fundament in probability and statistics. The student should understand some fundamental concepts and be able to apply these concepts to applications in the real world. Furthermore, the student should have a basic knowledge of the statistical programming language "R".
Introduction to Engineering Geology

Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract
This introductory course starts from a description of the behavior and phenomena of soils and rocks under near surface loading conditions and their key geotechnical properties. Lab and field methods for the characterization of soils, rocks and rock masses are introduced. Finally practical aspects of ground engineering, including tunneling and landslide hazards are presented.

Objective
Understanding the basic geotechnical and geomechanical properties and processes of rocks and soils. Understanding the interaction of rock and soil masses with technical systems. Understanding the fundamentals of geological hazards.

Content

Lecture notes
Written course documentation available under "Kursunterlagen".

Literature

Earth Sciences Master - Key for Type

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

<table>
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<tr>
<th>V</th>
<th>G</th>
<th>U</th>
<th>S</th>
<th>K</th>
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<tbody>
<tr>
<td>lecture</td>
<td>lecture with exercise</td>
<td>exercise</td>
<td>seminar</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>A</td>
<td>D</td>
<td>R</td>
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<tr>
<td>practical/laboratory course</td>
<td>independent project</td>
<td>diploma thesis</td>
<td>revision course / private study</td>
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ECTS

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
In this seminar students learn advanced techniques to support and to diagnose knowledge acquisition processes in school.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<tr>
<td>851-0240-00L</td>
<td>Human Learning (EW1)</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>E. Stern</td>
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</tbody>
</table>

Abstract
This course looks into scientific theories and also empirical studies on human learning and relates them to the school.

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

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

Prerequisites / notice
- You have a deep understanding about the cognitive mechanisms of knowledge acquisition.
- You have a basic understanding about psychological test theory and can appropriately administer tests.
- You know various techniques of formative assessment and can apply these to uncover students’ misconceptions.

Lecture notes
Folien werden zur Verfügung gestellt.

Literature

Structure of the course
- In this seminar students learn advanced techniques to support and to diagnose knowledge acquisition processes in school.
- Lectures and discussions are held to explore the cognitive mechanisms of knowledge acquisition.
- Students gain an understanding of psychological test theory and how to administer tests.
- Techniques of formative assessment are introduced and applied to uncover students’ misconceptions.
- Participants are expected to develop a deep understanding of the cognitive mechanisms of learning and the role of emotions and motivation in the learning process.


data: 06.03.2019 12:57
The goal is to promote the ability to understand biological concepts, principles and their interrelationships and to communicate specialist knowledge to various groups of recipients in an understandable manner.

Demanding biological topics are dealt with under consideration of the special needs of persons involved in teaching. The module comprises

2U
Lecturers
E. Hafen, J. Egli, M. Zwicky

- Students can discuss and put into practice in their teaching work the conditions and objectives set out in the regulations governing the Specialized Biology Course with an Educational Focus II: Teaching Diploma.
- Specialized aspects of biology are dealt with under the viewpoint of their presentation, their historical development, their significance for the basis of the subject structure and learner requirements.
- Students can reconstruct specialist contents in didactic terms and develop teaching modules suitable for the different levels from these on the basis of the subject structure and learner requirements.
- They can reduce the complexity of subject-based specialist contents and present them in such a way that they are comprehensible and meaningful for learners.
- Students are in a position to implement and discuss the concepts of biology teaching and learning on the basis of specific topics covered in school biology.

The program of this course represents one half (6 CP) of that of the Specialized Biology Course with an Educational Focus (551-0963-00, 12 CP).

The Specialized Biology Course with an Educational Focus (12 CP) can be acknowledged, in agreement with the advisor of the respective elective major, as one of the two obligatory research projects (each 15 CP). In such a case, additional 3 CP must be obtained in another course.

In case of overbooking of the course, students enrolled in the Teaching Diploma in Biology will have priority for registration.

The course is organized jointly with the University of Zurich (Fachbereich Biologie) and is held at the Life Science Zurich Learning Center of the ETH Zurich and the University of Zurich.

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<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<td>551-0963-02L</td>
<td>Specialized Biology Course with an Educational Focus II: Teaching Diploma</td>
<td>W</td>
<td>6</td>
<td>13A</td>
<td>E. Hafen, J. Egli, M. Zwicky</td>
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<tr>
<td>551-0913-00L</td>
<td>Professional Exercises in Biology</td>
<td>W</td>
<td>2</td>
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<td>P. Faller</td>
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<td>551-0971-00L</td>
<td>Subject Didactics I: Simultaneous enrolment in Introductory Internship Biology</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>P. Faller</td>
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Data: 06.03.2019 12:57
Autumn Semester 2016
Page 602 of 1571
Among other things, students are put in a position where they can comprehend the topics that are to be taught in a wider and, to some extent, unconventional context and critically assess pupils' prior knowledge, clarify it in greater detail and take it into account for planning lessons.

- Design a sequential curriculum suitable for the levels in question and put it into practice.
- Establish which subject matter can be presented with which teaching techniques and methods that have been recognised as efficient in teaching terms, and adapt these tools to the learning content in question.
- Break down technically complex contents to the right level for a class and still present these in a stringent, error-free manner in their simplified form.
- Divide up the subject matter into contents that can be learned by heart or accessed intellectually, and communicate these contents.
- Establish which subject matter can be presented with which teaching techniques and methods that have been recognised as efficient in teaching terms, and adapt these tools to the learning content in question.
- Plan school experiments, incorporate them in lessons, perform them in accordance with all the rules of the art, and also evaluate them in a beneficial manner.
- Assess pupils' prior knowledge, clarify it in greater detail and take it into account for planning lessons.
- Design a sequential curriculum suitable for the levels in question and put it into practice.
- Reliably identify stumbling blocks in the contents and get round these.

Specialised Courses

Selection of courses will be agreed with the course coordinator.

Introductory Courses

Spec. Courses in Respective Subject with Educational Focus

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<tr>
<th>Number</th>
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<tr>
<td>529-0962-00L</td>
<td>Fundamental Aspects of Chemistry with an Educational Focus B</td>
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<td>A. Togni, R. Alberto</td>
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<td>Mentored Work with an Educational Focus Chemistry B for Teaching Diploma.</td>
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<td>Students enrolled at UZH must register for this course and the corresponding exam at ETH.</td>
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<td>Selected topics in general chemistry:</td>
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<tr>
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<td>1) The language of chemistry</td>
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<td>2) Chirality and stereochemistry</td>
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<td>3) Oxidation of water</td>
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<td>4) Chemistry of the atmosphere</td>
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Objective

In this course, participants acquire extended and more in-depth knowledge of selected chemistry topics. The selection is based to a large extent on the partial aspects of chemistry that are typically taught at high school. By gaining a broader understanding, teachers are put in a position where they can comprehend the topics that are to be taught in a wider and, to some extent, unconventional context and critically assess pupils' prior knowledge, clarify it in greater detail and take it into account for planning lessons.

- At the same time, interrelationships between the classical sub-disciplines of chemistry are highlighted, along with the unique features of chemistry as one of the central natural sciences.

Content

Content of the four modules:

1) The language of chemistry: Concepts, formulas, aesthetics, and philosophical aspects
2) Chirality and stereochemistry: Selected aspects, origin of biomolecular chirality, inorganic chemistry
3) Cosmochemistry
4) Chemistry of the atmosphere

Lecture notes

Foli en und ausgewählte Literatur werden zur Verfügung gestellt.

Literature

Ausgewählte Artikel aus der Primärliteratur werden vorgestellt, kommentiert und zur Lektüre empfohlen.

Prerequisites / notice

| FV A (gelesen im Frühjahrsemester) und FV B (gelesen im Herbstsemester) bauen nicht aufeinander. Die Reihenfolge der Belegung ist somit indifferent |

Subject Didactics

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<td>529-0950-00L</td>
<td>Subject Didactics Chemistry I</td>
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<td>A. Baertsch</td>
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</table>

Abstract

Implementing findings from research into teaching and learning for chemistry lessons and coverage of subject-specific teaching and learning specialities.

Objective

Among other things, students are put in a position where they can:

- Divide up the subject matter into contents that can be learned by heart or accessed intellectually, and communicate these contents.
- Break down technically complex contents to the right level for a class and still present these in a stringent, error-free manner in their simplified form.
- Establish which subject matter can be presented with which teaching techniques and methods that have been recognised as efficient in teaching terms, and adapt these tools to the learning content in question.
- Plan school experiments, incorporate them in lessons, perform them in accordance with all the rules of the art, and also evaluate them in a beneficial manner.
- Assess pupils’ prior knowledge, clarify it in greater detail and take it into account for planning lessons.
- Design a sequential curriculum suitable for the levels in question and put it into practice.
- Reliably identify stumbling blocks in the contents and get round these.

Content

Schwerpunkte im ersten Studiensemester bilden die folgenden Themen:

- Auswahl gymnasiumsrelevanter Lerninhalte
- Modellbegriff in den Naturwissenschaften, insbesondere der Chemie
- Sprache und Fachsprache im Chemieunterricht
- Wechselwirkung zwischen Beobachtungen in der realen Welt und Deutungsversuchen auf der Modell-Ebene
- Interdisziplinarität mit Biologie, Mathematik und Physik
- Leistungserhebung und -beurteilung im Theorie- und Laborunterricht
- Atommodelle und chemische Bindung
- Mathematische Beschreibung chemischer Systeme (z.B. Stöchiometrie und Gleichgewichtssysteme)
- Auswahl, Konzeption, Einbettung, Vorbereitung, Durchführung, Nachbereitung und Auswertung von Demonstrations- und Schüler-Experimenten

Lecture notes

Der Chemieunterricht am Gymnasium soll einerseits dem zukünftigen Nichtnaturwissenschaftler ein grundlegendes Rüstzeug an chemischen Kenntnissen und Fähigkeiten für den Alltag an die Hand geben, andererseits aber auch auf ein naturwissenschaftlich orientiertes Hochschulstudium vorbereiten können. Diese beiden Anforderungen sind im Unterricht gleichermaßen zu berücksichtigen.

Da viele Lerninhalte zudem zwingend sequentiell und einander benützend strukturiert sind, ist dem logischen und aus Schülerperspektive nachvollziehbaren Aufbau des Unterrichts besonderes Augenmerk zu schenken. Dies bedeutet eine besonders feine Abstimmung von fachlichen Inhalten unterschiedlichen Niveaus und der für ihre Vermittlung eingesetzten didaktischen Methoden und Techniken auf die kognitive Leistungsfähigkeit der Lernenden.

Anhand der Diskussion ausgearbeiteter und bewährter Beispiele, aber auch durch selbständiges Probearbeiten und mit Hilfe selbst zu erstellender kleiner Unterrichtsbausteine soll die zukünftige Lehrkraft befähigt werden, einen den spezifischen Rahmenbedingungen angepassten eigenen Unterricht zu konzipieren und durchzuführen, der diesem hohen Qualitätsanspruch genügen kann.
Science promised us truth, or at least a knowledge of such relations as our intelligence can seize: it never promised us peace or happiness.

Gustave Le Bon

Physicists learned to realize that whether they like a theory or they don’t like a theory is not the essential question. Rather, it’s whether or not the theory gives predictions that agree with experiment.

Richard Feynman, 1985

Science in School (Current Topics for the Classroom)  W  2 credits  2G  C. Wagner, A. Vaterlaus

Enrolment in Physics Didactics I (402-0910-00L) and Physics Didactics II (402-0910-00L) is mandatory.

Kennenlernen und erarbeiten (Übungen) von Unterrichtssequenzen zu modernen Themen der Physik.

Wird angegeben.


Subject Didactics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
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<td>Physics Didactics I: Special Didactics of Physics Teaching</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>M. Mohr</td>
</tr>
<tr>
<td></td>
<td>Limited number of participants. Further information is available from the lecturer via email: <a href="mailto:mamohr@ethz.ch">mamohr@ethz.ch</a></td>
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<td>- course 402-0920-00L - is compulsory for Teaching Diploma Physic</td>
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<td></td>
<td>Information for UZH students: Enrolment to this course unit only possible at ETH. No enrolment to module 090-Phy1 at UZH. Please mind the ETH enrolment deadlines for UZH students: <a href="https://www.ethz.ch/en/studies/non-degree-courses/special-students/special-students-university-of-zurich.html">https://www.ethz.ch/en/studies/non-degree-courses/special-students/special-students-university-of-zurich.html</a></td>
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</table>

Objective


Content

Thematische Schwerpunkte


Fachspezifisches: Sachstrukturen der gängigen Unterrichtsthemen, Alltagsbezüge, Fehlvorstellungen, Demonstrations- und Schülerexperimente, Arbeitsmittel zu physikalischen Themen des Grundlagen- und Schwerpunktunterrichts

Einsatz verschiedener Unterrichtsmaterialien: Experimente, Computer, Taschenrechner, Video, Simulation Unterrichtsformen: Lernaufgabe, Werkstatt, Puzzle, Projekt, Gruppenarbeit, Praktikum

Lernformen

Interaktive Lehr-Lernveranstaltung mit Vorträgen und Demonstrationen des Dozenten, studentischer Einzel- und Kleingruppenarbeit, kurzen Präsentationen der Studierenden, Verliefung der Inhalte durch Bearbeitung von Aufträgen ausserhalb der Kontaktstunden

Lecture notes

Folien und weitere Unterlagen werden zur Verfügung gestellt

wird während der Veranstaltung mitgeteilt

Die Veranstaltung ist zusammen mit dem Einführungspraktikum zu belegen

402-0091-00L | Teaching science in Higher Education | W | 2 credits | 1V | G. Schiltz |

This course imparts fundamental didactic concepts that are relevant to teaching science in a Higher Education context.

Students are able to characterize and to discuss the model of outcomes based education.

Students are able to transfer the basic concepts of this model (ILO, TLA, assessment, constructive alignment) to science education.

Abstract

keines


(please buy the book in the price of 2011 to the earliest event erwerben!)

Science Education Master - Key for Type

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
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<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
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<tr>
<td>W</td>
<td>Eligible for credits</td>
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<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
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<tr>
<td>Key for Hours</td>
<td>Description</td>
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<tr>
<td>V</td>
<td>lecture</td>
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<td>G</td>
<td>lecture with exercise</td>
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<td>U</td>
<td>exercise</td>
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<td>S</td>
<td>seminar</td>
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<td>K</td>
<td>colloquium</td>
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<td>P</td>
<td>practical/laboratory course</td>
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<td>A</td>
<td>independent project</td>
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<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
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</tbody>
</table>

**ECTS**
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Military Studies

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>853-0037-01L</td>
<td>Military Psychology and Pedagogy I (without Exercises)</td>
<td>Z</td>
<td>3 credits</td>
<td>2V</td>
<td>H. Annen</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
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<td></td>
<td>Examine the fundamentals of the two sciences and establish links with military life. Discuss various schools of thought in psychology and focus on content and process theories of motivation. Explore characteristics of pedagogical thinking and discuss the values of military education with reference to the young adult serving in the armed forces.</td>
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<td>Objective</td>
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<tr>
<td></td>
<td>- Becoming acquainted with basic psychological views of human behaviour and experience</td>
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<td></td>
<td>- Knowing content- and process theories of motivation and being able to transfer these to the military context</td>
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<td>- Knowing the possibilities and limitations of military education and deriving consequences</td>
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<td>Content</td>
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<td>Overall, the objective is to become acquainted with the basics of both scientific areas and to make references to military practice. Military psychology is a branch of applied psychology; consequently selected aspects of psychological principles will be covered. Military pedagogy hasn't yet established itself firmly as an independent scientific discipline, it nevertheless can draw on a deep-seated tradition in Switzerland. Thus, the great importance that has been attached to the discussion of education in Swiss society and academia will be taken into account.</td>
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<td>Subjects:</td>
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<td>- History of military psychology</td>
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<td></td>
<td>- Psychological images of humanity (psychoanalysis, behaviourism, behavioural biology, humanistic psychology, cognitivism)</td>
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<td></td>
<td>- Motivational theories</td>
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<td></td>
<td>- Defence-, service-, operational- and combat motivation</td>
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<td></td>
<td>- Swiss military pedagogy</td>
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<td>- Education as defining feature of pedagogic thinking and acting</td>
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<td></td>
<td>Literature</td>
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<tr>
<td></td>
<td>- Annen, H., Steiger, R. &amp; Zwygart, U.: Gemeinsam zum Ziel, Huber, Frauenfeld 2004 (provided as pdf)</td>
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<td></td>
<td>- Stadelmann, J.: Führung unter Belastung, Huber, Frauenfeld 1998 (provided as pdf)</td>
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<td></td>
<td>The lecture is supported by a virtual learning environment containing relevant documents (presentations and texts) and information to further literature.</td>
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| 853-0063-02L   | Military History I (without Exercises)               | Z    | 3 credits | 2V   | M. Olsansky |
|                | Abstract                                             |      |      |       |           |
|                | The purpose of the lecture is to outline the development of the armed forces (assets regarding manpower, technology and armament), the concepts of warfare and the actual warfare in the 19th and 20th century. |
|                | Objective                                            |      |      |       |           |
|                | - Distinguish between military history as a subject and historiography as a way of describing events; |
|                | - Analyse the modern developments regarding armed forces and warfare in the context of socio-economic changes; |
|                | - Based on the approach regarding revolution in military affairs, describe the evolution of the armed forces and of warfare; |
|                | - Exemplify the issues regarding the evolution of the combat (First and Second World War, Vietnam War and Algerian War). |
|                | Content                                              |      |      |       |           |
|                | The lecture first examines the bases of the science of (military) history. It focuses on how military history developed from war history, on specific similarities and differences between military history and general historiography, the different ways of dealing with history in Switzerland, Germany, France and in the Anglo-Saxon cultural area (different approaches) as well as on institutions which deal with military history such as universities, military academies, national and international commissions and associations etc. |
|                | Literature                                           |      |      |       |           |
|                | The lecture is structured along the lines of the concept of "Military Revolution" and starts with the formation of modern, European armed forces after the Oranian Army reform in the 17th century. |
|                | Based on the "Military Revolution" approach, the lecture examines the structural changes regarding the armed forces and the development of warfare from the 18th to the 20th century. Special emphasis will be put on how the battlefield was revolutionized due to the Napoleonic wars, the industrialization in the 19th century, the First World War, the mechanization and totalization during the Second World War and the period of the Cold War. |
|                | Literature                                           |      |      |       |           |
|                | The lecture is supported by a virtual learning environment containing relevant documents (presentations and texts) and information to further literature. |

| 853-0082-00L   | Strategic Studies I                                  | Z    | 3 credits | 2V   | M. Mantovani |
|                | Abstract                                             |      |      |       |           |
|                | The lecture series treats high-impact theories of strategic studies from antiquity to the present. |
|                | Objective                                            |      |      |       |           |
|                | The participants know in what ways the understanding of strategy has evolved over time. They understand the balance of strategy's basic components: ends, ways and means. |
|                | They know the most important classics of strategy and war theory, especially against their specific background. |
|                | Based on the analysis of historical and contemporary examples, they are aware of the ambiguity of declaration and implementation of strategies. |
|                | They are capable of analyzing critically original texts and modern scholarly works in the field of strategic studies. |
|                | Content                                              |      |      |       |           |
|                | The two-term lecture series treats classic theories of strategic studies from antiquity to the present. Term 1 covers the theories up until roughly 1900, term 2 the theories ever since. |
|                | They are deemed classic, if they were prominent in their respective times and if they had a strong reception after, be it in literature, in academic debates or as guidelines for action. Each out of some 50 theories is discussed in three steps: historical context, core messages and reception. |
|                | Lecture notes                                        |      |      |       |           |
|                | Slides as well as a textbook with primary sources and a list of further reading are accessible electronically. The textbook is also available in hard copy. |
|                | Literature                                           |      |      |       |           |
|                | Peter Paret, Makers of Modern Strategy, From Machiavelli to the Nuclear Age, Princeton 1986 |
|                | Martin van Creveld, A History of Strategy; from Sun Tzu to William S. Lind, Kouvola 2015 |
|                | The lecture is held in German. Passive knowledge of English and French are required. |

| 853-0102-00L   | Military Business Administration II - Case Examples   | Z    | 3 credits | 2V   | M. M. Keupp |
|                | Abstract                                             |      |      |       |           |
|                | The elective course Military Business Administration II builds on the mandatory course Military Business Administration I and adds to it. It deals with in-depth case studies from international security and economic policy with a special emphasis on the economic and practical relevance of these issues for the Swiss Armed Forces. |
|                | Objective                                            |      |      |       |           |
|                | Students who are intrinsically interested in business-related issues will be provided with a big picture that transcends the micro view of business administration. Students learn how to integrate security and resource-related issues into a global economic analysis and how to derive relevant consequences, particularly economic ones, for Switzerland. |
The program of the course is organized into 14 units of 90 minutes each. The units combine the elements of lecture (where analytical concepts are taught) and application (where these concepts are applied). Additionally, guest lecturers will hold talks on selected issues.

* Swiss economic autarchy - madness or option?
* Global resource positions and world trade: Implications for the Swiss Armed Forces I
* Global resource positions and world trade: Implications for the Swiss Armed Forces II
* Economic causes of military instability
* Aggressive emerging economies: Economic growth and rearmament
* The process of an arms deal
* Costs and financing of a military conflict
* Economic analysis of terrorism
* Economic analysis of cyberwar
* Economic analysis of the present GSOA initiative: Compulsory military service vs. voluntary militia
* Global arms production and international arms trade
* The privatisation of military security
* Standardisation and interoperability: Does NATO membership increase Swiss military efficiency
* Written exam

Lecture notes
As this course has been completely redesigned and is being offered for the first time in the fall semester of 2013, a script is not yet available. However, the lecturer will distribute all necessary course material in time and directly to the students, either in the classroom or by uploading files to a public server.

Literature
The Lecturer will distribute all necessary literature directly to the students by disseminating pdf files or citing links to online references.

Prerequisites / notice
Exam “Military Business Administration I” passed successfully or profound basic knowledge of business administration and economics. The course is open to external participants.

853-0064-00L  Military Sociology I  Z  3 credits  2V  T. Szvircsev Tresch

Abstract
Beside of the most important terms of sociology, demographic changes and the related value and structure change will be analysed. The second part focuses on organizational sociology. Thirdly, the course examines to which extent armed forces can be considered as organizations like any other and to which extent they constitute a special case from an organizational and normative point of view.

Objective
Recognize and explain current changes (social change) in modern society (individualisation, pluralisation); describe demographic changes in Switzerland; explain the structures of societies; define issues and fields of research in modern military sociology and explain the foundations of organisational sociology; explain the military in terms of organisational sociology and identify specific traits of the military as an organisation.

Content
Societal change; organizations as societal phenomena; aims, structures, environments of organizations; specifics of the military as an organization; impacts of technological and societal changes on the armed forces in modern societies.

Specialized Continuing Education
Special internal ETH courses offered by LET and the Teaching Specialists.

Number  Title  Type  ECTS  Hours  Lecturers
999-9999-99L  EduApp Course  E-  0 credits  1V+1U  G. Schiltz

This course unit is not a genuine ETH course unit. It is used by LET and the Teaching Specialists for EduApp demonstration purposes.

Specialized Continuing Education
Special internal ETH courses offered by LET and the Teaching Specialists.

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<tr>
<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>999-9999-99L</td>
<td>EduApp Course</td>
<td>E-</td>
<td>0 credits</td>
<td>1V+1U</td>
<td>G. Schiltz</td>
</tr>
</tbody>
</table>

This course unit is not a genuine ETH course unit. It is used by LET and the Teaching Specialists for EduApp demonstration purposes.

Humanities, Social and Political Sciences (General Courses) - Key for Type

| O     | Compulsory | E- | Recommended, not eligible for credits |
| W+    | Eligible for credits and recommended | Z | Courses outside the curriculum |
| W     | Eligible for credits | Dr | Suitable for doctorate |

Key for Hours

| V     | lecture | P | practical/laboratory course |
| G     | lecture with exercise | A | independent project |
| U     | exercise | D | diploma thesis |
| S     | seminar | R | revision course / private study |
| K     | colloquium | | |

ECTS
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
The objectives of this course are three-fold. For one, the participants shall learn to question aesthetic certainties and received modes of practice. Students are introduced into how technological innovations take place within complex economical, political and cultural contexts. They get introduced into basic theories and practices of the field. Students become familiar with the mutual interdependence of social and technological change that characterises the history of computing and communication. At the end of this lecture course, students can: (a) highlight the most important changes in the "long nineteenth century" in Europe (b) explain their long-term effects; and (c) relate these changes to global developments.

GESS Science in Perspective

Only the topics listed in this paragraph can be chosen as GESS Science in Perspective. Further below you will find the "Type B courses Reflections about subject specific methods and content" as well as the language courses.

6 ECTS need to be acquired during the BA and 2 ECTS during the MA.

Students who already took a course within their main study program are NOT allowed to take the course again.

Type A: Enhancement of Reflection Competence

Suitable for all students

Students who already took a course within their main study program are NOT allowed to take the course again.

History

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>851-0549-00L</td>
<td>WebClass Introductory Course History of Technology</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>G. Hürlimann</td>
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<tr>
<td></td>
<td>Number of participants limited to 100.</td>
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<td>Particularly suitable for students of D-BAUG, D-INFK, D-ITET, D-MATL, D-MAVT.</td>
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<tr>
<td></td>
<td>Abstract</td>
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<tr>
<td></td>
<td>WebClass Introductory Course History of Technology is an introductory course to the history of technology. The students are challenged to discover how technological innovations take place within complex economical, political and cultural contexts. They get introduced into basic theories and practices of the field.</td>
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<td>Objective</td>
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<tr>
<td></td>
<td>Students are introduced into how technological innovations take place within complex economical, political and cultural contexts. They get to know basic theories and practices of the field.</td>
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<td>Content</td>
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<td>Lecture notes</td>
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<td>Literature</td>
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<td><a href="https://www.tg.ethz.ch/de/programme/">https://www.tg.ethz.ch/de/programme/</a></td>
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<tr>
<td></td>
<td>Prerequisites / notice</td>
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<td>Literature</td>
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<tr>
<td></td>
<td>Power Point Slides und sources will be made available at POLYBOX in the course of the semester.</td>
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<td></td>
<td>Weitere Informationen unter <a href="https://www.tg.ethz.ch/de/programme/">https://www.tg.ethz.ch/de/programme/</a></td>
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History Part One: Europe (The Cradle of Modernity, Britain ca. 1789-1839)

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>853-0725-00L</td>
<td>History Part One: Europe (The Cradle of Modernity, Britain ca. 1789-1839)</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>H. Fischer-Tiné</td>
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<tr>
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<td>Abstract</td>
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<td>Using the concrete example of Britain, the &quot;cradle of modernity&quot;, this lecture offers a survey and analysis of the crucial historical transformations that engendered &quot;modernity&quot; in Europe from the late 18th to the mid 20th centuries.</td>
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<td>At the end of this lecture course, students can: (a) highlight the most important changes in the &quot;long nineteenth century&quot; in Europe (b) explain their long-term effects; and (c) relate these changes to global developments.</td>
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<td>The thematic foci include: the economic and social consequences of the industrial revolution, the genesis of political ideologies and social movements, shifts in gender roles, colonialism and imperialism, as well as the emergence of consumerism and a &quot;leisure society.&quot;</td>
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<td>Lecture notes</td>
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<td>Power Point Slides and sources will be made available at POLYBOX in the course of the semester.</td>
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<td></td>
<td>Literature</td>
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<td>Mandatory and further reading will be listed on course plan that is made available before the first session.</td>
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Postal Knowledge and the History of Digital Societies

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<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>851-0551-03L</td>
<td>Postal Knowledge and the History of Digital Societies</td>
<td>W</td>
<td>3</td>
<td>2S</td>
<td>D. F. Zetti</td>
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<tr>
<td></td>
<td>Particularly suitable for students of D-ARCH, D-BAUG, D-HEST, D-INFK, D-ITET, D-MAVT</td>
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<td>In the second half of the 20th century, postal services have dramatically changed. Communication today is computerbased. The lecture offers problem oriented insights into this sociotechnical process of translation.</td>
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<td>Students become familiar with the mutual interdependence of social and technological change that characterises the history of computing and communication.</td>
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<td>Literature</td>
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"Bollywood and Beyond" - A Cultural History of Indian Cinema in the 20th Century

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<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>851-0101-18L</td>
<td>&quot;Bollywood and Beyond&quot; - A Cultural History of Indian Cinema in the 20th Century</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>H. Fischer-Tiné</td>
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<tr>
<td></td>
<td>Abstract</td>
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<td>The Indian film industry has been around for 100 years and is one of the richest and most variegated of the world. The lecture reconstructs the historical development of Indian cinema and uses it as a lens through which cultural, social and political change in the subcontinent can be explored.</td>
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<td>The objectives of this course are three-fold. For one, the participants shall learn to question aesthetic certainties and received modes of perception of cinematic art. Secondly they will be acquainted with the huge potential of films as a historical source to grasp processes of social and cultural change. Besides, the reconstruction of the international career of a specific variety of art and entertainment will also raise important questions of cultural globalisation and consumerism. As a side-effect, a sit were, the students will will also be provided with important insights into the chequered history of the Indian subcontinent in during the course of the 20th century.</td>
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<td>Zur Einführung:</td>
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<td>Prerequisites / notice</td>
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<td>A detailed course description and session plan will be available from 15 Sept 2013 onwards at <a href="http://www.gmw.ethz.ch/education">http://www.gmw.ethz.ch/education</a></td>
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Collections in Context: What Do Historians and Scientists Learn from Butterflies, Stones, and Bones?

Abstract
Zurich holds huge scientific collections. They contain objects from around the world, some of them dating back to the 18th century. This interdisciplinary seminar combines perspectives from the history of science and from current scientific disciplines. What do these objects tell us about Zurich's place in the global history of science? What potentials do old collections hold for scientists today?

Objective
The aim of this seminar is threefold: Firstly, students will become familiarised with historiographical approaches to scientific collections. Among them are constructivist approaches that seek to understand scientific knowledge not primarily as a system of objective truths, but rather as an outcome of human 'constructions'. Other approaches deal with the problem of how scientific objects are related to systems of power and oppression, namely in the case of objects collected during the time of European colonialism overseas. Secondly, students will become familiarised with how old collections can yield new insights for current scientists working, e.g., on questions of ecology. Thirdly, the seminar shall serve as a platform to discuss ways of dialogue and possible collaboration between these different approaches.

Literature
- L. Stalder
- W. W. W., M. Greeff
- 2 credits
- http://www.stalder.arch.ethz.ch/courses

Regional Politics of the Arabian Peninsula

Abstract
The course explores the complex nature of politics and history of the Arabian Peninsula. It takes a closer look at the political systems of several countries of the Arabian Peninsula, especially Yemen, Saudi Arabia and Oman and Bahrain.

Objective
To highlight how the politics of the Arabian Peninsula is a product of two spheres: politics within states and politics between states.

Content
- The neighbouring states of the Arabian Peninsula - especially Saudi Arabia, Oman and Yemen - make for strange bedfellows. They are governed by different systems with different results, calling into question how their internal policies affect regional relations and vice versa.
- Saudi Arabia is a monarchy, a prosperous, religious and restrictive state increasingly facing problems of social/political unrest. Oman is a small, thriving, stable sultanate, modernised and moderate but tightly controlled; and the republic of Yemen, which has the region's poorest economy, has still not shrugged off the legacy of its turbulent modern history. Each state adheres to a different Islamic sect, moreover, and though their populations are overwhelmingly Arab, differing tribal structures result in widely variant effects on the political process in their respective systems.
- Each state has also had extensive historical relationships with the Ottoman and British empires, the US and Russia, and these too have coloured regional relations. Recent events like the terrorist attacks of 11 September 2001, the American-led invasion of Iraq, and the Arab Spring of 2011 have also influenced these states' internal policy decisions, further affecting their dealings with one another and at with the world at large.

History of Art and Architecture III

Abstract
The two-semester course offers an introduction to the history and theory of architecture from the industrial revolution up to now. Based on current questions a variety of case studies will be discussed.

Objective
The aim is to give an overview on crucial events, works of art, buildings and theories since the beginning of the 19th century up to today. The course should enhance the comprehension of historical and theoretical issues, and allow the students to localize their own practice within a broader historical context.

Content
- The subject of this lecture course is the history and theory of architecture since the beginning of the 19th century up to now. It examines the architectural answers to the changing technical inventions and social practices. Consequently, the focus will be less on individual architects and these too have coloured regional relations. Recent events like the terrorist attacks of 11 September 2001, the American-led invasion of Iraq, and the Arab Spring of 2011 have also influenced these states' internal policy decisions, further affecting their dealings with one another and at with the world at large. This course examines each country in detail, from state formation to current affairs and from local to international government.

History of Urban Design I

Abstract
The lecture covers the time from the beginning of urban culture until the mid 19th century. With selected examples it emphasizes on the historical plannings and methods of European cities. Each specific urban development will be presented within a broader context.

Objective
This course analyzes the history of urban architecture primarily in its existing three dimensional form as a complex human artefact. It also explores the inspirations that prompted the creation of this artefact: philosophical and religious concepts, social conditions, property relationships and the mechanisms that exploit the economics of real estate and the influence of building technology. Intellectual, literary or artistic modes of thought will also be assessed with regard to their impact on urban development. Urbanism has its own distinctive approach as a discipline, but it is also clearly responsive to the influence of related disciplines. Study is made of actual cities and urban expansion plans which are in the process of implementation, as well as unrealized projects and visions of the future. These projects sometimes illustrate ways of thinking that are equal to, or clearer than, actual urban situations.

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In the first semester an introduction to the discipline and the methods are given along the thematic issues from the beginning of urban culture until the mid-19th century.

01. Introduction to the discipline and method: The history of urban design as a historical project
02. Athens and Rome in the ancient world: Myth, selfportrayal and speculation
03. From the spirit of equality to the colonial module: Greek and Roman City foundings
04. From the urban ideal to new cities in the Middle Ages and the Renaissance
05. Baroque strategies: The new organisation of Rome under Sixtus V, the production of Versailles under Louis XIV and the invention of St. Peters burg
06. The city between Absolutism and Enlightenment: baroque defence-designs, the European colonization of the American continent and the reconstruction of Lisbon
07. Ideology and speculation after the Glorious Revolution: landscapegardens and urban figurations in England from 1650-1850
08. Between modernization, Grandeur and repression: Embellishment in Paris from 1750-1830
09. The construction of the bourgeois city: Georges-Eugène Haussmann transforms Paris into the capital of the 19th century
10. Architectural insertion and plan for the expansion of the city: From the Berlin of Karl Friedrich Schinkel to James Hobrecht
11. Neobsolete power, bourgeois self-confidence and Marxian Idealism: The Viennese Ringstrasse and Ildesfonso Cerdas Ensanche for Barcelona

Lecture notes
The lectures are accompanied by a script (two semesters of the bachelor studies), that can be purchased at the chair for the history of urban design (HIL D 75.2) at the price of CHF 30. The script serves as an auxiliary means to the attended lecture compiling the most important illustrations showed and the names and dates of the buildings and its builders along with a short introductory note.

Literature
Further recommended literature to consult is listed within the script.

Prerequisites / notice
History of Urban Design from antiquity to the 19th century

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<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
<th>Type</th>
<th>Prerequisites / notice</th>
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<tbody>
<tr>
<td>701-0791-00L</td>
<td>Environmental History - Introduction and Overview</td>
<td>W 2</td>
<td>2V</td>
<td>D. Speich Chassé</td>
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<td></td>
<td>Number of participants limited to 100.</td>
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<tr>
<td>Abstract</td>
<td>Our society faces a serious ecological crisis. Of what historical dimension is this crisis? How have human societies already in earlier times changed their environment, and, consequently, perhaps also ours? What were the main ecological challenges for societies and how did they change over time? And how did societies adapt to changing environmental conditions?</td>
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<td>Objective</td>
<td>Introduction into environmental history; survey of long-term development of human-nature-interrelations; discussion of selected problems. Improved ability to assess current problems from a historical perspective and to critically interrogate one's own standpoint.</td>
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<tr>
<td>Literature</td>
<td>Course material is provided on OLAT.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Uekötter, Frank (Ed.) 2010. The turning points of environmental history, Pittsburgh: University of Pittsburgh Press.</td>
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<th>Prerequisites / notice</th>
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<tr>
<td>063-0366-00L</td>
<td>The Architecture of the City from Modernity to Today</td>
<td>W 2</td>
<td>2V</td>
<td>V. Magnago Lampugnani</td>
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<td>The lecture covers the time of the 20th century and describes with theories, projects and implemented plannings the history of the modern city. The lectures emphasizes on the historical plannings and methods and presents each specific urban development within a broader context.</td>
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<tr>
<td>Abstract</td>
<td>This course analyzes the history of urban architecture primarily in its existing three dimensional form as a complex human artefact. It also explores the inspirations that prompted the creation of this artefact: philosophical and religious concepts, social conditions, property relationships and the mechanisms that exploit the economics of real estate and the influence of building technology. Intellectual, literary or artistic modes of thought will also be assessed with regard to their impact on urban development. Urbanism has its own distinctive approach as a discipline, but it is also clearly responsive to the influence of related disciplines. Study is made of actual cities and urban expansion plans which are in the process of implementation, as well as unrealized projects and visions of the future. These projects sometimes illustrate ways of thinking that are equal to, or clearer than, actual urban situations.</td>
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<td>Objective</td>
<td>The lecture which will be hold only in one semester includes the developments of the 20th century</td>
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<td>Content</td>
<td>The lecture which will be hold only in one semester includes the developments of the 20th century</td>
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<td>1. Le Corbusier: theories, visions and clearcuts in the name of the autorité</td>
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<td>2. The United States in the Jazz Age: Between Metropolis of Tomorrow and Broadacre City</td>
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<td>3. Italy in the Fascist Era: Monumental ensembles and new town between assiduousness of modernization and obsession of representation</td>
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<td>4. Urban design under totalitarian regimes: The architects of the &quot;Tausendjährige Reich&quot; and the &quot;engineers of luck&quot; of the Soviet Union of Stalin</td>
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<td>5. Coming to terms with the past and the Cold War: Reconstruction in the two German states</td>
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<td>6. The myth of the human scale: the 1950s in Spain, Great Britain, Scandinavia and Italy</td>
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<td>7. Postwar Experiments: Rationalistic classicism in France</td>
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<td>8. Two new towns in the 20th century: Chandigarh and Brasilia</td>
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<td>9. Fictions and visions: The international utopia of the city</td>
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<td>10. The second conquest of the North American territorium: The automobile and the city in the USA</td>
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<td>11. Analysis, analogy and renewal: The adventure of the typological city</td>
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### Literature

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<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>851-0300-85L</td>
<td>The Knowledge of Literature. An Introduction</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>A. Kilcher</td>
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<tr>
<td>Abstract</td>
<td>Students know a wide variety of literary text</td>
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<tr>
<td>Content</td>
<td>Students are introduced to the various</td>
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<td>approaches and methods of literature studies</td>
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<td>and gain an overview of literary theory.</td>
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<td>Objective</td>
<td>Students read and discuss texts from</td>
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<td>Prerequisites</td>
<td>- all interested students are most welcome.</td>
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<td>notice</td>
<td>The course focuses on the role of technology</td>
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<td>and the effect of literature on the society.</td>
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<tr>
<td>Prerequisites</td>
<td>All interested students are most welcome.</td>
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Abstract  The course discusses texts from Henry James to Margaret Atwood whose interest for photography led them to elaborate new intriguing models of representation. The aim is to identify how literature, photography and art meet to promote a photographic aesthetics while approaching the theories of Susan Sontag, Roland Barthes and Bourdieu as well as postmodern or posthuman criticism.

Objective  Students are introduced to the various approaches and methods of literature studies and gain an overview of literary theory.

Prerequisites / notice  All interested students are most welcome. The course is not intended as a language course but a good knowledge of English is a necessary requirement in order to participate to class discussions and to do the reading.

851-0301-05L  Beginnings  W  3  2S  C. Jany  

Abstract  "All beginnings are difficult," goes the saying, "but without them there wouldn't be an end." However, what makes beginnings so difficult? What kind of action is that? Which knowledge does it presuppose? And what would a beginning say about the end? We will pursue these questions by reading sacred, philosophical, literary, and scientific texts that, each in its own way, make a beginning.

Objective  Students are introduced to the various approaches and methods of literature studies and gain an overview of literary theory.

Prerequisites / notice  All interested students are most welcome. The course is not intended as a language course but a good knowledge of English is a necessary requirement in order to participate to class discussions and to do the reading.

851-0306-05L  Literature about Technology - Simulations, Prototypes, Machines  W  3  2S  E. Edelmann-Olher  

Abstract  Literature about technology transposes models, products and procedures of scientific progress into the logic of poetry. This literature converts not only technology into fiction, but it also creates new cultural and social contextualisations, which reveal alternative readings of configurations of knowledge.

Objective  Students are introduced to the various approaches and methods of literature studies and gain an overview of literary theory.

Prerequisites / notice  All interested students are most welcome. The course is not intended as a language course but a good knowledge of English is a necessary requirement in order to participate to class discussions and to do the reading.
In the natural sciences as well as in engineering we set up experiments, analyze equation systems, and formulate theories. In order to

We will look at a number of essays and texts on that subject. We will also read Zadie Smith's highly entertaining novel "White Teeth" which


Die Teilnehmerzahl ist begrenzt. SCHRIFTLICHE ANMELDUNG erforderlich (bis 31. August): uwe.justus.wenzel@nzz.ch

851-0315-01L Writing: Precision of Language as a Field of Research W 1 credit 1G F. Kretzen

Abstract When we write a literary text we enter into a set-up for experiments and explore the possibilities ensuing from the specific structure and consistency of such a text. Literary writing allows us to go over to another kind of knowledge. Thus, the question: what is it that I want to write about? is replaced by: what do I write?

Objective In this course we shall analyze and apply conditions and criteria for literary writing on the basis of our own texts. The course is intended for persons who are interested in literary approaches to exactitude. Any attempt to write literature is confronted with an unforeseeable linguistic dynamism whose feasibility is determined by laws and rules quite different from those of science and technology. For the science-oriented writer, experiencing the self-evidence produced by literary approaches in his or her own writing project opens up a field of language with new content and new methods.

Content In the natural sciences as well as in engineering we set up experiments, analyze equation systems, and formulate theories. In order to complement these practices, the course «Writing» shall pursue precision in literary writing, its choice of word and its self-evidence.

When we write a literary text we also enter into a set-up for experiments and explore the possibilities ensuing from the specific structure and overall consistency of such a text. This form of writing takes us from the question: what is it that I want to write about? to the question: what do I write?

Prerequisites / notice Those wishing to participate are required to send in between two and three pages text of their own writing that will be discussed in class. The next step will be writing a text on a preset topic as a basis for discussing the various realizations of a given task.

851-0331-06L The Secretaries of the Baroque Age and the "Honest Dissimulation" W 3 credits 2V S. Nigro

Abstract Torquato Accetto, secretary and poet, published the treatise "Della simulazione onesta" in 1641. It was a thin manual to survive political turmoils and moral instability of the time; it was also a guide to "secret" writing in a time of censorship. The course follows the reception of the treatise up to the 20th century and focuses on how it got shaped to meet various historical and political ideas.

Objective The students know the author and his coeval context; the students can relate the writing modalities of the treatise to the socio-cultural context of various historical times; the students know how to identify and interpret the metaphorical potential of the texts, as well as its literary power.

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Economics

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Abstract This colloquium offers an opportunity for students to discuss their ongoing research and scientific ideas in the behavioral sciences, both at the micro- and macro-levels of cognitive, behavioral and social science. It also offers an opportunity for students from other disciplines to discuss their research ideas in relation to behavioral science. The colloquium also features invited research talks.

Objective Students know and can apply autonomously up-to-date investigation methods and techniques in the behavioral sciences. They achieve the ability to develop their own ideas in the field and to communicate their ideas in oral presentations and in written papers. The credits will be obtained by a written report of approximately 10 pages.
Content
This colloquium offers an opportunity for students to discuss their ongoing research and scientific ideas in the behavioral sciences, both at the macro- and micro-levels of cognitive, behavioral and social science. It also offers an opportunity for students from other disciplines to discuss their ideas in so far as they have some relation to behavioral science. The possible research areas are wide and may include theoretical as well as empirical approaches in Social Psychology and Research on Higher Education, Sociology, Modeling and Simulation in Sociology, Decision Theory and Behavioral Game Theory, Economics, Research on Learning and Instruction, Cognitive Psychology and Cognitive Science. Ideally the students (from Bachelor, Master, Ph.D. and Post-Doc programs) have started to start work on their thesis or on any other term paper. Course credit can be obtained either based on a talk in the colloquium plus a written essay, or by writing an essay about a topic related to one of the other talks in the course. Students interested in giving a talk should contact the course organizers (Rütsche, Stern) before the first session of the semester. Priority will be given to advanced / doctoral students for oral presentations. The course credits will be obtained by a written report of approximately 10 pages. The colloquium also serves as a venue for invited talks by researchers from other universities and institutions related to behavioral and social sciences.

851-0626-01L International Aid and Development
Does not take place this semester. Prerequisites: Basic knowledge of economics

Abstract
The course gives economic and empirical foundations for a sound understanding of the instruments, prospects and limitations of international development aid.

Objective
Students have a theoretically and empirically sound understanding of the prospects and limitations of international development aid.

Content
Introduction to the Determinants of Underdevelopment; History of Aid; Aid and Development: Theories and Empirics; Political Economy of Aid; Experience and Impact of Aid; New Instruments of Aid: e.g. Micro-Finance, Budget-Support, Fair Trade.

Literature
Articles and book abstracts will be uploaded to a course website.

851-0609-06L Governing the Energy Transition
Number of participants limited to 30.

Abstract
This course addresses the role of policy and its underlying politics in the transformation of the energy sector. It covers historical, socio-economic, and political perspectives and applies various theoretical concepts to specific aspects of governing the energy transition.

Objective
- To gain an overview of the history of the transition of large technical systems
- To recognize current challenges in the energy system to understand the theoretical frameworks and concepts for studying transitions
- To demonstrate knowledge on the role of policy and politics in energy transitions

Content
Climate change, access to energy and other societal challenges are directly linked to the way we use and create energy. Both the recent United Nations Paris climate change agreement and the UN Sustainable Development Goals make a fast and extensive transition of the energy system necessary. This course introduces the social and environmental challenges involved in the energy sector and discusses the implications of these challenges for the rate and direction of technical change in the energy sector. It compares the current situation with historical socio-technical transitions and derives the consequences for policy-making. It then introduces theoretical frameworks and concepts for studying innovation and transitions. It then focuses on the role of policy and policy change in governing the energy transition, considering the role of political actors, institutions and policy feedback.

860-0006-00L Applied Statistics and Policy Evaluation
Number of participants limited to 20.

Abstract
This course introduces students to key statistical methods for analyzing social science data with a special emphasis on causal inference and policy evaluation. Students learn to choose appropriate analysis strategies for particular research questions and to perform statistical analyses with the statistical Software Stata.

Objective
- Students have a sound understanding of linear and logit regression
- Know strategies to test causal hypotheses using regression analysis and/or experimental methods
- Are able to formulate and implement a regression model for a particular policy question and a particular type of data
- Are able to critically interpret results of applied statistics, in particular, regarding causal inference
- Are able to critically read and assess published studies on policy evaluation
- Are able to use the statistical software STATA for data Analysis

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The topics covered in the first part of the course are a revision of basic statistics and linear and logit regression analysis. The second part
understand the limits and the potential of corporate sustainability for sustainable development
Health expenditures constitute about 10% of GDP in OECD countries. Extensive government intervention is a typical feature in health markets. Risk factors to health have been changing with growing importance of lifestyle factors such as smoking, obesity and lack of physical activity. This course gives an introduction to the economic concepts and empirical findings in health economics.

In a second part, the major participants on the supply side of health care markets - physicians, hospitals, nurses and pharmaceutical manufacturers - will be discussed. E.g., how important are financial incentives in the choice of medicine as a career, specialty choice and practice location? What does it mean and imply that a physician is an agent for a patient? How do pharmaceutical firms decide on investments in new products and how can public policy encourage pharmaceutical innovation?
The choices made by societies about how health care services are financed and about the types of organizations that supply health care will be addressed in a third part. One important choice is whether a country will rely on public financing of personal health care services or encourage private health insurance markets. How could and should a public health insurance system be designed? What health care provision services should be included or excluded from a public system? Another important choice is whether a society relies on government provision of health care services, private provision by not-for-profit or for-profit organizations or some combination. The advantages and disadvantages of the alternatives will be discussed to provide a framework for analyzing specific types of health care systems.

The set-up of the course will closely follow the book of J.E. Sturm.

Presentation slides will be made available on moodle prior to lectures.

Literature recommendations will be distributed during the lecture.

W

The course gives an introduction to the economic concepts and empirical findings in health economics to enhance students understanding of how health care institutions and markets function.

The course gives an introduction to the economic concepts and empirical findings in health economics to enhance students understanding of how health care institutions and markets function. First, the three important decisions made by individuals will be analyzed: What determines the health behaviors, like the intensity of preventive measures like sport, that an individual undertakes? What types and amount of personal health care services does an individual demand? How much health insurance coverage will be purchased?

In a second part, the major participants on the supply side of health care markets - physicians, hospitals, nurses and pharmaceutical manufacturers - will be discussed. E.g., how important are financial incentives in the choice of medicine as a career, specialty choice and practice location? What does it mean and imply that a physician is an agent for a patient? How do pharmaceutical firms decide on investments in new products and how can public policy encourage pharmaceutical innovation?
The choices made by societies about how health care services are financed and about the types of organizations that supply health care will be addressed in a third part. One important choice is whether a country will rely on public financing of personal health care services or encourage private health insurance markets. How could and should a public health insurance system be designed? What health care provision services should be included or excluded from a public system? Another important choice is whether a society relies on government provision of health care services, private provision by not-for-profit or for-profit organizations or some combination. The advantages and disadvantages of the alternatives will be discussed to provide a framework for analyzing specific types of health care systems.

In-depth case studies of corporate sustainability challenges in the track phase: How to deal with environmental pressure groups? How to use the strengths of business to solve pressing sustainability problems? How to catalyze technological innovations for sustainability? How to invest money in a sustainable way?

Critical thinking skills for corporate sustainability.

Business implications of sustainable development, in particular for the assessment of sustainability performance, strategic change towards sustainability, technological innovations and sustainability, and finance and corporate sustainability.

Be able to recognize and realize opportunities for corporate sustainability in a business environment

Overview of the key concepts of corporate sustainability and topics related to Water, Energy, Mobility, and Food

Develop critical thinking skills (argumentation, communication, evaluative judgment) that are useful in the context of corporate sustainability using an innovative writing and peer review method.

Literature recommendations will be distributed during the lecture.

The course examines the behaviour of macroeconomic variables, such as gross domestic product, unemployment and inflation rates. It tries to answer questions like: How can we explain fluctuations of national economic activity? What can economic policy do against unemployment and inflation? What significance do international economic relations have for Switzerland?

This lecture helps you understand the world in which you live. There are many questions about the macroeconomy that might spark your curiosity. Why are living standards so meagre in many African countries? Why do some countries have high rates of inflation while others have stable prices? Why have some European countries adopted a common currency? These are just a few of the questions that this course will help you answer.

Furthermore, this course will give you a better understanding of the potential and limits of economic policy. As a voter, you help choose the policies that guide the allocation of society's resources. When deciding which policies to support, you may find yourself asking various questions about economics. What are the burdens associated with alternative forms of taxation? What are the effects of free trade with other countries? What is the best way to protect the environment? How does the government budget deficit affect the economy? These and similar questions are always on the minds of policy makers.

The course webpage (to be found at https://moodle-app2.let.ethz.ch/course/view.php?id=2467) contains announcements, course information and lecture slides.


We advise you to also buy access to Aplia. This internet platform will support you in learning for this course. To save money, you should buy the book together with Aplia. This is sold as a bundle (ISBN: 9781473715948).

Besides this textbook, the slides and lecture notes will cover the content of the lecture and the exam questions.

I aim to introduce students to the concepts and tools of modern finance and to make them understand the limits of these tools, and the many problems met by the theory in practice. I will put this course in the context of the on-going financial crises in the US, Europe, Japan and China, which provide fantastic opportunities to make the students question the status quo and develop novel solutions.
Objective
The course explains the key concepts and mechanisms of financial economics, their depth and then stresses how and why the theories and models fail and how this is impacting investment strategies and even a global view of citizenship, given the present developing crises in the US since 2007 and in Europe since 2010.

- Development of the concepts and tools to understand these risks and master them.
- Working knowledge of the main concepts and tools in finance (Portfolio theory, asset pricing, options, real options, bonds, interest rates, inflation, exchange rates)
- Strong emphasis on challenging assumptions and developing a systemic understanding of financial markets and their many dimensional risks

Content
1- The Financial Crises: what is really happening? Historical perspective and what can be expected in the next decade(s). Bubbles and crashes. The illusion of the perpetual money machine.
2- Risks in financial markets
   - What is risk?
   - Measuring risks of financial assets
   - Introduction to three different concepts of probability
   - History of financial markets, diversification, market risks
3- Introduction to financial risks and its management.
   - Relationship between risk and return
   - Portfolio theory: the concept of diversification and optimal allocation
   - How to price assets: the Capital Asset Pricing Model
   - How to price assets: the Arbitrage Pricing Theory, the factor models and beyond
4- Financial markets: role and efficiency
   - What is an efficient market?
   - Financial markets as valuation engines: exogeneity versus endogeneity (reflexivity)
   - Deviations from efficiency, puzzles and anomalies in the financial markets
   - Financial bubbles, crashes, systemic instabilities
5- An introduction to Options and derivatives
   - Calls, Puts and Shares and other derivatives
   - Financial alchemy with options (options are building blocks of any possible cash flow)
   - Determination of option value; concept of risk hedging
6- Valuation and using options
   - A first simple option valuation model
   - the Binomial method for valuing options
   - the Black-scholes model and formula
   - Practical examples and implementation
   - Realized prices deviate from these theories: volatility smile and real option trading
   - How to imperfectly hedge with real markets?
7- Real options
   - The value of follow-on investment opportunities
   - The timing option
   - The abandonment option
   - Flexible production
   - Conceptual aspects and extensions
8- Government bonds and their valuation
   - Relationship between bonds and interest rates
   - Real and nominal rates of interest
   - Term structure and Yields to maturity
   - Explaining the term structure
   - Different models of the term structure
9- Managing international risks
   - The foreign exchange market
   - Relations between exchanges rates and interest rates, inflation, and other economic variables
   - Hedging currency risks
   - Currency speculation
   - Exchange risk and international investment decisions

Lecture notes
Lecture slides will be available on the site of the lecture

Literature
Corporate finance
Brealey / Myers / Allen
Eight edition

+ additional paper reading provided during the lectures

Prerequisites / notice
none
The simulation project is intended for Master’s or Doctoral students of the Global Studies Institute (GSI) of the University of Geneva, of the ETH and for interested students of the Geneva Centre for Security Policy (GCSP). The simulation will be in French and English and is conducted by Prof. Calmy-Rey, former President of Switzerland.

In the lectures, students will be provided with basic information on disarmament issues and on the functioning of the Conference on Disarmament as well as on negotiation techniques in general. Students will take the role of negotiators in the simulation (including the heads of the delegations), of keeper of the minutes or of observers and analysts. Students will co-develop their mandates for the negotiation and be assisted by experts that are specialized in international negotiations as well as in the topic of disarmament. The negotiation tables will be chaired by former diplomats. Representatives of diplomatic missions in Geneva will play the role of the “Capitals” to which the heads of delegations will have to give account of the ongoing negotiations.

More details on the program, timetable, reading lists and performance assessment will be published here: https://chamilo.unige.ch/home/courses/M165/?id_session=0

The simulation will take place on the 26 and 27 November 2015 at the University of Geneva.

Languages: English and French

Dates/Time/Location (GE = University of Geneva)
22 Sept. | ETH HG D 22 | 10:15-12:00 | Introduction
29 Sept. | GE Uni Mail Salle 1170 | 10:15-12:00 | Introduction to Negotiation Techniques (Dr. Vitalij Butenko and Dr. Sibylle Zürcher, ETH)
6 Oct. | ETH HG D 16.2 | 10:15-12:00 | Distribution of the roles, composition of the negotiation tables, preparation of mandates for the HA (humanitarian approach)
13 Oct. | ETH HG D 22 | 10:15-12:00 | Preparation of the mandates for the FMCT (Fissile Material Cut-off Treaty)
20 Oct. | GE Uni Mail Salle 1170 | 10:15-12:00 | No session; Students deepen and summarize their mandates on one page (A4)
27 Oct. | GE Uni Mail Salle 1170 | 10:15-12:00 | Discussion of the Mandates I (FMCT)
10 Nov. | GE Uni Mail Salle 1170 | 10:15-12:00 | Discussion of the Mandates II (HA)
17 Nov. | GE Uni Mail Salle 1170 | 10:15-12:00 | Preparation Meeting
26 & 27 Nov. | GE Salles 407 et 408 | 10:00-18:00 | Simulation at Uni Dufour
1 Dec. | GE Uni Mail Salle 1170 | 10:15-12:00 | Discussion of the results

Note: The participation in the simulation on 26. and 27. November in Geneva is necessary. The two hours lectures on the 22. September, 6. and 13. October have to be attended in Zürich via conference call (ETH HG D 16.2). The other lectures during the semester can be attended via Skype.

To get the 3 ECTS, students have to participate at the 2 days simulation In Geneva, attend the 3 mandatory lecture parts via conference call an Zürich and write a report of 5 pages at the end of the course.

(technical note for registration: At this stage all registered students are on the waiting list)

351-0555-00L Open- and User Innovation W 3 credits 2G S. Häfliger, S. Spaeht

Abstract
The course introduces the students to the long-standing tradition of actively involving users of technology and other knowledge-intensive products in the development and production process, and through own cases they develop an entrepreneurial understanding of product development under distributed, user-centered, or open innovation strategies.

Objective
The course includes both lectures and exercises alternately. The goal is to understand the opportunity of user innovation for management and develop strategies to harness the value of user-developed ideas and contributions for firms and other organizations.

The students actively participate in discussions during the lectures and contribute presentations of case studies during the exercises. The combination should allow to compare theory with practical cases from various industries.

The course presents and builds upon recent research and challenges the students to devise innovation strategies that take into account the availability of user expertise, free and public knowledge, and the interaction with communities that span beyond one organization.

Grading is based on the final exam, the class presentations (including the slides) as well as class participation.

Content
This course on user innovation extends courses on knowledge management and innovation as well as marketing. The students are introduced to the long-standing tradition of actively involving users of technology and other knowledge-intensive products in the development and production process, and through own cases they develop an entrepreneurial understanding of product development under distributed, user-centered, or open innovation strategies. Theoretical underpinnings taught in the course include models of innovation, the structuration of technology, and an introduction to entrepreneurship.

Lecture notes
The slides of the lectures are made available and updated continuously through the SMI website:

Literature
Relevant literature for the exam includes the slides and the reading assignments. The corresponding papers are either available from the author online or distributed during class.

Reading assignments: please consult the SMI website:


Abstract
Discovering Management offers an introduction to the field of business management and entrepreneurship for engineers and natural scientists. The module provides an overview of the principles of management, teaches knowledge about management that is highly complementary to the students’ technical knowledge, and provides a basis for advancing the knowledge of the various subjects offered at D-MTEC.

Objective
Discovering Management combines in an innovate format a set of lectures and an advanced business game. The learning model for Discovering Management involves ‘learning by doing’. The objective is to introduce the students to the relevant topics of the management literature and give them a good introduction in entrepreneurship topics too. The course is a series of lectures on the topics of strategy, innovation, corporate finance, leadership, design thinking and corporate social responsibility. While the 14 different lectures provide the theoretical and conceptual foundations, the experiential learning outcomes result from the interactive business game. The purpose of the business game is to analyse the innovative needs of a large multinational company and develop a business case for the company to grow. This business case is as relevant to someone exploring innovation within an organisation as it is if you are planning to start your own business. By discovering the key aspects of entrepreneurial management, the purpose of the course is to advance students’ understanding of factors driving innovation, entrepreneurship, and company success.
Discovering Management aims to broaden the students' understanding of the principles of business management, emphasizing the interdependence of various topics in the development and management of a firm. The lectures introduce students not only to topics relevant for managing large corporations, but also touch upon the different aspects of starting up your own venture. The lectures will be presented by the respective area specialists at D-MTEC.

The course broadens the view and understanding of technology by linking it with its commercial applications and with society. The lectures are designed to introduce students to topics related to strategy, corporate innovation, leadership, corporate and entrepreneurial finance, value chain analysis, corporate social responsibility, and business model innovation. Practical examples from industry experts will stimulate the students to critically assess these issues. Creative skills will be trained by the business game exercise, a participant-centered learning activity, which provides students with the opportunity to place themselves in the role of Chief Innovation Officer of a large multinational company. As they learn more about the specific case and identify the challenge they are faced with, the students will have to develop an innovative business case for this multinational corporation. Doing so, this exercise will provide an insight into the context of managerial problem-solving and corporate innovation, and enhance the students' appreciation for the complex tasks companies and managers deal with. The business game presents a realistic model of a company and provides a valuable learning platform to integrate the increasingly important development of the skills and competencies required to identify entrepreneurial opportunities, analyse the future business environment and successfully respond to it by taking systematic decisions, e.g. critical assessment of technological possibilities.

No prior knowledge of business or economics is required to successfully complete this course.

### 701-0747-00L Environmental Policy of Switzerland

**Abstract**
This course presents the basics of policy analysis and the specific characteristics of Swiss environmental policy. Policy instruments, actors and processes are addressed both theoretically as well as by means of current Swiss environmental policy examples.

**Objective**
Beyond acquiring basic knowledge about policy analysis, this course teaches students how to analytically address current and concrete questions of environmental policy. Through exercises the students learn about political science concepts and frameworks as well as real-life political decision-making processes. The well-grounded examination of complex political conflict situations is an important precondition for the entry into the (environmental policy) workforce or a future research career.

**Content**
The processes of change, overuse or destruction of the natural environment through humans have historically placed high demands on social and political institutions. In the interplay between the environment, society and economy, the environmental policy field encompasses the sum of public measures that have the goal to eliminate, reduce or avoid environmental degradation. The course systematically presents the basics of environmental policy instruments, actors, programs and processes as well as their change over time. A key aspect is the distinction between politics and political science and specifically environmental policy.

**Lecture notes / Literature**
Instead of lecture notes different texts on policy analysis and Swiss environmental policy are made available to the students.

**Prerequisites / notice**
The detailed semester program (syllabus) is made available to the students at the beginning of the semester.

### 701-0757-00L Principles of Economics

**Abstract**
This course covers the basics for understanding micro- and macroeconomic issues and theories. Participants are given the tools to argue in economic and political terms and to evaluate the corresponding measures. Group and individual exercises deepen the knowledge gained.

**Objective**
Students are able to:
- describe fundamental micro- and macroeconomic issues and theories.
- apply microeconomic arguments to a given theme.
- evaluate economic measures.

**Content**
Supply and demand behaviour of firm and households; market equilibrium and taxation; national income and indicators; inflation; unemployment; growth; macroeconomics policies

**Lecture notes / Literature**

**Prerequisites / notice**

### 701-0985-00L Social Intercourse with Current Environmental Risks

**Abstract**
The lecture treats the social intercourse with risks of technical systems. The notion of risk and the perception of risk are discussed by case studies (e.g. nanotechnology) and socio-political instruments for decision-making are presented. Methods are presented that can be applied to deal with environmental risks and how they can be used for sustainable innovation.

**Objective**
- Getting acquainted to the extended risk concept
- Evaluation of the risks caused by technology within the societal context
- Knowledge about the mode science and society handle current environmental risks (examples gene- and nanotechnology)
- Knowledge about handling risks (e.g. precautionary principle, protection goal, damage definition, ethics)

**Content**
- Risks and technical systems (risk categories, risk perception, risk management)
- Illustration with case studies (nanotechnology)
- Implementation (politics, science, media, etc.)
- Decision making (technology assessment, cost/benefit analysis etc.)
- The role of the media
- prospects for future developments

**Lecture notes / Prerequisites / notice**
Copies of slides and selected documents will be distributed. The lecture is held biweekly (for 2 hours). The dates are 26.9., 3.10. (out of schedule), 24.10, 7.11, 21.11, 5.12, 19.12

### 701-0727-00L Politics of Environmental Problem Solving in Developing Countries

**Abstract**
The course focuses on processes and drivers of decision-making on natural resources management issues in developing countries. It gives insights into the relevance of ecological aspects in developing countries. It covers concepts, instruments, processes and actors in environmental politics at the example of specific environmental challenges of global importance.
Objective After completion of the module, students will be able to:
- Identify and appraise ecological aspects in development cooperation, development policies and developing countries’ realities
- Analyze the forces, components and processes, which influence the design, the implementation and the outcome of ecological measures
- Characterize concepts, instruments and drivers of environmental politics and understand, how policies are shaped, both at national level and in multilateral negotiations
- Study changes (improvements) in environmental politics over time as the result of the interaction of processes and actors, including international development organizations
- Analyze politics and design approaches to influence them, looking among others at governance, social organization, legal issues and institutions

Content Key issues and basic concepts related to environmental politics are introduced. Then the course predominantly builds on case studies, providing information on the context, specifying problems and potentials, describing processes, illustrating the change management, discussing experiences and outcomes, successes and failures. The analysis of the cases elucidates factors for success and pitfalls in terms of processes, key elements and intervention strategies.

Different cases not only deal with different environmental problems, but also focus on different levels and degrees of formality. This ranges from local interventions with resource user groups as key stakeholders, to country level policies, to multi- and international initiatives and conventions. Linkages and interaction of the different system levels are highlighted. Special emphasis is given to natural resources management.

The cases address the following issues:
- Land use and soil fertility enhancement: From degradation to sustainable use
- Common property resource management (forest and pasture): Collective action and property rights, community-based management
- Ecosystem health (integrated pest management, soil and water conservation)
- Payment for environmental services: Successes in natural resources management
- Climate change and agriculture: Adaptation and mitigation possibilities
- Biodiversity Convention: Implications for conservations and access to genetic resources
- Biodiversity as a means for more secure livelihoods: Agroforestry and intercropping
- The Millennium Development Goals: Interactions between poverty and the environment
- Poverty and natural resources management: Poverty reduction strategies, the view of the poor themselves
- Food security: Policies, causes for insecurity, the role of land grabbing
- Biofuels and food security: Did politics misfire?
- Strategy development at global level: IAASTD and World Development Report 2008

Lecture notes Information concerning the cases and specific issues illustrated therein will be provided during the course (uploaded on Moodle).

Literature


Prerequisites / notice The performance assessment will consist of an individual essay to be written by each student based on at least five references in addition to the sources provided in the course. Students can choose from a list of topics. Criteria for assessment will be communicated at the beginning of the course.

Philosophy

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>851-0125-03L</td>
<td>Research Colloquium for Ph.D.-Students and Members of Staff</td>
<td>Z</td>
<td>0</td>
<td>1K</td>
<td>L. Wingert</td>
</tr>
<tr>
<td></td>
<td>Open for Master students on personal invitation. Personal registration required to Mr. Wingert.</td>
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<tr>
<td>Abstract</td>
<td>Ph.D. students and members of staff report on their research.</td>
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<tr>
<td>Objective</td>
<td>Key problems of research projects will be discussed. Participants will learn to know arguments and ideas dealing with systematic problems in philosophy.</td>
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<tr>
<td>851-0125-41L</td>
<td>Introduction Into Philosophy of Technology</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>O. Müller</td>
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<tr>
<td></td>
<td>Particularly suitable for students of D-ITET, D-MATL, D-MAYT</td>
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<tr>
<td>Abstract</td>
<td>Since antiquity philosophy reflects about and evaluates technology. The technical developments in the 19th and 20th century have led to a autonomous philosophy of technology, which had become important also for other philosophical disciplines (e.g. in Heidegger's philosophy).</td>
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<td>Objective</td>
<td>The course gives an overview on the main schools in the philosophy of technology. Students should learn to analyse and evaluate different philosophies of technology (compensation, objectification, externalisation). For credit point a critical protokoll is to be written.</td>
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<tr>
<td>851-0125-58L</td>
<td>Philosophy of the Environmental Sciences: An Introduction</td>
<td>W</td>
<td>3</td>
<td>2S</td>
<td>A. Schwarz</td>
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<td></td>
<td>Particularly suitable for students of D-ARCH, D-BSSE, D-CHAB, D-MTEC, D-USYS</td>
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<tr>
<td>Abstract</td>
<td>Environmental knowledge and management is quite common in different research fields and in everyday practice. We will be identifying those concepts, objects and methods that mainly construe what might be called the core of the environmental sciences. This will be done by using different philosophical tools and approaches.</td>
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<tr>
<td>Objective</td>
<td>The environmental sciences cover a wide range of scientific practices and objects and accordingly afford different kinds of scientific knowledge. Additionally, there is an important interplay between the scientific and the societal sphere. In this seminar we will examine likewise central and widespread concepts such as sustainable development or resilience by using philosophical tools that will allow to probe the different uses of those concepts, their semantic range in terms of historical depth and semantic fields and finally their logical coherence. Another important topic is the philosophical investigation of methods and objects that can be identified in the environmental sciences. Those methods are for instance Life Cycle Assessment or Adaptive Ecosystem Management, technological objects may be a wind engine or a hydropower plant. The latter raise questions of how renewable energies can be assessed and valued, including the more general issue of how values and norms can be embedded in technological objects. This leads us to the third and last complex of topics that focus on current deliberations about possible new ways of existence in the age of the Anthropocene and as a consequence the formation of adequate life styles in our societies. This refers to issues in philosophical and social anthropology and the challenge of climate change.</td>
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<tr>
<td>851-0125-60L</td>
<td>Introduction to Epistemology</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>N. El Kassar</td>
</tr>
<tr>
<td>Abstract</td>
<td>In this course we will examine fundamental questions of epistemology, e.g. What is knowledge? How are we to conceive of perception? Which beliefs are rational and justified? How do we acquire knowledge? By discussing a selection of seminal philosophical texts we will study fundamental epistemological theories.</td>
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851-0125-18L  Self-Ownership - Philosophical and Juridical Perspectives  W  3 credits  2G
Does not take place this semester.

Abstract
Rights in Objects are founded by an inalienable Self-Ownership. These ideas are central for personal rights. We speak of my body, my genes, my name, my portrait, my ideas or ways of expression.

Objective
Participants will make acquaintance with founding texts of the natural rights property concept (John Locke). They will see the connection between inalienable self-ownership, prohibition of slavery, derivative commercial rights and modern personal rights. They will learn about the problems of self-ownership today concerning property in one’s body and intellectual property. Critical alternatives to the property paradigm will be discussed.

Participants will have the opportunity to gain access to unfamiliar texts from the philosophical tradition and to see their relevance today. They experience the consequences of a certain use of concepts and orient themselves in current bioethical, juridical and political discussions.

Content
Texts by Locke, Nozick, Chrestman, Otsuka, Schneider, Stirner, Fichte and Forschner. Founding of property right in self-ownership (Locke), revival of this concept in Nozick and his egalitarian critics. Critique of the concept of self-ownership related to property in one's body. Looking back to the personal self-relatedness that comes up again in Intellectual Property and in modern personal rights.

Literature
Text, Seminarplan und Literaturliste in ILIAS Lehrdokumentenablage.

851-0125-51L  Man and Machine  W  3 credits  2G  M. Hampe
Does not take place this semester.

Abstract
The lecture gives an overview about the different Man-Machine-Relations since the 16th century. Different models of machines will be important here: the clockwork, the steam engine and the computer.

Objective
On the one hand models of machines had a heuristic value in research on man, e.g. in Harvey’s discovery of blood circulation in the 17th century or in brain research in the 20th century. On the other hand these models were always criticised, sometimes polemically, because they are supposedly not adequate for man.

Students should learn about the connections between the history of anthropology and technology and be able at the end of the course to evaluate the critical philosophical arguments that are connected with the metaphor of the machine.

851-0125-61L  What is the Value of Truth?  W  3 credits  2G  L. Wingert
Does not take place this semester.

Abstract
It is useful to know which fellowships are available or to know the causes of frequent occurrence of extreme weather. These truths are of instrumental value. Is it also intrinsically good to know the truth, e.g. to know that there are gravitational waves? And which is the role of truth in our lives? The course will deal with such philosophical questions.

Objective


3. Ebenso soll ein besseres Urteil gebildet werden darüber, welche existenzielle Rolle die Suche nach Wahrheiten in unserem persönlichen Leben hat.

Does not take place this semester.

Abstract
How should we human beings understand ourselves according to our best knowledge about us, the social world, human history and nature? What are the relationships between biological and socio-cultural determinants of our thinking and doing? Michael Tomasello, psychologist, and social philosopher, has answered these questions in a thought-provoking way. His answers will be studied and examined.

Literature


851-0125-63L  Images of Mathematics  W  3 credits  2G  M. Hampe, A. Schubbach
Particularly suitable for students of D-MATH

Abstract
The lecture series “Images of Mathematics” deals with the formalization of the objects and the logical language of mathematics from Hilbert to Gödel and considers its consequences in view of our conception of mathematical practice and knowledge, the limits of calculability and computability in mathematics, and the relation between the logical proof procedures and the involved intuitive aspects.

Objective
The lecture series will present philosophical problems of theoretical mathematics in the 20th century and will discuss the consequences of formalization and axiomatization. It aims at a critical reflection on the modern images of mathematics.
How we understand Mathematics is probably strongly influenced by the Mathematics lessons we participated in during our school days. The common image of mathematics is therefore often characterized by the impression of a very stable form of knowledge with clear-cut problems and suitable recipes for finding the solution. It is a very static image which is very much in conflict with the rapid series of innovations that the discipline has experienced especially since the 19th century: Mathematics as a field of research has been highly innovative and even revolutionary as few other scientific disciplines in the last 200 hundred years.

These mathematical innovations did not only contribute to a progress amassing more and more knowledge. They very often changed how mathematicians conceived of their discipline. Even a contribution to a specific research question that appears at first sight to be minor can sometimes establish new connections to other fields, found a whole research field of its own or introduce new methods thereby changing the whole image of mathematics in the same way that a small addition to a picture can alter radically what we take it to represent.

The lecture series "Images of Mathematics" deals with a few moments in the history of the scientific discipline since the middle of the 19th century when the image of mathematics changed. In particular, it focuses on the consequences of the fact that in the 19th century mathematics started to not only reflect on their own conceptual and methodological foundations in a general manner (which had been done since the dawn of mathematics and was especially a philosophical task), but to formalize them in a strict, mathematical way: the objects of mathematics, its logical language and its proof procedures. Through Cantor's set theory, the mathematical treatment of logic since Boole and especially through Frege and the formalization of its axioms in a wide ranging discussion involving Zermelo, Fraenkel and others, this self-reflexive stance came to the fore.

Yet, the deeper mathematics dug into its foundations, the more radical the problems became. Finally, the optimistic Hilbert program of laying the foundation of mathematics within mathematics and of proving its own consistency as well as its completeness contributed to clarifying of the foundation of mathematics primarily insofar as it was doomed to failure. Gödel proved his famous incompleteness theorems and thereby dismissed at the same time the formalist attempt to reduce mathematical truth to logical provability. His work resulted in detailed insights in the precariousness of the foundation of mathematics and further numerous of productive consequences within mathematics.

Moreover, Gödel's theorems open many far-reaching and intriguing questions in view of our image of mathematics, questions concerning the conception of mathematical practice and knowledge, the limits of calculability of mathematics and the possible role of computability and machines in mathematics, the relation between the logical proof procedures and the involved intuitive aspects. In short, the image of mathematics is not as static as we sometimes expect it to be, it was radically redrawn by the mathematicians of the 20th century and has since then again been open to diverging interpretations.

I. Ethics & the Process of Ethical Inquiry

Introduction in Ethics and Research Ethics
- What is ethics? What ethics is not...;
- Awareness: what constitutes an ethical question? Distinguishing ethical questions from other kinds of questions; Science & ethics: a comparison;
- The ethics movement in the biological and health sciences;
- What is research ethics and why is it important?
- Values (personal, cultural & ethical) in science & principles for ethical conduct in research;
- Professional codes of conduct: functions and limitations

Ethical approaches in the conduct of research (Normative Ethics)
- Overview over important theories for research ethics: virtue theories, duty-based theories (rights theory, categorical imperative, prima facie duties), consequentialist theories, other theories);
- The plurality of ethical theories and its consequences;
- The concept of dignity

Moral reasoning I: Arguments
- Why arguments? What is a good argument? The structure of (moral) arguments;
- Deductive and inductive arguments; Validity and soundness;
- Assessing moral arguments

Moral reasoning II: Decision-making
- How (not) to approach ethical issues...; Is there a correct method for answering moral questions?
- Models of method in Applied Ethics: a) Top-down approaches; b) the reflective equilibrium; c) a bottom-up approach: casuistry (or reasoning-by-analogy);
- Is there a right answer?

II. Research Ethics / Responsible Conduct of Research (RCR)

Integrity in Research & Research Misconduct
- What is "integrity" in scientific research? What is research misconduct (falsification, fabrication, plagiarism - FFP) and questionable research practices (QRP)?
- Factors leading to misconduct; Procedure for responding to allegations of research misconduct;
- The confidant of ETH Zurich

Data Management
- Data collection and recordkeeping; Analysis and selection of data;
- Ownership of data; retention and sharing of data;
- Falsification and fabrication of data

Research involving animals
- The moral status of animals; Ethical approaches to animal experimentation: Animal welfare (Peter Singer) and Animal rights (Tom Regan);
- The 3 Rs (replacement, reduction, refinement);
- Ethical assessment of conflicting issues in animal experimentation;
- The dignity of animals in the Swiss constitution;

Research involving human subjects
- History & guidelines (Nuremberg Code; Declaration of Helsinki; Belmont Report; International Ethical Guidelines for Biomedical Research Involving Human Subjects (CIOMS Guidelines); Convention on Human Rights and Biomedicine (Oviedo Convention);
- Informed consent; confidentiality and anonymity; research risks and benefits; vulnerable subjects;
- Clinical trials;
- Biobanks
- Ethics Committees / Institutional Review Boards (IRB)

Authorship & Peer review
- Criteria for authorship;
- Plagiarism;
- Challenges to openness and freedom in scientific publication;
- Open access
- Peer review

Social responsibility
- What is social responsibility? Social responsibility: whose obligation?
- Public advocacy by researchers

Lecture notes
- Course material (handouts, case studies, exercises, surveys and papers) will be available during the lectures and on the course homepage.

Literature
- "Introduction to the Responsible Conduct of Research" (http://ori.dhhs.gov/education/products/RCRintro/)

Recommended literature:
- "Introduction to the Responsible Conduct of Research" (http://ori.dhhs.gov/education/products/RCRintro/)

Detailed literature lists for the different topics of the course will be provided in the script/handout or on the course work space.

851-0145-05L Narratives of Health and Illness W 3 credits 2S S. Baier

Number of participants limited to 30

Particularly suitable for students of D-HEST

Abstract
Das Seminar gibt einen Einblick in den Forschungsbereich der Narrativen Medizin als Teilbereich der Medizinischen Geisteswissenschaften. Erzählungen spielen eine vielfältige Rolle, wenn es um Gesundheit und Krankheit geht.

851-0148-04L  
Cyclical time  
W  
3 credits  
2S  
T. Böhm

Abstract: The idea of cyclical time is found in ancient pieces of wisdom (Pythagoreans, Plato, Buddhism) as reincarnation or memory, but also in Nietzsche as eternal return, in Deleuze as repetition, in Freud as repetition compulsion. We investigate the concept of repetition in combination with differences of time and thinking change.

Objective: Understanding of the various forms and functions of repetition on the basis of texts by Plato (anamnesis), Freud (repetition compulsion), Kierkegaard (narration), Nietzsche (eternal return as cosmological and ethical principle), Deleuze (time synthesis and repetition of the future), Poincaré's theorem of recurrence.

851-0144-20L  
Philosophical Aspects of Quantum Physics  
W  
3 credits  
2S  
N. Sieroka, R. Renner

Abstract: This course provides an introduction to philosophical issues surrounding quantum physics. In particular, we will examine different interpretations of quantum mechanics (such as the many-world interpretation) and the transition between the quantum and the classical physical realm (here phenomena such as decoherence will be highlighted).

Objective: By the end of the course students are able to describe and compare different interpretations of quantum mechanics. They are able to identify and examine issues concerning these different interpretations and issues concerning the transition between quantum and classical descriptions in physics. Students are in a position to critically discuss and evaluate the repercussions of these issues in broader scientific contexts.

851-0144-19L  
Philosophy of Time  
W  
3 credits  
2V  
N. Sieroka

Abstract: This course provides an introduction to philosophical issues surrounding the concept of time. We will treat topics such as: the existence of past, present, and future; the possibility of time travel; the constitution of time consciousness and its possible neurophysiological counterparts; temporal biases in the conduct of our lives; responsibility to future and past generations.

Objective: By the end of the course students are able to describe and compare different theories and concepts of time (physical time, perceptual time, historical time ...). They are able to identify and examine issues concerning time as they occur in various philosophical subdisciplines - especially in philosophy of science, philosophy of mind, metaphysics, and ethics. Students are in a position to critically discuss and evaluate the repercussions of these issues in broader scientific and social contexts.

Part of the course reflects on methods and contents from physics, neuroscience/cognitive science, and logic.

851-0144-21L  
Philosophical Issues and Problems in Theoretical Computer Science  
W  
3 credits  
2V  
G. Sommaruga, J. Copeland, D. Proudfoot

Abstract: This course studies philosophical issues concerning computers and computing. Topics include: information (and information content), computational complexity, the Turing Test for computer thought; the "Chinese Room" argument against the possibility of strong AI; connectionist AI; consciousness; the Church-Turing thesis; computational and hypercomputational models of mind; and free will.

Objective: 
- Exhibit a general understanding of the philosophy and history of computing.
- Explain central problems in the field and their potential solutions, independently and at a level requiring in-depth knowledge and critical understanding.
- Communicate clearly in writing about topics in this field.

851-0144-22L  
Developments in Logic after Gödel: Applications to Theoretical Computer Science  
W  
3 credits  
2V  
G. Sommaruga, J. Copeland

Abstract: The course will start by presenting a modern logic, namely (propositional) modal logic, which has turned out to be extremely fruitful and to have numerous interesting applications in computer science, mathematics and philosophy. Subsequently, two of these applications to computer science, tense logic and dynamic logic, and one application to mathematics, provability logic, will be introduced.

Objective: 
- Learn the fundamental concepts of a range of propositional logics.
- Learn how to construct proofs in these logics.
- Study the interface between mathematical logic and computer science, and mathematical logic and mathematics.

851-0127-28L  
Death - The Secret Problem of Life  
W  
3 credits  
2S  
H. Wiedebach

Abstract: No detective novel without a corpse, no religion without knowledge about death and life, no large transplantation of an organ without certificate for the donor's death. Is a dead person always a corpse? - Death is part of life and yet stands simultaneously in opposition to it. We cling to life and nonetheless wish to have the option to commit suicide. Do we know what we really want in that case?

Objective: Discussion of 1) several conceptions of death in history, 2) determination of death in a medical sense (brain-death, etc.), 3) The search for a personal view about life and death. 4) The practice of a precise manner of speaking based on reflection.

Literature: Texte als Diskussionsgrundlage werden zu Beginn des Semesters genannt bzw. als PDF unter "Lernmaterialien" veröffentlicht.

Prerequisites / notice: Leistungsnachweise der Studenten:

- Ihre Texte schicken Sie bitte an die eigens eingerichtete Email-Adresse: grundproblem-tod@ethz.ch

Formalism (Minimalanforderungen):
- Schriftbild: Zeilenabstand 1.5, Schriftgröße 12, Seitenabstand 2.5cm, Schriftart: Arial, Times New Roman.
- Vor- und Nachname, Matrikelnummer, Veranstaltungsname, Dozent, E-Mail-Adr., Studiengang.
- organisatorische Rückfragen bitte an den Assistenten Raphael Salvi: raphael.salvi@phil.gess.ethz.ch

701-0701-00L  
Philosophy of Science  
W  
3 credits  
2V  
G. Hirsch Hadorn, C. J. Baumberger
### 701-0701-01L Philosophy of Science: Exercises

<table>
<thead>
<tr>
<th>Objective</th>
<th>Abstract</th>
<th>Literature</th>
<th>Prerequisites / notice</th>
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<tbody>
<tr>
<td>Students engage in applied ethics.</td>
<td>The exercises in philosophy of science serve to develop skills in critical thinking by discussing seminal texts about the rationality of science. Topics discussed include the significance and limits of empirical, mathematical and logical methods, as well as problems and ethical issues raised by the use of science in society.</td>
<td>A reader will be available for students.</td>
<td>Students want to subscribe for this course also have to subscribe for the lecture 701-0701-00 V &quot;Wissenschaftsphilosophie&quot;. Credit points are given for preparing a structure and a summary of one of the texts.</td>
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<tr>
<th>Literature</th>
<th>Prerequisites / notice</th>
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<tbody>
<tr>
<td>- N. Mazouz, Introduction to Ethics of Science</td>
<td></td>
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<tr>
<td>- C. J. Baumberger, Environmental Ethics</td>
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<tr>
<th>Content</th>
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<tbody>
<tr>
<td>1. Introduction to general and applied ethics.</td>
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<tr>
<td>2. Overview and discussion of ethical theories relevant to the environment.</td>
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<tr>
<td>3. Cross-section topics, such as sustainability, intergenerational justice, protection of species, etc.</td>
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<tr>
<td>4. Practising of newly acquired knowledge in case studies (protection of species, climate change, etc.)</td>
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<tr>
<th>Lecture notes</th>
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<tbody>
<tr>
<td>Summaries of the individual sessions will be distributed, including the most important theories and keywords; reading list.</td>
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<th>Objective</th>
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<tr>
<td>On completion of this lecture course you will have acquired the ability to identify and process general and environmental ethical problems. You will be capable of recognising and analysing environmental ethical problems and of working towards a solution. You will have acquired a fundamental knowledge of standpoints and arguments to be found within the field of environmental ethics and will have practised these in small case studies.</td>
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### 851-0594-00L International Environmental Politics

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<th>Objective</th>
<th>Abstract</th>
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<tr>
<td>Students learn to identify, analyse and evaluate problems concerning research ethics as well as the political and social role of science. They form their abilities to reason as well as to interpret and write texts.</td>
<td>This course focuses on the conditions under which cooperation in international environmental politics emerges and the conditions under which such cooperation and the respective public policies are effective and/or efficient.</td>
<td>The procedure for accumulating CP will be explained at the start of term.</td>
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<tr>
<td>I expect participants to be motivated and contribute to discussions, keeping the course interesting and lively.</td>
</tr>
</tbody>
</table>
Content

This course deals with how and why international cooperation in environmental politics emerges, and under what circumstances such cooperation is effective and efficient. Based on theories of international political economy and theories of government regulation various examples of international environmental politics are discussed: the management of international water resources, the problem of unsafe nuclear power plants in eastern Europe, political responses to global warming, the protection of the stratospheric ozone layer, the reduction of long-range transboundary air pollution in Europe, the prevention of pollution of the oceans, etc.

The course is open to all ETH students. Participation does not require previous coursework in the social sciences.

After passing an end-of-semester test (requirement: grade 4.0 or higher) students will receive 3 ECTS credit points. The workload is around 90 hours (meetings, reading assignments, preparation of test).

Lecture notes

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

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

Literature

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

Prerequisites / notice

None

851-0589-00L Technology and Innovation for Development

W Dr 3 credits 2V P. Aerni

Abstract

Technological change plays a crucial role in efforts to create a more sustainable future. In this context, policy decision makers must design rules that minimize its risks and maximize its benefits for society at large. The course discusses this challenge from an interdisciplinary perspective taking into account legal, economic, historical, development and environmental aspects.

Objective

- to recognize the challenges and opportunities of technological change in terms of sustainable development
- to become familiar with policy instruments to promote innovation
- to improve understanding of political decision-making processes in the regulation of science & technology
- improved understanding of the role of science and technology in the context of human and societal development

Content

Science and Technology Policy is normally associated with the improvement of national competitiveness; yet, it is also an integral part of effective environmental and development policies.

The course will discuss the challenges and opportunities of technological change in terms of sustainable development and show how public policy on the national and the international level is responding to this change.

In this context, students are to become familiar with the basic principles of political economy and New Growth Theory and how such theories help explain political decisions as well as political outcomes in the area of Science, Technology and Innovation. State interventions are either designed to regulate (e.g. environmental regulations, anti-trust law) or facilitate (e.g. intellectual property rights protection, public investment in R&D and technical education, technology transfer) technological change. This will be illustrated by looking at different industries and different national systems of innovation. Subsequently the positive and negative consequences for society and the natural environment will be discussed from a short-term and a long-term perspective.

Lecture notes

Reader with issue-specific articles. E-version is partly available under https://www.ethz.ch/content/specialinterest/gess/cis/international-relations/en/teaching/materials/tech.html


The 2-hour course (5-7 p.m.) will be held as a series of lectures. The course materials will be available in form of an electronic Reader at the beginning of the semester. The class will be taught in English. Students will be asked to give a (a) presentation (15 Minutes) or write a review paper based on an article selected from the electronic script, and (b) they will have to pass a written test at the end of the course in order to obtain 3 credit points in the ECTS System. In the final mark (a) will have a weight of 40% and (b) 60%.

853-0038-00L Swiss Foreign Policy W 3 credits 2V D. Möckli

This course analyzes the foundations and challenges of Swiss foreign policy. After reviewing the history of foreign policy conceptions since the early 20th century, we will discuss the determining factors of Swiss foreign policy and examine, together with guest speakers from the foreign ministry, current issues such as the Syria crisis, the migration challenge, terrorism, and Swiss-EU relations.

Students should acquire a sound understanding of Swiss foreign policy and the relevant academic and political debates associated with it.
This course offers an introduction to research on causes of wars. War as a social phenomenon is covered from the pre-state world to today’s state system after the end of the Cold War. Topics include state formation and collapse, nationalism, decolonization, democracy, and ethnic conflict.

The 1-hour written exam will take place during the last lecture in the semester.

The course will be supported by an e-learning environment.

Students will receive a handout of slides accompanying the lectures. A reading list will be handed out at the beginning of the semester.

The lectures “Leadership I” (WS) and “Leadership II” (SS) have been designed as a two-semester lecture series, but may also be followed independently of one another or in reverse order. “Leadership I” covers the following fields: leadership basics, leadership theories and leadership styles, the concept of leadership responsibility and the role of communication in practical leadership.

The aim of the course is to provide participants with an overview of international security politics with a special focus on dual-use technologies. Students will analyze the character of dual-use security risks and of risk-based security strategies and instruments. Thematic areas include the nuclear non-proliferation regime, biological and chemical weapons conventions, missile proliferation, the nuclear programs of Iran and North Korea, cyber and space technologies, as well as robotics and nanotechnology.

The students should become aware of how researchers can deal with sensitive knowledge regarding research transparency and control. In addition, the students should become aware of the different concepts of leadership enabling them to gain a deeper understanding of the leadership phenomenon.

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The 1-hour written exam will take place during the last lecture in the semester.

Lecture notes

Prerequisites / notice

The lectures "Leadership I" (WS) and "Leadership II" (SS) have been designed as a two-semester lecture series, but may also be followed independently of one another or in reverse order. "Leadership I" covers the following fields: leadership basics, leadership theories and leadership styles, the concept of leadership responsibility and the role of communication in practical leadership.

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The students should become aware of how researchers can deal with sensitive knowledge regarding research transparency and control. In addition, the students should become aware of the different concepts of leadership enabling them to gain a deeper understanding of the leadership phenomenon.
The seminar covers the theory, development, and core policy fields of European integration as well as structures and processes of the EU as a decision- and policy-making system.

Literature

Basislektüre

Prerequisites / notice

The grade is based on a written exam.

860-0001-00L Public Institutions and Policy-Making Processes  W  3 credits  3G  T. Bernauer, S. Bechtold, F. Schimmelfennig

Number of participants limited to 25.

Priority for Science, Technology, and Policy MSc students.

Abstract

Students acquire the contextual knowledge for analyzing public policies. They learn why and how public policies and laws are developed, designed, and implemented at national and international levels, and what challenges arise in this regard.

Objective

Public policies result from decision-making processes that take place within formal institutions of the state (parliament, government, public administration, courts). That is, policies are shaped by the characteristics of decision-making processes and the characteristics of public institutions and related actors (e.g. interest groups). In this course, students acquire the contextual knowledge for analyzing public policies. They learn why and how public policies and laws are developed, designed, and implemented at national and international levels, and what challenges arise in this regard. The course is organized in three modules. The first module (Stefan Bechtold) examines basic concepts and the role of law, law-making, and law enforcement in modern societies. The second module (Thomas Bernauer) deals with the functioning of legislatures, governments, and interest groups. The third module (Frank Schimmelfennig) focuses on the European Union and international organisations.

Content

Schedule (for up-to-date information, see the syllabus that will be distributed to participants electronically):

W1: Bechtold, Bernauer: Introduction
How are laws created and interpreted? How are they enforced?
W2: Bechtold: Why do we need laws and why do people and firms usually obey the law? What are possible goals of legal systems? What is the relationship between laws, social norms, and moral values?
W3: Bechtold: What role does scientific evidence play in the creation and enforcement of the law? How does the law deal with non-quantifiable factors or incommensurable values?
W4: no class
W5: Bernauer: How are parliaments (legislatures) elected, how do they work, and how do their characteristics and processes affect policy-making.
W6: Bernauer: Why do forms of government differ and how does this affect policy-making? Why and in what respect are public administrations efficient/effective, and why sometimes not?
W7: Bernauer: How do interest groups and social movements affect policy-making.
W8: Study week
W9: Schimmelfennig: Governance beyond the state: why and how states create international institutions.
W10: Schimmelfennig: International organizations and regimes: case studies of global governance.
W11: Schimmelfennig: Institutions and policy-making in the European Union.
W12: Schimmelfennig: International organizations and policy diffusion.
W13: End-of-semester exam

An add-on module to this course (3 ECTS) involves an essay. This part of the course is accessible only to ISTP MSc students and requires enrollment in the main course (3 ECTS). ISTP MSc students must enrol in both parts. Other students can only enrol in the main course.

3rd week of January: deadline for review essay

Lecture notes

Reading materials will be distributed electronically to the students when the semester starts.
This course offers a comprehensive examination of the role of international organizations (IOs) in world politics. Besides teaching the basic theories and methods that are necessary for studying IOs, this course considers the application of those theories and methods to a range of special institutions.

The first part of this course offers an introduction and will seek to explain how, if at all, IOs obtain some measure of authority in international affairs, i.e., why states delegate certain tasks to IOs instead of dealing unilaterally or multilaterally outside of an institutional context. The second part of the course focuses on the impact and effectiveness of international institutions. We assess whether and how IOs influence state compliance with agreements, and whether IOs socialize states to behave in certain ways. The third and final part of the course examines a special set of IOs: international alliances and international regimes, i.e., explicit principles, norms, rules, and decision-making procedures that define expected behavior in a specific problem field.

The requirements for the course include participation in class discussions (10%), one class presentation (30%), and a final exam (60%).

a) Participation: The quality of students' experience in this course depends on the participation of students. Regular attendance and active class participation constitute a significant portion of the course grade. Students will be expected to read the required readings, think critically about them, and discuss them in class.

b) Class Presentation: First, you will submit one short (maximum 2 pages) paper summarizing the readings for a particular week. This short paper should be distributed to the class ahead of the meeting time (email, at least 24 hours in advance). Each student writing such a paper must also prepare a short class presentation. The goal of this exercise is not simply to summarize the assigned readings, as others in the class will already be familiar with the assignment. Rather, a good summary discusses the broader issues, themes, and questions underlying the readings or identifies problems with research design or potential flaws in the particular articles. The paper(s) and presentation(s) serve as a starting point for a more focused in-class discussion.

c) Final exam: The final examination will take place at the last week of the course. It lasts 1.5 hours, during which you will be required to answer 3 questions out of 9 questions.

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**Psychology, Pedagogics**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>851-0240-00L</td>
<td>Human Learning (EW1)</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>E. Stern</td>
</tr>
</tbody>
</table>

This lecture is only apt for students who intend to enrol in the programs "Teaching Diploma" or "Teaching Certificate". It is about learning in childhood and adolescence.

This course looks into scientific theories and also empirical studies on human learning and relates them to the school.

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

Lernformen:


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**Literature**


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**Prerequisites / notice**

This is a Master level course. The course is capped at 25 students, with ISTP Master students having priority.
This seminar introduces theory and methods in human-computer interaction and usability. Cognitive Science provides a theoretical framework for designing user interfaces as well as a range of methods for assessing usability (user testing, cognitive walkthrough, GOMS). The seminar will provide an opportunity to experience some of the methods in applied group projects.

**Abstract**

This seminar introduces theory and methods in human-computer interaction and usability. Cognitive Science provides a theoretical framework for designing user interfaces as well as a range of methods for assessing usability (user testing, cognitive walkthrough, GOMS). The seminar will provide an opportunity to experience some of the methods in applied group projects.

**Objective**

This seminar will introduce key topics, theories and methodology in human-computer interaction (HCI) and usability. Presentations will cover basics of human-computer interaction and selected topics like mobile interaction, adaptive systems, human error and attention. A focus of the seminar will be on getting to know evaluation techniques in HCI. Students form work groups that first familiarize themselves with a select usability evaluation method (e.g. user testing, GOMS, task analysis, heuristic evaluation, questionnaires or Cognitive Walkthrough). They will then apply the methods to a human-computer interaction setting (e.g. an existing software or hardware interface) and present the method as well as their procedure and results to the plenary. Active participation is vital for the success of the seminar, and students are expected to contribute to presentations of foundational themes, methods and results of their chosen group project. In order to obtain course credit a written essay / report will be required (details to be specified in the introductory session of the course).

**Literature**


**Prerequisites / notice**

This lecture is only apt for students who intend to enrol in the programs "Lehrdiplom" or "Didaktisches Zertifikat". It is about learning in childhood and adolescence.
The lecture covers the following main topics: Social perception and interpersonal judgement; attitudes; group dynamics and group performance; leadership behavior and leadership styles.

The aim of the lecture is to impart a well-founded scientific understanding of social influence processes in individuals, groups, organizations, and social settings.

The participants should develop competencies in the structuring of communication, interaction, and management processes.

Im Einzelnen sollen die Teilnehmerinnen und Teilnehmer lernen:

- an den Beispielen von Kaufverhalten oder ökologischem Verhalten zu beschreiben, wie Normen und Einstellungen Einfluss auf das Verhalten nehmen.
- Die Subjektivität und die Fehlerquellen sozialer Wahrnehmung verstehen.
- Prinzipien der Psychologie der Kommunikation zu nutzen für eine Verbesserung der Kommunikation in Studium und Beruf.
- Merkmale und Strukturen von Gruppen zu identifizieren und mit geeigneten Methoden zu analysieren.
- Die Grundlagen von Konformität und Gehorsam gegenüber Autoritäten zu erkennen.
- Gruppennahomene wie soziales Faulenzen, Risiko- und Konservativismus-Schub und Gruppendenken entgegenzuwirken.
- Gruppenleistungen und -entscheidungen zu optimieren.
- Führungsstile zu unterscheiden lernen.
- Techniken zur Moderation von interagierenden Gruppen kennen zu lernen.

There is no script, but slides will be made available before the lectures.

The course is restricted to 40 participants who will work closely with the lecturers on case studies prepared by the lecturers on topics relevant in their own companies (Swiss Re, Skyguide, Swisscom).

566-0311-00L Psychological Aspects of Risk Management and Technology W 3 credits 2V G. Grote, J. Schmutz, R. Schneider, M. Zumbühl

Abstract Using uncertainty management by organizations and individuals as conceptual framework, risk management and risk implications of new technologies are treated. Three components of risk management (risk identification/evaluation, risk mitigation, risk communication) and underlying psychological and organizational processes are discussed, using company case studies to promote in-depth understanding.

Objective
- understand basic components of risk management in organizations
- know and apply methods for risk identification/evaluation, risk mitigation, risk communication
- know psychological foundations of risk perception, decision-making under risk, and risk communication
- know organizational principles for managing uncertainty
- apply theoretical foundations to applied issues such as safety management, regulatory activities, and technology design and implementation in different domains (e.g., transport systems, IT, insurance)

Content The syllabus includes the following topics:
- Elements of risk management
- risk identification and evaluation
- risk mitigation
- risk communication
- Psychological and organizational concepts relevant in risk management
- decision-making under uncertainty
- risk perception
- resilient organizational processes for managing uncertainty

Case studies on different elements of risk management (e.g., rule making, training, managing project risks, automation)

Group projects related to company case studies

Lecture notes There are no script, but slides will be made available before the lectures.

Literature There are texts for each of the course topics made available before the lectures.

Prerequisites / notice The course is restricted to 40 participants who will work closely with the lecturers on case studies prepared by the lecturers on topics relevant in their own companies (Swiss Re, Skyguide, Swisscom).

701-0721-00L Psychology W 3 credits 2V R. Hansmann, C. Keller, M. Siegrist

Abstract This course provides an introduction to psychological research and modelling, focusing on cognitive psychology and the psychological experiment. Participants learn to formulate problems for psychological investigation and apply basic forms of psychological experiment.

Objective Students are able to:
- describe the areas, concepts, theories, methods and findings of psychology.
- differentiate scientific psychology from "everyday" psychology.
- structure the conclusions and significance of an experiment, according to a theory of psychology.
- formulate a psychological problem for investigation.
- apply basic forms of psychological experiment.

Content Einführung in die psychologische Forschung und Modellbildung unter besonderer Berücksichtigung der kognitiven Psychologie und des psychologischen Experiments. Themen sind u.a.: Wahrnehmung; Lernen und Entwicklung; Denken und Problemlösen; Kognitive Sozialpsychologie; Risiko und Entscheidung.

851-0252-08L Cognition in Studio Design - Analytic Tools for Evidence-Based Design W 3 credits 2S B. Emo Nax, M. Brösamle, C. Hölscher

Abstract How can Behavioral and Cognitive Science inform architecture? In this project-oriented course, students are introduced to cognitive and analytical methods to evaluate their design projects. Existing theories are introduced and complemented with hands-on sessions, in which students learn how to implement a range of methods. The course is tailored for students from relevant design studios.

Objective Taking the perspectives of the end user (occupants and visitors) is vital for a human-centered design approach. Students will learn about relevant theory and methods in cognitive science and environmental psychology that can be used to address human cognitive and behavioral needs in built environments. The foundations of environmental psychology and human spatial cognition will be introduced. A focus of the course will be on how people perceive their surroundings and orient in space. Students will learn about a range of methods including real-world observation, and methods of architectural analysis such as mental models and psychophysical analysis. Students will also be exposed to behavior simulation in design, virtual reality experiments, and eye-tracking. Students will reflect the roles of designers and other stakeholders with respect to human-centered design as well as an evidence-based design perspective. The course is tailored for students from a relevant design studio. Upon registering, students should send an email about their design studio to b emo gess etzh ch. As an alternative to obtaining D-GESS credit, architecture students can obtain course credit in "Vertiefungsfach" or "Wahlfach".

851-0238-01L Support and Diagnosis of Knowledge Acquisition Processes (EW3) W 3 credits 3S L. Schalk, P. Edelsbrunner, S. Hofer

Abstract Enrolment only possible with matriculation in Teaching Diploma (except for students of Sport Teaching Diploma, who complete the sport-specific course unit EW3) and for students who intend to enrol in the "Teaching Diploma".
The aim of this workshop is to equip students with legal skills and methods to solve or treat problems and questions of the environment.

Prerequisites: successful participation in 851-0240-00L "Human Learning (EW1)".

Objectives:
1. You have a deep understanding about the cognitive mechanisms of knowledge acquisition.
2. You have a basic understanding about psychological test theory and can appropriately administer tests.
3. You know various techniques of formative assessment and can apply these to uncover students' misconceptions.

Abstract:
In this seminar students learn advanced techniques to support and to diagnose knowledge acquisition processes in school.

Lecture notes:
Further documents will be available online (see https://moodle-app2.let.ethz.ch/course/view.php?id=2170).

Lecturers:
- O. Streiff Gnöpff
- C. Jäger
- O. Bucher

Language:
German

Prerequisite:
- Prerequisites: Environmental Law: Conceptions and Fields (851-0705-01L) offered in spring semester.

Particularly suitable for students of D-ARCH, D-BAUG, D-USYS

Number of participants limited to 20.

Does not take place this semester.

Number:
851-0703-00L

Title:
Introduction to Law

Type: W
ECTS: 2 credits
Hours: 2V
Lecturers: O. Streiff Gnöpff

Lecture notes:
Jaap Hage, Bram Akkermans (Eds.), Introduction to Law, Cham 2014 (Online Resource ETH Library)

Literature:
Further documents will be available online (see https://moodle-app2.let.ethz.ch/course/view.php?id=2170).

Number:
851-0705-02L

Title:
Environmental Law: Topics and Case Studies

Type: W
ECTS: 2 credits
Hours: 2S
Lecturers: C. Jäger

Prerequisites:
- Prerequisites: Environmental Law: Conceptions and Fields (851-0705-01L) offered in spring semester.

Particularly suitable for students of D-ARCH, D-BAUG, D-USYS

Abstract:
This class introduces students into basic features of the legal system. Fundamental issues of constitutional law, administrative law, private law and the law of the EU are covered.

Objective:
Students are able to identify basic structures of the legal system. They understand selected topics of public and private law and are able to apply the fundamentals in more advanced law classes.

Content:
- Basic concepts of law, sources of law.
- Private law: Contract law (particularly contract for work and services), tort law, property law.
- Public law: Human rights, administrative law, procurement law, procedural law.
- Insights into the law of the EU and into criminal law.

Lecture notes:
Den Studierenden werden Unterlagen zur juristischen Methoden- und Quellenlehre sowie zum Inhalt und Ablauf des Kurses zu Beginn der Veranstaltung kostenlos abgegeben.

Literature:
Rechtgrundlagen, Literatur und Gerichtsentscheide werden themenspezifisch selber rechechiert, unter Mithilfe und Beratung des Dozenten.

Prerequisites / notice:
Die Veranstaltung erfordert die Bereitschaft, sich aktiv und selbständig mit einer selbstgewählten Fragestellung oder einem eigenen Fallbeispiel aus dem Gebiet des Umweltrechts und allenfalls aus Schmittstellengebieten auseinanderzusetzen. Damit die Interaktivität und die Begleitung der Teams gewährleistet werden kann, ist die Teilnehmerzahl auf maximal 16 Personen beschränkt. Es handelt sich um eine Vertiefungsveranstaltung. Der Besuch der Vorlesung "Umweltrecht: Konzepte und Rechtsgebiete" (851-0705-01) ist Voraussetzung.

Number:
851-0707-00L

Title:
Space Planning Law and Environment

Type: W
ECTS: 2 credits
Hours: 2G
Lecturers: O. Bucher

Prerequisites:
- Prerequisite: System of Swiss planning law, Constitutional and statutory provisions, Space planning and fundamental rights, instruments, Application, legal protection, enforcement, Practical training.

Abstract:
System of swiss planning law, Constitutional and statutory provisions, Space planning and fundamental rights, instruments, Application, legal protection, enforcement, Practical training.

Objective:
Basic understanding of nature and function of space planning from a legal point of view. Basic knowledge of space planning instruments, relationship between space planning and constitutional law (especially property rights), solving of practical cases.

Content:

Lecture notes:
Haller, Walter/Karlen, Peter, Raumplanung-, Bau- und Umweltrecht, 3.A., Zürich 1999
Hänni, Peter, Planungs-, Bau- und besonderes Umweltschutzrecht, 6.A., Bern 2016

Number:
851-0709-00L

Title:
Introduction to Civil Law

Type: W
ECTS: 2 credits
Hours: 2V
Lecturers: H. Peter

Abstract:
In this seminar students learn advanced techniques to support and to diagnose knowledge acquisition processes in school.

Lecture notes:
Further documents will be available online (see https://moodle-app2.let.ethz.ch/course/view.php?id=2170).

Literature:
Hänner, Peter, Planungs-, Bau- und besonderes Umweltschutzrecht, 6.A., Bern 2016
traffic law / traffic commercial law

Vorgesehene Strukturierung der Vorlesung:

Business Law

Participants are acquiring a comprehensive summary about the system Traffic Law/Traffic Commercial Law in Switzerland. With practical

Es wird mit Folien gearbeitet, die als PDF über die elektronische Dokumentenablage (ILIAS) auf dem System der ETHZ vorgängig abrufbar

Weiterführende Materialien, Links und Literatur sind auf dem Termin- und Themenplan aufgeführt (zu gegebener Zeit abrufbar via


Editions officielles récentes des lois fédérales, en langue française (Code civil et Code des obligations) ou italienne (Codice civile e Codice delle obbligazioni), disponibles auprès de la plupart des bibliothèques.

Sind indispensables:

- le Code civil et le Code des obligations;
- Sont conséquents:
- Nef, Urs Ch.: Le droit des obligations à l’usage des ingénieurs et des architectes, trad. Bovay, J., éd. Payot, Lausanne
- Bollard, J.-P.: Manuel de droit, éd Statkine, Genève

Prerequisites / notice

- Le cours de droit civil et le cours de droit public (2e sem.) sont l’équivalent des cours "Recht I" et "Recht II" en langue allemande et des
- exercices y relatifs.
- Les examens peuvent se faire en français ou en italien.
- Examen au 1er propédeutique; convient pour travail de semestre.

851-0727-02L E-Business-Law

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

Abstract

The course deals with the basic legal framework for doing e-business as well as using information technology. It discusses a variety of legal concepts and rules to be taken into account in practice, be it when designing and planning new media business models, be it when implementing online projects and undertaking information technology activities.

Objective

The objective is knowing and understanding key legal concepts relevant for doing e-business, in particular understanding how e-business is regulated by law nationally and internationally, how contracts are concluded and performed electronically, which rules have to be obeyed in particular in the Internet with regard to third party and own content and client data, the concept of liability applied in e-business and the role of the law in the practical implementation and operation of e-business applications.

Content

Vorgesehene Strukturierung der Vorlesung:

1) Welches Recht gilt im E-Business?
   Internationalität des Internets
   Regulierte Branchen

2) Gestaltung und Vermarktung von E-Business-Angeboten
   Verwendung fremder und Schutz der eigenen Inhalte
   Haftung im E-Business (und wie sie beschränkt werden kann)
   Domain-Namen

3) Beziehung zu E-Business-Kunden
   Verträge im E-Business, Konsumentenschutz
   Elektronische Signaturen
   Datenschutz
   Spam

4) Verträge mit E-Business-Providern


Lecture notes

Es wird mit Folien bearbeitet, die als PDF über die elektronische Dokumentenablage (ILIAS) auf dem System der ETHZ vorgängig abrufbar sind. Auf dem Termin- und Themenplan (ebenfalls online abrufbar) sind Links zu Geberthetc. und weiteren Unterlagen abrufbar. Schliesslich wird jede Vorlesung auch als Podcast aufgezeichnet, der jedoch nur für die Studierenden mit einem Passwort (erhältlich beim Dozenten) zugänglich sind.


Literature


Prerequisites / notice

Die Semesterendprüfung ist in Form eines schriftlichen Kurztests (normalerweise MC) in voraussichtlich der letzten Doppelstunde geplant.

Es wird angegeben, welche Unterlagen beim jeweiligen Thema den Prüfungsstoff definieren. Der Test wird möglicherweise elektronisch durchgeführt.


Ferner bietet Ursula Widmer eine Vorlesung zum Thema Informationssicherheit an, welche die rechtlichen Aspekte der Sicherheit von ICT-Infrastrukturen und Netzen und der transportierten und verarbeiteten Informationen.

851-0733-00L Traffic Law / Traffic Commercial Law

Abstract

Within the scope of the lecture "Traffic Law / Traffic Commercial Law", besides an introduction into the legal basis of the national and international traffic, the main interest will be laid on actual political and economical questions and problems with respect to traffic (e.g. financing of traffic, road pricing, rail reform, air traffic vs. environment law etc.).

Objective

Participants are acquiring a comprehensive summary about the system Traffic Law/Traffic Commercial Law in Switzerland. With practical exercises and subsequent detailed reviews themes and subjects of special interest to participants are being treated more thoroughly.

Content

Within the scope of the lecture "Traffic Law / Traffic Commercial Law", besides an introduction into the legal basis of the national and international traffic, the main interest will be laid on actual political and economical questions and problems with respect to traffic (e.g. financing of traffic, road pricing, rail reform, air traffic vs. environment law etc.). With practical exercises and subsequent detailed reviews themes and subjects of special interest to participants are being treated more thoroughly.

Lecture notes

Script will be distributed during the lecture.

851-0735-10L Business Law

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

Abstract

The course Private Law focuses on the Swiss Code of Obligations (contracts, torts) and on Property Law (ownership, mortgage and easements). In addition, the course will provide a short overview of Civil Procedure and Enforcement.

Objective


Content

The course deals with the basic legal framework for doing e-business as well as using information technology. It discusses a variety of legal concepts and rules to be taken into account in practice, be it when designing and planning new media business models, be it when implementing online projects and undertaking information technology activities.

Objective

The objective is knowing and understanding key legal concepts relevant for doing e-business, in particular understanding how e-business is regulated by law nationally and internationally, how contracts are concluded and performed electronically, which rules have to be obeyed in particular in the Internet with regard to third party and own content and client data, the concept of liability applied in e-business and the role of the law in the practical implementation and operation of e-business applications.

Content

Vorgesehene Strukturierung der Vorlesung:

1) Welches Recht gilt im E-Business?
   Internationalität des Internets
   Regulierte Branchen

2) Gestaltung und Vermarktung von E-Business-Angeboten
   Verwendung fremder und Schutz der eigenen Inhalte
   Haftung im E-Business (und wie sie beschränkt werden kann)
   Domain-Namen

3) Beziehung zu E-Business-Kunden
   Verträge im E-Business, Konsumentenschutz
   Elektronische Signaturen
   Datenschutz
   Spam

4) Verträge mit E-Business-Providern


Lecture notes

Es wird mit Folien bearbeitet, die als PDF über die elektronische Dokumentenablage (ILIAS) auf dem System der ETHZ vorgängig abrufbar sind. Auf dem Termin- und Themenplan (ebenfalls online abrufbar) sind Links zu Geberthetc. und weiteren Unterlagen abrufbar. Schliesslich wird jede Vorlesung auch als Podcast aufgezeichnet, der jedoch nur für die Studierenden mit einem Passwort (erhältlich beim Dozenten) zugänglich sind.


Literature


Prerequisites / notice

Die Semesterendprüfung ist in Form eines schriftlichen Kurztests (normalerweise MC) in voraussichtlich der letzten Doppelstunde geplant.

Es wird angegeben, welche Unterlagen beim jeweiligen Thema den Prüfungsstoff definieren. Der Test wird möglicherweise elektronisch durchgeführt.


Ferner bietet Ursula Widmer eine Vorlesung zum Thema Informationssicherheit an, welche die rechtlichen Aspekte der Sicherheit von ICT-Infrastrukturen und Netzen und der transportierten und verarbeiteten Informationen.
The students shall obtain a basic knowledge about business law. They shall be able to recognize and evaluate issues in the area of business law and suggest possible solutions.

- They shall obtain a working knowledge on the legal aspects involved in setting up and managing an enterprise.
- They shall be acquainted with corporate functions as contracting, negotiation, claims management and dispute resolution.
- They shall be familiar with the issues of corporate compliance, i.e. the systems ensuring that all legal and ethical rules are observed.
- They shall be able to contribute to the legal management of the company and to discuss legal issues.
- They shall have an understanding of the law as a part of the corporate strategy and as a valuable resource of the company.

A comprehensive script will be made available online on the moodle platform.

Workshop and Lecture Series in Law and Finance  W  2 credits  2S  G. Hertig

This series is a joint seminar of ETH Zurich and the University of Zurich. It provides an overview of interdisciplinary research on intellectual property law.

To be discussed papers are posted in advance on the course's web page.

Participants discuss current Law & Finance issues with guest scholars from Europe and the U.S. In addition, participants write a comment on one of the discussed papers.

The Workshop and Lecture Series in Law & Finance aims at allowing participants to discuss current financial regulation and corporate governance issues with leading academics.

The students shall obtain the following competence:

- Viral Acharya et al., Regulating Wall Street (Wiley 2011)

Workshop & Lecture Series on the Law & Economics of Innovation  W  2 credits  2S  S. Bechtold, H. Gersbach, A. Heinemann

This series is a joint project by ETH Zurich and the University of Zurich. It provides an overview of interdisciplinary research on intellectual property law.

After the workshop and lecture series, participants should be acquainted with interdisciplinary approaches towards intellectual property, innovation, antitrust and technology policy research. They should also have an overview of current topics of international research in these areas.

Papers discussed in the workshop and lecture series are posted in advance on the course web page.

Suzanne Scotchmer, Innovation and Incentives, 2004
Bronwyn Hall / Nathan Rosenberg (eds.), Handbook of the Economics of Innovation, 2010
Bronwyn Hall / Dietmar Harhoff, Recent Research on the Economics of Patents, 2011
Einer Elhauge / Damien Geradin, Global Competition Law and Economics, 2007
Dennis Carlton / Jeffrey Perloff, Modern Industrial Organization, 4th edition, 2004
Stefan Bechtold, Law and Economics of Copyright and Trademark on the Internet, in: Durlauf/Blume (eds.), The New Palgrave Dictionary on one of the discussed papers.

The course will be offered again in the spring semester 2017.

Number of participants limited to 15.

Does not take place this semester.

The course will be offered again in the spring semester 2017.

The objective of this course is to make students with a technical scientific background aware of the legal and political context of environmental policy in order to place technical solutions in their regulatory context.

The aim of this course is to equip students with a legal and regulatory skill-set that allows them to translate their technical knowledge into a policy brief directed at legally trained regulators. More generally, it aims to inform students with a technical scientific background of the legal and political context of environmental policy. The focus of the course will be on international and European issues and regulatory frameworks - where relevant, the position of Switzerland within these international networks will also be discussed.
An electronic copy of relevant readings will be provided to the students at no cost before the start of the lectures.

Protecting Inventions in Chemistry

The course is taught as a small interactive seminar and significant participation is expected from the students. Participation will be capped in recent years, knowledge about intellectual property has become increasingly important for engineers. Both in production and distribution. The lecture gives students of chemistry-related degree programs an overview of the options to protect inventions and the underlying research efforts. The lecture aims to put the participants in a position to use this know-how in the workplace.

The aim of this course is to enable students at ETH Zurich to recognize which rights may protect their creations, and which rights may be afforded by the various intellectual property rights as well as the practical difficulties involved in the enforcement of intellectual property rights. This knowledge is imparted based on current rulings and cases.

Another goal is to enable the students to participate in the current debate over the goals and desirability of protecting intellectual creations, particularly in the areas of copyright (keywords: fair use, Creative Commons, Copyleft) and patent law (software patents, patent trolls, patent thickets).

Topics covered during the lecture will include:
- The importance of innovation in industrialised countries
- An overview of the different forms of intellectual property
- The protection of technical inventions and how to safeguard their commercialisation
- Patents as a source of technical and business information
- Practical aspects of intellectual property in day-to-day research, at the workplace and for the formation of start-ups.

The lecture will acquaint students with practical aspects of intellectual property and enable them to use the acquired knowledge in their future professional life.

Topics covered in lectures:

(1) Environmental Regulation
   a. Perspectives
   b. Regulatory Challenges of Environment Problems
   c. Regulatory Tools
(2) Law: International, European and national laws
   a. International law
   b. European law
   c. National law
(3) Policy: Case studies

Assessment:
(i) Class participation (25%): Students will be expected to contribute to class discussions and prepare short memos on class readings.
(ii) Exam (75%) consisting of three parts:
   a. Policy brief - a maximum of 2 pages (including graphs and tables);
   b. Background document to the policy brief - this document sets out a more detailed and academic overview of the topic (maximum 8 pages including graphs and tables);
   c. Presentation of the policy brief: presentations can use a maximum of 5 slides and can last 7 minutes.

Lecture notes

The course is taught as a small interactive seminar and significant participation is expected from the students. Participation will be capped at 15 in order to maintain the interactive nature of the classes. All classes, readings, and assignments, are in English.

Teaching will take place over two weeks in September and October. The exam date will be in December.

During the second week of the teaching period, students will have individual 30-minute meetings with the lecturer to discuss their project.

The lecture will acquaint students with practical aspects of intellectual property and enable them to use the acquired knowledge in their future professional life.

Case studies will illustrate and deepen the topics addressed during the lecture.

The seminar will comprise practical exercises on how to use and search patent information. Basic knowledge of how to read and evaluate patent documents as well as how to use publicly available patent databases to obtain the required patent information will also be provided.

The lecture is in particular tailored to the needs of the following degree programs: Agricultural science, architecture, civil engineering, geomatic engineering and planning, interdisciplinary sciences, materials science, mathematics, mechanical engineering, physics.

For students of chemistry-related degree programs, the lecture ‘Protecting inventions in chemistry’ (851-0738-03) will be offered in the autumn semester.

851-0738-00L Intellectual Property: Introduction

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

Abstract

The course provides an introduction to Swiss and European intellectual property law (trademarks, copyright, patent and design rights).

Objectives

The lecture is in particular tailored to the needs of the following degree programs: Agricultural science, architecture, civil engineering, geomatic engineering and planning, interdisciplinary sciences, materials science, mathematics, mechanical engineering, physics.

An electronic copy of relevant readings will be provided to the students at no cost before the start of the lectures.

No specific pre-existing legal knowledge is required, however all students must have successfully completed Grundzüge des Rechts (851-0708-00 V) or an equivalent course.

The course is (inter)related to materials discussed in Politikwissenschaft: Grundlagen (851-0577-00 V), Ressourcen- und Umweltökonomie (751-1551-00 V), Umweltrecht: Konzepte und Rechtsgebiete (851-0705-01 V), Rechtlicher Umgang mit natürlichen Ressourcen (701-0743-01 V), Environmental Governance (701-1651-00 G), Policy and Economics of Ecosystem Services (701-1653-00 G), International Environmental Politics: Part I (851-0594-00 V).

851-0738-01L The Role of Intellectual Property in Daily Routine: A Practical Introduction

Particularly suitable for students of D-BAUG, D-ITET, D-MAVT

Abstract

The lecture gives an overview of the fundamental aspects of intellectual property, which plays an important role in the daily routine of engineers. The lecture aims to make participants aware of the various methods of protection and to put them in a position to use this knowledge in the workplace.

Objectives

In recent years, knowledge about intellectual property has become increasingly important for engineers. Both in production and distribution, and in research and development, engineers are increasingly being confronted with questions concerning the patenting of technical inventions and the use of patent information.

The lecture will acquaint students with practical aspects of intellectual property and enable them to use the acquired knowledge in their future professional life.

Topics covered during the lecture will include:
- The importance of innovation in industrialised countries
- An overview of the different forms of intellectual property
- The protection of technical inventions and how to safeguard their commercialisation
- Patents as a source of technical and business information
- Practical aspects of intellectual property in day-to-day research, at the workplace and for the formation of start-ups.

Case studies will illustrate and deepen the topics addressed during the lecture.

The seminar will comprise practical exercises on how to use and search patent information. Basic knowledge of how to read and evaluate patent documents as well as how to use publicly available patent databases to obtain the required patent information will also be provided.

The lecture is in particular tailored to the needs of the following degree programs: Agricultural science, architecture, civil engineering, computational science and engineering, computer science, electrical engineering and information technology, environmental engineering, geomatic engineering and planning, interdisciplinary sciences, materials science, mathematics, mechanical engineering, physics.

For students of chemistry-related degree programs, the lecture ‘Protecting inventions in chemistry’ (851-0738-03) will be offered in the autumn semester.

851-0738-03L Protecting Inventions in Chemistry

Particularly suitable for students of D-CHAB

Abstract

The lecture gives students of chemistry-related degree programs an overview of the options to protect inventions and the underlying research efforts. The lecture aims to put the participants in a position to use this know-how in the workplace.

Data: 06.03.2019 12:57  Autumn Semester 2016  Page 635 of 1571
Objective
Research and development play an important role in chemistry-related technology sectors such as inorganic and organic chemistry or pharmacy.

Investments in the development of new substances and active components in these sectors are traditionally secured by patents because publicly known inventions, generally chemical substances, may easily be reproduced by others.

In the last years, the know-how about intellectual property has become increasingly important for chemists and engineers. Both in the production process and in the distribution sector, chemists and engineers are increasingly being confronted with questions concerning the protection of technical inventions and the use of patent information. As more than three-quarters of all publicly available technical information are available only in patents, it is more and more important for researchers and engineers to be capable of extracting relevant information from the flood of patents.

Patents are not only a powerful measure to protect investments and inventions in chemistry-related sectors but also an important source of information about competitors and potential cooperation partners and about the development of markets. Accordingly, the know-how about patents and patent information has become a key qualification on the strategic level in companies and in the research sector.

The seminar is customised to the needs of chemists and students of related degree programs. Participants will become familiar with practice-oriented aspects of intellectual property and will be enabled to use the acquired knowledge in their future professional life.

Topics covered during the lecture will include:
- The importance of innovation in industrialised countries
- An overview of the different forms of intellectual property
- The protection of technical inventions and how to safeguard their commercialisation
- Patents as a source of technical and business information
- Practical aspect of intellectual property in day-to-day research, at the workplace and for the formation of start-ups
- Special aspects of protecting inventions in chemistry-related sectors, e.g. polymorphs and inventions in the field of nanotechnology.

Case studies will illustrate and deepen the topics addressed during the lecture.

The seminar will comprise practical exercises on how to use and search patent information. Basic knowledge of how to read and evaluate patent documents as well as how to use publicly available patent databases to obtain the required patent information will also be provided.

Prerequisites / notice
The lecture is coordinated in particular to the needs of the following degree programs: Agricultural science, biotechnology, chemical engineering, chemistry, food science, pharmaceutical sciences.

For engineering and physics students, the lecture 'The Role of Intellectual Property in daily routine: A Practical Introduction' (851-0738-01) will be offered in the autumn semester.

701-0743-01L Law and Natural Resources W 2 credits 2V
Does not take place this semester.
The course will be offered again in the spring semester 2017.

Abstract
This course teaches the possibilities and limits of the law in order to protect natural resources and landscapes against harm and nuisance. The learning concept is based on the co-ordinated implementation of the relevant legislations. The complexity of the legal situation will be discussed by analysing virtual and real law cases focused on spatial projects and planning.

Objective
The students know the opportunities and restrictions which are given by the law when using natural resources. They have insights into the complex environmental legal system and their application in concrete cases. The students are able to formulate typical legal questions, to understand the argumentation of courts and to solve simple legal problems with respect to environmental problems.

Content
- Waldrecht - Natur- und Landschaftsschutzrecht - Wasserrecht - Raumplanungsrecht - Umweltschutzrecht - Verfahrensrecht
- Unterrichtssprache: Deutsch

Lecture notes
Den Studierenden werden Unterlagen wie eine Übersicht über den behandelten Stoff auf PP-Folien, typische Gerichtsentscheide, Zeitungsartikel etc. über neue Vorhaben mit Auswirkungen auf die Umwelt und entsprechenden Rechtsfragen abgegeben.

Literature
Griffel, A.; Raumplanungs- und Baurecht in a nutshell, Dike Verlag, Zürich/St. Gallen 2012
Rausch/Marti/Griffel; Umweltrecht - Ein Lehrbuch. Herausgeber: Walter Haller. Schulthess Verlag, Zürich 2004
Rausch, H.; Panorama des Umweltrechts - Kompendium der Umweltschutzvorschriften des Bundes, BUWAL-Schriftenreihe Umwelt Nr. 226, 4. A., Bern 2005
Keel/Zimmermann; Bundesgerichtliche Rechtsprechung zur Waldgesetzgebung. In URP 2009/3
Umweltrecht in der Praxis URP (Juristische Fachzeitschrift für Umweltrechtsfragen, herausgegeben von der Vereinigung für Umweltrecht (VUR))
Weitere Literaturangaben erfolgen in der ersten Veranstaltung.

Prerequisites / notice

Sociology

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
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<tr>
<td>851-0585-15L</td>
<td>Complexity and Global Systems Science</td>
<td>W</td>
<td>3 credits</td>
<td>2V</td>
<td>D. Helbing, N. Antulov-Fantulin</td>
</tr>
</tbody>
</table>

Abstract
This course discusses complex techno-socio-economic systems, their counter-intuitive behaviors, and how their theoretical understanding empowers us to solve some long-standing problems that are currently bothering the world.

Objective
Participants should learn to get an overview of the state of the art in the field, to present it in a well understandable way to an interdisciplinary scientific audience, to develop models for open problems, to analyze them, and to defend their results in response to critical questions. In essence, participants should improve their scientific skills and learn to think scientifically about complex dynamical systems.
Content
This course starts with a discussion of the typical and often counter-intuitive features of complex dynamical systems such as self-organization, emergence, (sudden) phase transitions at “tiping points”, multi-stability, systemic instability, deterministic chaos, and turbulence. It then discusses phenomena in networked systems such as feedback, side and cascade effects, and the problem of radical uncertainty. The course progresses by demonstrating the relevance of these properties for understanding societal and, at times, global-scale problems such as traffic jams, crowd disasters, breakdowns of cooperation, crime, conflict, social unrests, political revolutions, bubbles and crashes in financial markets, epidemic spreading, and/or “tragedies of the commons” such as environmental exploitation, overfishing, or climate change. Based on this understanding, the course points to possible ways of mitigating technosocio-economic-environmental problems, and what data science may contribute to their solution.

Prerequisites / notice
Mathematical skills can be helpful.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Credits to</th>
<th>Authors</th>
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<tr>
<td>851-0252-07L</td>
<td>Recent Debates in Social Networks Research</td>
<td>W 2 credits</td>
<td>2S</td>
<td>C. Stadtfeld, P. Block</td>
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<tr>
<td>851-0585-04L</td>
<td>Lecture with Computer Exercises: Modelling and Simulating Social Systems with MATLAB</td>
<td>W 3 credits</td>
<td>2S</td>
<td>D. Helbing, L. Sanders, O. Wooley</td>
</tr>
<tr>
<td>851-0591-00L</td>
<td>Digital Sustainability in the Knowledge Society</td>
<td>W 2 credits</td>
<td>2V</td>
<td>M. M. Dapp</td>
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</tbody>
</table>

Abstract
This colloquium offers an opportunity for students to discuss their ongoing research and scientific ideas in the behavioral sciences, both at the micro- and macro-levels of cognitive, behavioral and social science. It also offers an opportunity for students from other disciplines to discuss their ideas in relation to behavioral science. The colloquium also features invited research talks.

Objective
Students know and can apply autonomously up-to-date investigation methods and techniques in the behavioral sciences. They achieve the ability to develop their own ideas in the field and to communicate their ideas in oral presentations and in written papers. The credits will be obtained by a written report of approximately 10 pages.

Content
This colloquium offers an opportunity for students to discuss their ongoing research and scientific ideas in the behavioral sciences, both at the micro- and macro-levels of cognitive, behavioral and social science. It also offers an opportunity for students from other disciplines to discuss their ideas in relation to behavioral science. The possible research areas are wide and may include theoretical as well as empirical approaches in Social Psychology and Research on Higher Education, Sociology, Modeling and Simulation in Sociology, Decision Theory and Behavioral Game Theory, Economics, Research on Learning and Instruction, Cognitive Psychology and Cognitive Science. Ideally the students (from Bachelor, Master, Ph.D. and Post-Doc programs) have started to start work on their thesis or on any other term paper. Course credit can be obtained either based on a talk in the colloquium plus a written essay, or by writing an essay about a topic related to one of the other talks in the course. Students interested in giving a talk should contact the course organizers (Rütsche, Stern) before the first session of the semester. Priority will be given to advanced / doctoral students. The course credits will be obtained by a written report of approximately 10 pages. The colloquium also serves as a venue for invited talks by researchers from other universities and institutions related to behavioral and social sciences.

Abstract
Social Networks research is a highly interdisciplinary fields. For example, scholars in Sociology, Psychology, Political Sciences, Computer Science, Physics, Mathematics and Statistics contribute to the development of theories and methods. This course aims at understanding, comparing and structuring recent debates in the field of Social Networks.

Objective
Social Networks research is a highly interdisciplinary fields. At the end of this seminar, students will understand and be able to compare different subject-specific approaches to social networks research (e.g., from Sociology, Psychology, Political Sciences, Computer Science, Physics, Mathematics and Statistics). They will be familiar with recent publications in the field of Social Networks and be able to critically participate in a number of recent debates. Amongst others, these debates touch upon the co-evolution of selection and influence mechanisms, appropriateness of statistical models, generic mechanisms and features of social networks, models for the analysis of dynamic networks.

Abstract
This course introduces first the basic functionalities and features of the mathematical software package MATLAB, such as the simple operations with matrices and vectors, differential equations, statistical tools, the graphical representation of data in various forms, and video animations of spatio-temporal data. With this knowledge, students are expected to implement themselves in MATLAB, models of various social processes and systems, including agent-based models, e.g. models of interactive decision making, group dynamics, human crowds, or game-theoretical models.

Objective
Part of this course will consist of supervised programming exercises in a computer pool. Credit points are finally earned for the implementation of a mathematical model from the sociological literature in MATLAB and the documentation in a seminar thesis.

Lecture notes
The lecture slides will be presented on the course web page after each lecture.

Literature

Further literature, in particular regarding computer models in the social sciences, will be provided in the course.

Prerequisites / notice
The number of participants is limited to the size of the available computer teaching room. The MATLAB code related to the seminar thesis should be well enough documented for further use by others and must be handed over to the Chair of Sociology, in particular of Modeling and Simulation, for further free and unrestricted use.

Abstract
How do various interest groups influence the methods of production, distribution, and use of digital resources? Current models focusing on strong intellectual property rights are contrasted with open models like, e.g. Open Source/Content/Access. The course discusses consequences from different models and introduces "digital sustainability" as an alternative vision for society.

Objective
At the heart of the discourse is the handling of digital goods and intellectual property in society. Digitization and the Internet allow handling knowledge in a way, which directly contrasts with the traditional understanding of "intellectual property" and the industries based on it. Starting from economic and legal basics, we compare proprietary and open/"free" models. Sustainable development as a concept is transferred to digital goods, taking into account the particular nature of digital stuff.

After the lecture, you should (hopefully) be able to:
- characterize the nature of digital goods vs. physical goods
- critique the basic concepts of copyright and patent rights
- explain the political/legal and economic differences between proprietary and open approaches to the production and use of digital goods
- using an example, explain the meaning of digital sustainability and argue why it is relevant for a knowledge society
- transfer the ideas of the free/open source software model to other digital goods (e.g., open content, open access)

Data: 06.03.2019 12:57
Autumn Semester 2016
Page 637 of 1571
Technical reality: Within minutes you can make perfect copies of high-value digital goods of knowledge or culture (as text, audio, video, image or software) and distribute them around the globe -- for free. «Digitization plus Internet» allows for the first time in humankind's history the (theoretically) free access and global exchange of knowledge at minimal cost. A tremendous opportunity for societal development, in north and south. «Cool, so what's the problem?»

The point here is that this reality poses a fundamental threat to today's business model of the knowledge and culture industries (starting from the music label and Hollywood, via publishers, up to software vendors). Powerful commercial interests are at stake as «knowledge» (the fourth factor of production) will become ever more important in the 21st century. Accordingly, «piracy» and «file-sharing» are attacked with all means. At the core lies the question about the design of property in digital assets. For that, we apply a concept of «intellectual property», which is several hundred years old and does not address digital reality in an adequate manner, sometimes leading to absurd situations. Its original goal seems to get forgotten: to help society develop by spreading knowledge as much as possible.

Using the PC becomes the new cultural technique of the 21st century. In contrast to «reading, writing and arithmetics», this new cultural technique cannot exist in isolation, but depends on a hard- and software infrastructure. This dependency extends to the provider of the infrastructure, who can define technical rules, which can take away or restrict the user's freedom. Even advanced users may have difficulties in recognizing these, often hidden, restrictions and in evaluating their societal relevance. But exactly these invisible consequences we need to understand and investigate, because they decide about access, distribution and usage of digital knowledge.

Comparative to the environmentalist movement of the 60s and 70s, a growing political movement for «Free Software» exists today, with «GNU/Linux» as its most popular symbol. The movement fights against treating software code as private property but as a central cultural good available to all without private interests. Based on the success of the Free Software movement, new initiatives extend the concepts to other domains (e.g. scientific knowledge, music)... As a «leader» to the lecture, you are invited to read the essay «ETH Zurich - A Pioneer in Digital Sustainability!». It can be downloaded from www.essays2030.ethz.ch. More on teach.digius.info starting from September. Stay tuned.

**Lecture notes**

Slides and other material (both usually in English) will be made available on a weekly basis as the lecture proceeds.

**Literature**

Content of the following books is covered (PDFs freely available online):


Other recommended books are:

1. (general) Chris DiBona et al., Open Sources: Voices from the Open Source Revolution, O'Reilly, 1999.

**Prerequisites / notice**

For administrative and didactic reasons (high level of interaction and credit group assignments on current hot topics), the number of participants is limited to 45.

Of course, any interested person is invited to attend the lecture without doing the group assignment. The website is actively used for the course.

**851-0588-00L**

Introduction to Game Theory. Models and Experimental Studies

*Particularly suitable for students of D-MAVT, D-MATL*

**Abstract**

This course introduces the foundations of game theory. It focuses on models of social interaction, conflict and cooperation, the emergence of cooperation and concepts of strategic decision-making behaviour. Examples, applications and the contrast between theory and empirical results are particularly emphasized.

**Objective**

Learn the fundamentals, models, and logic of thinking about game theory.

Apply game theory models to strategic interaction situations and critically assess game theory’s capabilities through a wide array of experimental results.

**Content**


- In der Vorlesung wird Wert darauf gelegt, Modelle an Beispielen zu demonstrieren und empirische Untersuchungen ("experimentelle Spieltheorie") vorzustellen.

**Lecture notes**

Die folgenden Einführungen unterscheiden sich nach Anwendungen und Grad der Formalisierung. Zur Einführung kann man sich eines der folgenden Bücher ansehen, die ab Januar im Handapparat der D-GESS-Bibliothek stehen werden:


Weitere Literatur und Übungsaufgaben zum Download unter: http://www.socio.ethz.ch/publications/spieltheorie

### Prerequisites / notice

Um Missverständnisse zu vermeiden: Die Vorlesung ist für Hörerinnen und Hörer aller Departemente geeignet. (Nicht nur für D-MATL, D-MAVT)

<table>
<thead>
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<td>851-0585-43L</td>
<td>Experimental Game Theory</td>
<td>2</td>
<td>A. Diekmann</td>
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<tr>
<td>227-0802-02L</td>
<td>Sociology</td>
<td>2</td>
<td>A. Diekmann</td>
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<tr>
<td>051-0811-00L</td>
<td>Sociology I</td>
<td>1</td>
<td>C. Schmid</td>
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</table>

### Objective


### Literature


(Ein Handapparat dieser und weiterer Literatur wird in der D-GESS-Bibliothek bereitgestellt.)

Literatur zum Download befindet sich auch auf der Webseite: http://www.socio.ethz.ch/publications/spieltheorie

Folgende Themen werden behandelt:

3. Der Beitrag der Sozialtheorie. Vorstellung und Diskussion ausgewählter Studien zu einzelnen Themenbereichen, z.B.: (1) Die Entstehung sozialer Kooperation, (2) Reputation und Märkte, (3) Soziale Netzwerke u.a.m.

### Literature

Folien der Spieltheorie-Vorlesung und Literatur (Fachartikel, Kapitel aus Lehrbüchern) können auf der Webseite des Seminar eingesehen werden. Weitere Literatur und Übungsaufgaben zum Download unter: http://www.socio.ethz.ch/publications/spieltheorie
This elective course highlights the sociological perspective on architectural practice and provides an introduction to sociological research.

Upon completion of this course, the student should have acquired:
1. Knowledge on the foundations of several methods of multivariate data analysis, along with the conditions under which their use is appropriate
2. Skill in the estimation, specification and diagnostics of the various models
3. Hands-on experience with those methods through the use of appropriate software and actual data sets in the PC lab

The course will begin with an introduction to multivariate methods such as analysis of variance and multiple linear regression, where a metric dependent variable is "explained" by two or more independent variables. Then two methods for structuring complex data, cluster analysis and factor analysis will be covered. In the last part, procedures for the analysis of relationships involving dichotomous or polytomous dependent variables (e.g., the choice of a mode of transportation) will be discussed.

Literature
Will be announced at the beginning of the course.

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### 701-1541-00L Multivariate Methods

**Objective**
This series of lectures should enable students to comprehend architecture in its social context. It approaches the architectural profession from two different angles: macro-sociological and micro-sociological.

**Content**
Sociology I deals with the macro-sociological point of view, and investigates the relation between social developments and the production of the built environment. In the first part some central aspects of social change are examined in particular the transition from Fordism to Postfordism and from Modernism to Postmodernism, and the interlinked processes of globalization and regionalization. The second part deals with historical and present-day forms of urbanization. Among other aspects treated here are the changed significance of urban-rural contrasts, the processes of suburbanization and periurbanization, the formation of global cities and metropolitan regions, the growth of new urban configurations in centres (gentrification) and on urban peripheries (edge city, exopolis). In the third part these general processes are illustrated by typical models of urbanization.

**Literature**

- Special Topics in Cognitive Neuroscience
- Cognitive neuroscience bridges two seemingly distinct but closely related disciplines. On one side, there is cognitive psychology and on the other side biology, or more specifically, neuroscience. In terms of research, this relatively young field aims to explain such diverse mental processes as thinking, perceiving, feeling, and reasoning by exploring their underlying biological or neural mechanisms.
This course explores selected topics of cognitive neuroscience. The course begins with a basic introduction to the field covering neural anatomy and brain physiology. Contemporary methods used in neuroscientific research (e.g., IMRI, EEG) will also be introduced and their benefits and limits critically reviewed. Using this knowledge, we will discuss some of the classic works in neuroscience in visual perception, memory and emotion. This will be accompanied by some famous cases of patients demonstrating problems in these domains (e.g., patients with agnosia or amnesia). Further topics will include the cognitive and neural processes involved in pain processing, the placebo effect, as well as spatial representation and navigation.

This course targets students at the Bachelor level with no previous experience. The main requirement for this course is an open and critical mind. By the end of the course, the student will be able to identify the major brain structures and to explain the basic functioning of neurons as well as some of the fundamental principles of how our brain works. Students should have an understanding of the methods used to generate the various findings reported in the literature and the media. The course aims to enable and encourage the students to critically evaluate these findings, and what can and cannot be answered with neuroscience techniques. For each of the topics, students should be able to identify the phenomenon, give examples, and discuss one or two of the main theories explaining it.

### Objective

This course explores selected topics of cognitive neuroscience. The course begins with a basic introduction to the field covering neural anatomy and brain physiology. Contemporary methods used in neuroscientific research (e.g., IMRI, EEG) will also be introduced and their benefits and limits critically reviewed. Using this knowledge, we will discuss some of the classic works in neuroscience in visual perception, memory and emotion. This will be accompanied by some famous cases of patients demonstrating problems in these domains (e.g., patients with agnosia or amnesia). Further topics will include the cognitive and neural processes involved in pain processing, the placebo effect, as well as spatial representation and navigation.

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### Literature


### Prerequisites / notice


### Science Research

<table>
<thead>
<tr>
<th>Number</th>
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<tr>
<td>851-0157-00L</td>
<td>Mind and Brain</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>M. Hagner</td>
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<tr>
<td>851-0157-66L</td>
<td>Who was Sigmund Freud?</td>
<td>W</td>
<td>3</td>
<td>2S</td>
<td>M. Hagner</td>
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<tr>
<td>851-0157-67L</td>
<td>Creativity</td>
<td>W</td>
<td>3</td>
<td>2S</td>
<td>M. Wulz, V. Wolff</td>
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<tr>
<td>851-0157-69L</td>
<td>History of Astronomy</td>
<td>W</td>
<td>3</td>
<td>2S</td>
<td>S. Mastorakou</td>
</tr>
</tbody>
</table>
Die Veranstaltung ist ausgebucht

**Abstract**
The course is designed to provide an overview of the astronomical developments from the ancient Greek world to the 16th century. We are going to use primary sources tackling historical, technical and philosophical questions. Special attention will be paid to the dramatic change in the way people understood the structure of the heavens and the nature of the physical world.

**Objective**
The course aims at providing a working knowledge of astronomy and cosmology from the ancient world to the 16th century. Upon its completion the students will be able to describe how our knowledge of the heavens changed from Aristotle's system to the Copernican Revolution. In addition, they will also have acquired an appreciation of the debates about man's place in the cosmos and the philosophical principles underpinning cosmology.

**851-0157-70L** The Mathematics of Scientific Racism

**Abstract**
How did racial scientists determine racial affiliation? In the seminar we will examine the practical challenges and eventual works of physical anthropologists from 1850 to the present. By scrutinizing the scientific toolbox of racial scientists, we will reveal how national affiliation, anti-Semitic perceptions and Gender identity shaped scholars' choices of graphical and computational methods.

**Objective**
The aim of the course is to analyze the mutual relations between scientific theories and social perceptions, and to follow the formation of the "scientific mind". The course focuses on racial scientists and on the way their practices of computation and statistical analysis influenced their world-views - and vice versa. The students will be instructed on the way historians of science analyze scientific sources. They will gain a better understanding of the complexities of disciplinary dynamics, social biases and institutional pressures shaping scientific ideas, and learn on the influences such scientific ideas may have on the society as a whole.

**Prerequisites / notice**
Please note that the seminar will be held in English and most texts will be in English. However, a small portion of the reading material will be in German.

**701-0771-00L** Environmental Consciousness and Public Relations

**Number of participants limited to 60.**

Sign in until 29.09.2016.

Please describe your expectations. Why do you want to attend this special topic? Do you have any pre-information about the integral model? Do you have any practical experience in environmental communication?

**Abstract**
"Environmental Consciousness and Public Relations" shows how to communicate about environment and sustainability successfully. We look at campaigns, exhibitions and other public relations measures to learn, how to design and realize good communication.

**Objective**
You learn how to handle tools and concepts in environmental communication. And you can evaluate communication projects. We also discuss the evolution of consciousness.

**Content**
- Methods and tools in environmental communication.
- Marketing mix
- Examples of campaigns, events, print products, media relations.
- Integral sustainability

**Lecture notes**
Handouts

**Literature**
- Integral Vision; Ken Wilber, 2005

**Prerequisites / notice**
We will discuss new trends in environmental communication with the focus on integral solutions.

**851-0158-07L** Worldviews in Conflict

**Abstract**
Worldviews guide our thoughts and our actions even though we may not be aware of it. They often are realized only when they are confronted with each other. By means of lectures, discussions and contributions of participants, we will examine those worldviews as to the underlying philosophical concepts and their relations to the sciences, philosophy and religion.

**Objective**
Students of all disciplines shall obtain a basis for their own exploration of worldviews. Prior knowledge of philosophical concepts and history is not required.

**Type B: Reflection About Subject-Specific Methods and Contents**

Subject-specific courses: Recommended for doctoral, master and bachelor students (after first-year examination only).

Students who already took a course within their main study program are NOT allowed to take the course again.

These course units are also listed under "Type A", which basically means all students can enroll

**D-ARCH**

**Number**

<table>
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<tr>
<th>Title</th>
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<tr>
<td>851-0724-00L Property Law for Geometers: Land Registry and Geoinformation Law</td>
<td>W</td>
<td>2 credits</td>
<td>2V</td>
<td>M. Huser</td>
</tr>
</tbody>
</table>

**Abstract**
Particularly suitable for students of D-ARCH, D-BAUG, D-USYS

**Objective**
Overview of the legal forms and surveying law.

**Content**
Basic principles of material and formal land registry law, components of the land register, process of registration with the Land Register, legal problems of land surveying, reform of the official land surveying.

**Lecture notes**
Abgegebene Unterlagen: Skript in digitaler Form

**Literature**
- Meinrad Huser, Schweizerisches Vermessungsrecht, unter besonderer Berücksichtigung des Geoinformationsrechts und des Grundbuchrechts, Beiträge aus dem Institut für schweizerisches und internationales Baurecht der Universität Freiburg/Schweiz, Zürich 2014
- Meinrad Huser, Schweizerisches Vermessungsrecht, unter besonderer Berücksichtigung des Geoinformationsrechts und des Grundbuchrechts, Zürich 2014
- Meinrad Huser, Geo-Informationsrecht, Rechtlicher Rahmen für Geographische Informationssysteme, Zürich 2005
- Meinrad Huser, Darstellung von Grenzen zur Sicherung dinglicher Rechte, in ZBGf 2013, 238 ff.
- Meinrad Huser, Datenschutz bei Geodaten

**Prerequisites / notice**
Requirements: Property Law (12-722)
Prerequisites: Environmental Law: Conceptions and Fields (851-0705-01L) offered in spring semester.

Objectives
- To equip students with legal skills and methods to solve or treat problems and questions of the environmental law and to foster the understanding on the possibilities and limits of legal problem-solving. The students choose an inquiry with practical relevance. To this end they work out the legal basis demonstrating a legal correct solution or approach to a solution. In doing so, students will get to know legal methods and research possibilities.
- To teach the students legal methods and research possibilities.
- To foster the understanding on the possibilities and limits of legal problem-solving.
- To equip students with legal skills and methods to solve or treat problems and questions of the environmental law.

Lecture notes
- Den Studierenden werden Unterlagen zur juristischen Methoden- und Quellenlehre sowie zum Inhalt und Ablauf des Kurses zu Beginn der Veranstaltung kostenlos abgegeben.
- Rechtsgrundlagen, Literatur und Gerichtsentscheide werden themenspezifisch selber rechekheicht, unter Mithilfe und Beratung des Dozenten.

Prerequisites / notice
- Die Veranstaltung erfordert die Bereitschaft, sich aktiv und selbständig mit einer selbstgewählten Fragestellung oder einem eigenen Fallbeispiel aus dem Gebiet des Umweltrechts und allenfalls aus Schnittstellengebieten auseinanderzusetzen. Damit die Interaktivität und die Begleitung der Teams gewährleistet werden kann, ist die Teilnehmerzahl auf maximal 16 Personen beschränkt. Es handelt sich um eine Vertiefungsveranstaltung. Der Besuch der Vorlesung "Umweltrecht: Konzepte und Rechtsgebiete" (851-0705-01) ist Voraussetzung.

Lecture notes

Objective
- To introduce key topics, theories and methodology in human-computer interaction (HCI) and usability. Presentations will cover basic of human-computer interaction and selected topics like mobile interaction, adaptive systems, human error and attention. A focus of the seminar will be on getting to know evaluation techniques in HCI. Students form work groups that first familiarize themselves with a select usability evaluation method (e.g. user testing, GOMS, task analysis, heuristic evaluation, questionnaires or Cognitive Walkthrough). They will then apply the methods to a human-computer interaction setting (e.g. an existing software or hardware interface) and present the method as well as their procedure and results to the plenary. Active participation is vital for the success of the seminar, and students are expected to contribute to presentations of foundational themes, methods and results of their chosen group project. In order to obtain course credit a written essay / report will be required (details to be specified in the introductory session of the course).

Lecture notes
In recent years, knowledge about intellectual property has become increasingly important for engineers. Both in production and distribution, protection of innovation and product development are essential tasks for engineers. The lecture offers problem oriented insights into this sociotechnical process of translation.

Students become familiar with the mutual interdependence of social and technological change that characterises the history of computing and communication.


851-0551-03L
Postal Knowledge and the History of Digital Societies

- Particularly suitable for students of D-ARCH, D-BAUG, D-HEST, D-INFK, D-ITET, D-MAVT

**Abstract**
In the second half of the 20th century, postal services have dramatically changed. Communication today is computer-based. The lecture offers problem-oriented insights into this sociotechnical process of translation.

**Objective**
Students become familiar with the mutual interdependence of social and technological change that characterises the history of computing and communication.

**Content**

851-0125-58L
Philosophy of the Environmental Sciences: An Introduction

- Particularly suitable for students of D-ARCH, D-BSSE, D-CHAB, D-MTEC, D-USYS

**Abstract**
Environmental knowledge and management is quite common in different research fields and in everyday practice. We will be identifying those concepts, objects and methods that mainly construe what might be called the core of the environmental sciences. This will be done by using different philosophical tools and approaches.

**Objective**
The environmental sciences cover a wide range of scientific practices and objects and accordingly afford different kinds of scientific knowledge. Additionally, there is an important interplay between the scientific and the societal sphere. In this seminar we will examine likewise central and widespread concepts such as sustainable development or resilience by using philosophical tools that will allow to probe the different uses of those concepts, their semantic range in terms of historical depth and semantic fields and finally their logical coherence. Another important topic is the philosophical investigation of methods and objects that can be identified in the environmental sciences. Those methods are for instance Life Cycle Assessment or Adaptive Ecosystem Management, technological objects may be a wind engine or a hydropower plant. The latter raise questions of how renewable energies can be assessed and valued, including the more general issue of how values and norms can be embedded in technological objects. This leads us to the third and last complex of topics that focus on current deliberations about possible new ways of existence in the age of the Anthropocene and as a consequence the formation of adequate life styles in our societies. This refers to issues in philosophical and social anthropology and the challenge of climate change.

**D-BAUG**

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<tr>
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<tr>
<td>851-0738-01L</td>
<td>The Role of Intellectual Property in Daily Routine: A Practical Introduction</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>C. Soltmann</td>
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</table>

**Abstract**
The lecture gives an overview of the fundamental aspects of intellectual property, which plays an important role in the daily routine of engineers. The lecture aims to make participants aware of the various methods of protection and to put them in a position to use this knowledge in the workplace.

**Objective**
In recent years, knowledge about intellectual property has become increasingly important for engineers. Both in production and distribution and in research and development, engineers are increasingly being confronted with questions concerning the patenting of technical inventions and the use of patent information.

The lecture will acquaint students with practical aspects of intellectual property and enable them to use the acquired knowledge in their future professional life.

Topics covered during the lecture will include:
- The importance of innovation in industrialised countries
- An overview of the different forms of intellectual property
- The protection of technical inventions and how to safeguard their commercialisation
- Patents as a source of technical and business information
- Practical aspects of intellectual property in day-to-day research, at the workplace and for the formation of start-ups.

Case studies will illustrate and deepen the topics addressed during the lecture.

The seminar will comprise practical exercises on how to use and search patent information. Basic knowledge of how to read and evaluate patent documents as well as how to use publicly available patent databases to obtain the required patent information will also be provided.

Prerequisites / notice
The lecture is in particular tailored to the needs of the following degree programs: Agricultural science, architecture, civil engineering, computational science and engineering, computer science, electrical engineering and information technology, environmental engineering, geomatic engineering and planning, interdisciplinary sciences, materials science, mathematics, mechanical engineering, physics.

For students of chemistry-related degree programs, the lecture ‘Protecting inventions in chemistry’ (851-0738-03) will be offered in the autumn semester.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>851-0724-00L</td>
<td>Property Law for Geometers: Land Registry and Geoinformation Law</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>M. Huser</td>
</tr>
</tbody>
</table>

**Abstract**
Fundamental concepts of Land Register Law and Land Surveying Law (substantive and procedural rules of Land Register Law, the parts and the relevance of the Land Register, process of registration with the Land Register, legal problems of land surveying, reform of the official land surveying).

**Objective**
Overview of the legal norms of land registry and surveying law.

**Content**
Basic principles of formal and formal land registry law, components of the land register, consequences of the land register, the registration process, legal problems of surveying, the reform of official surveying, liability of the geom-eter. The lecture unit is carried out within a frame of 8 sessions (2 hours): the first hour of each is given in the form of a lecture, the second in the form of a case-study.

**Lecture notes**
Abgegebene Unterlagen: Skript in digitaler Form

Pflichtlektüre: Meinrad Huser, Schweizerisches Vermessungsrecht, unter besonderer Berücksichtigung des Geoinformationsrechts und des Grundbuchrechts, Beiträge aus dem Institut für schweizerisches und internationales Baurecht der Universität Freiburg/Schweiz, Zürich 2014
This workshop offers to the students the opportunity to intensify their environmental legal knowledge on the basis of individual topics or cases of their respective programme or professional interest in a guided self-study. They develop a better understanding for the practical application of legal regulations on environmental matters.

Objective
At the beginning of the workshop the students are introduced to the legal methods and sources as well as in the aim and the process of the workshop. The participants will organize themselves in a team of two persons giving themselves an inquiry on topics of the environmental law. It is also possible to choose questions at the interfaces of e.g. zoning law, energy law, transport law. A proposal, which will be presented to the lecturer, as well as an optional Q&A-session in class will facilitate the start. Next the working on topics will follow by self-study. The results will be presented in form of a memo/paper with a maximum of ten pages (excluding graphs and tables). At the end of the workshop, a presentation of ten minutes will be made to the plenum including a question-and-answer session. Class language will be German.

Content
At the beginning of the workshop the students are introduced to the legal methods and sources as well as in the aim and the process of the workshop. The participants will organize themselves in a team of two persons giving themselves an inquiry on topics of the environmental law. It is also possible to choose questions at the interfaces of e.g. zoning law, energy law, transport law. A proposal, which will be presented to the lecturer, as well as an optional Q&A-session in class will facilitate the start. Next the working on topics will follow by self-study. The results will be presented in form of a memo/paper with a maximum of ten pages (excluding graphs and tables). At the end of the workshop, a presentation of ten minutes will be made to the plenum including a question-and-answer session. Class language will be German.

Literature
- Meinrad Huser, Schweizerisches Vermessungsrecht, unter besonderer Berücksichtigung des Geoinformationsrechts und des Grundbuchrechts, Zürich 2014
- Meinrad Huser, Geo-Informationsrecht, Rechtlicher Rahmen für Geographische Informationssysteme, Zürich 2005
- Meinrad Huser, Darstellung von Grenzen zur Sicherung dinglicher Rechte, in ZBOR 2013, 238 ff.
- Meinrad Huser, Datenschutz bei Geodaten

Prerequisites
Requirements: Property Law (12-722)

851-0705-02L Environmental Law: Topics and Case Studies W 2 credits 2S C. Jäger
Does not take place this semester.
Number of participants limited to 20.

Prerequisites: Environmental Law: Conceptions and Fields (851-0705-01L) offered in spring semester.
Particularly suitable for students of D-ARCH, D-BAUG, D-USYS

Abstract
This workshop offers to the students the opportunity to intensify their environmental legal knowledge on the basis of individual topics or cases of their respective programme or professional interest in a guided self-study. They develop a better understanding for the practical application of legal regulations on environmental matters.

Objective
At the beginning of the workshop the students are introduced to the legal methods and sources as well as in the aim and the process of the workshop. The participants will organize themselves in a team of two persons giving themselves an inquiry on topics of the environmental law. It is also possible to choose questions at the interfaces of e.g. zoning law, energy law, transport law. A proposal, which will be presented to the lecturer, as well as an optional Q&A-session in class will facilitate the start. Next the working on topics will follow by self-study. The results will be presented in form of a memo/paper with a maximum of ten pages (excluding graphs and tables). At the end of the workshop, a presentation of ten minutes will be made to the plenum including a question-and-answer session. Class language will be German.

Content
At the beginning of the workshop the students are introduced to the legal methods and sources as well as in the aim and the process of the workshop. The participants will organize themselves in a team of two persons giving themselves an inquiry on topics of the environmental law. It is also possible to choose questions at the interfaces of e.g. zoning law, energy law, transport law. A proposal, which will be presented to the lecturer, as well as an optional Q&A-session in class will facilitate the start. Next the working on topics will follow by self-study. The results will be presented in form of a memo/paper with a maximum of ten pages (excluding graphs and tables). At the end of the workshop, a presentation of ten minutes will be made to the plenum including a question-and-answer session. Class language will be German.

Literature
- Meinrad Huser, Schweizerisches Vermessungsrecht, unter besonderer Berücksichtigung des Geoinformationsrechts und des Grundbuchrechts, Zürich 2014
- Meinrad Huser, Geo-Informationsrecht, Rechtlicher Rahmen für Geographische Informationssysteme, Zürich 2005
- Meinrad Huser, Darstellung von Grenzen zur Sicherung dinglicher Rechte, in ZBOR 2013, 238 ff.
- Meinrad Huser, Datenschutz bei Geodaten

Prerequisites
Requirements: Property Law (12-722)

851-0707-00L Space Planning Law and Environment W 2 credits 2G O. Bucher
Particularly suitable for students of D-ARCH, D-BAUG, D-USYS

Abstract
System of swiss planning law, Constitutional and statutory provisions, Space planning and fundamental rights, Instruments, Application, legal protection, enforcement, Practical training.

Objective
Basic understanding of nature and function of space planning from a legal point of view. Basic knowledge of space planning instruments, relationship between space planning and constitutional law (especially property rights), solving of practical cases.

Content

Lecture notes
Haller, Walter/Karlen, Peter, Raumplanung-, Bau- und Umweltrecht, 3.A., Zürich 1999
Hänni, Peter, Planungs-, Bau- und besonderes Umweltschutzrecht, 6.A., Bern 2016

851-0549-00L WebClass Introductory Course History of Technology W 3 credits 2V G. Hürlimann
Number of participants limited to 100.

Abstract
WebClass Introductory Course History of Technology is an introductory course to the history of technology. The students are challenged to discover how technological innovations take place within complex economical, political and cultural contexts. They get introduced into basic theories and practices of the field.

Objective
Students are introduced into how technological innovations take place within complex economical, political and cultural contexts. They get introduced into basic theories and practices of the field.

Content

Lecture notes

Literature
https://www.tg.ethz.ch/de/programme/

Prerequisites / notice
Does not take place this semester. Number of participants limited to 20.

851-0705-01L Environmental Law: Conceptions and Fields W 2 credits 2S G. Hürlimann
Does not take place this semester.
Number of participants limited to 20.

Prerequisites: Environmental Law: Conceptions and Fields (851-0705-01L) offered in spring semester.
Particularly suitable for students of D-ARCH, D-BAUG, D-USYS

Abstract
This workshop offers to the students the opportunity to intensify their environmental legal knowledge on the basis of individual topics or cases of their respective programme or professional interest in a guided self-study. They develop a better understanding for the practical application of legal regulations on environmental matters.

Objective
At the beginning of the workshop the students are introduced to the legal methods and sources as well as in the aim and the process of the workshop. The participants will organize themselves in a team of two persons giving themselves an inquiry on topics of the environmental law. It is also possible to choose questions at the interfaces of e.g. zoning law, energy law, transport law. A proposal, which will be presented to the lecturer, as well as an optional Q&A-session in class will facilitate the start. Next the working on topics will follow by self-study. The results will be presented in form of a memo/paper with a maximum of ten pages (excluding graphs and tables). At the end of the workshop, a presentation of ten minutes will be made to the plenum including a question-and-answer session. Class language will be German.

Content
At the beginning of the workshop the students are introduced to the legal methods and sources as well as in the aim and the process of the workshop. The participants will organize themselves in a team of two persons giving themselves an inquiry on topics of the environmental law. It is also possible to choose questions at the interfaces of e.g. zoning law, energy law, transport law. A proposal, which will be presented to the lecturer, as well as an optional Q&A-session in class will facilitate the start. Next the working on topics will follow by self-study. The results will be presented in form of a memo/paper with a maximum of ten pages (excluding graphs and tables). At the end of the workshop, a presentation of ten minutes will be made to the plenum including a question-and-answer session. Class language will be German.

Literature
- Meinrad Huser, Schweizerisches Vermessungsrecht, unter besonderer Berücksichtigung des Geoinformationsrechts und des Grundbuchrechts, Zürich 2014
- Meinrad Huser, Geo-Informationsrecht, Rechtlicher Rahmen für Geographische Informationssysteme, Zürich 2005
- Meinrad Huser, Darstellung von Grenzen zur Sicherung dinglicher Rechte, in ZBOR 2013, 238 ff.
- Meinrad Huser, Datenschutz bei Geodaten

Prerequisites
Requirements: Property Law (12-722)
Environmental Ethics

The lecture begins with an introduction to applied ethics in general. The main focus is on environmental ethics. Students learn to handle important concepts and positions of environmental ethics. They achieve a deeper understanding of these concepts and positions in applying them to ecological problems and discussing them in case studies.

- Introduction to general and applied ethics.
- Overview and discussion of ethical theories relevant to the environment.
- Familiarisation with various basic standpoints within environmental ethics.
- Current debates, such as sustainability, intergenerational justice, protection of species, etc.
- Practising of newly acquired knowledge in case studies (protection of species, climate change, etc.)

In the part of the course serving as an introduction to general and applied ethics, we shall be using the following textbook: Barbara Bleisch/Markus Huppenbauer: Ethische Entscheidungsfundung, Ein Handbuch für die Praxis, 2nd Edition Zürich 2014

Generel introductions:
- Barbara Bleisch/Markus Huppenbauer: Ethische Entscheidungsfundung, Ein Handbuch für die Praxis, Zürich 2014, 2. Auflage
- Marcus Düwell et. al (Hrsg.), Handbuch Ethik, 2. Auflage, Stuttgart (Metzler Verlag), 2006

...
Applied Statistics and Policy Evaluation  

Number of participants limited to 20.

Science, Technology, and Policy MSc and MAS in Development and Cooperation have priority.

Abstract
This course introduces students to key statistical methods for analyzing social science data with a special emphasis on causal inference and policy evaluation. Students learn to choose appropriate analysis strategies for particular research questions and to perform statistical analyses with the statistical Software Stata.

Objective
Students
- have a sound understanding of linear and logit regression
- know strategies to test causal hypotheses using regression analysis and/or experimental methods
- are able to formulate and implement a regression model for a particular policy question and a particular type of data
- are able to critically interpret results of applied statistics, in particular, regarding causal inference
- are able to critically read and assess published studies on policy evaluation
- are able to use the statistical software STATA for data Analysis

Content
The topics covered in the first part of the course are a revision of basic statistics and linear and logit regression analysis. The second part of the course focuses on causal inference and introduces methods such as panel data analysis, difference-in-difference methods, instrumental variable estimation, and randomized controlled trials mostly used for policy evaluation. The course shows how the various methods differ in terms of the required identifying assumptions to infer causality as well as the data needs.

Students will apply the methods from the lectures by solving weekly assignments using statistical software and data sets provided by the instructors. These data sets will cover topics at the interface of policy, technology and society. Solving the assignments contributes to the final grade with a weight of 30%. Students are assisted in solving the assignments during the exercises session.

D-BIOL

<table>
<thead>
<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</table>
| 851-0180-00L | Research Ethics  
Particularly suitable for students of D-BIOL, D-CHAB, D-HEST | W    | 2    | 2G    | G. Achermann |

Abstract
This course has its focus on the responsible conduct of research (RCR) and the ethical dimensions of the biological and biomedical sciences.

Objective
The main goal of this course is to enhance the student's ability to:
- recognize and identify ethical issues and conflicts,
- analyze and develop well-reasoned responses to the kinds of ethical problems a scientist is likely to encounter.

Additionally, students will become familiar with regulations and ethical guidelines relevant for their research field on the international, governmental, institutional and professional level.

To achieve these objectives, teaching methods will include lectures, discussions, case study work (alone and in groups), moral games, paper work and exercises.

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Content

I. Ethics & the Process of Ethical Inquiry
---------------------------------------

Introduction in Ethics and Research Ethics
- What is ethics? What ethics is not ...;
- Awareness: what constitutes an ethical question? Distinguishing ethical questions from other kinds of questions; Science & ethics: a comparison;
- The ethics movement in the biological and health sciences;
- What is research ethics and why is it important?
- Values (personal, cultural & ethical) in science & principles for ethical conduct in research;
- Professional codes of conduct: functions and limitations

Ethical approaches in the conduct of research (Normative Ethics)
- Overview over important theories for research ethics: virtue theories, duty-based theories (rights theory, categorical imperative, prima facie duties), consequentialist theories, other theories);
- The plurality of ethical theories and its consequences;
- The concept of dignity

Moral reasoning I: Arguments
- Why arguments? What is a good argument? The structure of (moral) arguments;
- Deductive and inductive arguments; Validity and soundness;
- Assessing moral arguments

Moral reasoning II: Decision-making
- How (not) to approach ethical issues... Is there a correct method for answering moral questions?
- Models of method in Applied Ethics: a) Top-down approaches; b) the reflective equilibrium; c) a bottom-up approach: casuistry (or reasoning-by-analogy);
- Is there a right answer?

II. Research Ethics / Responsible Conduct of Research (RCR)
----------------------------------------------------------

Integrity in Research & Research Misconduct
- What is “integrity” in scientific research? What is research misconduct (falsification, fabrication, plagiarism - FFP) and questionable research practices (QRP)?
- Factors leading to misconduct; Procedure for responding to allegations of research misconduct;
- The confidant of ETH Zurich

Data Management
- Data collection and recordkeeping; Analysis and selection of data;
- Ownership of data; retention and sharing of data;
- Falsification and fabrication of data

Research involving animals
- The moral status of animals; Ethical approaches to animal experimentation: Animal welfare (Peter Singer) and Animal rights (Tom Regan);
- The 3 Rs (replacement, reduction, refinement);
- Ethical assessment of conflicting issues in animal experimentation;
- The dignity of animals in the Swiss constitution;

Research involving human subjects
- History & guidelines (Nuremberg Code; Declaration of Helsinki; Belmont Report; International Ethical Guidelines for Biomedical Research Involving Human Subjects (CIOMS Guidelines); Convention on Human Rights and Biomedicine (Oviedo Convention);
- Informed consent; confidentiality and anonymity; research risks and benefits; vulnerable subjects;
- Clinical trials;
- Biobanks;
- Ethics Committees / Institutional Review Boards (IRB)

Authorship & Peer review
- Criteria for authorship;
- Plagiarism;
- Challenges to openness and freedom in scientific publication;
- Open access;
- Peer review

Social responsibility
- What is social responsibility? Social responsibility: whose obligation?
- Public advocacy by researchers

Lecture notes
Course material (handouts, case studies, exercises, surveys and papers) will be available during the lectures and on the course homepage.

Literature
Recommended literature:
- “Introduction to the Responsible Conduct of Research” (http://ori.dhhs.gov/education/products/RCRintro/)

Detailed literature lists for the different topics of the course will be provided in the script/handout or on the course work space.

851-0144-19L Philosophy of Time
W 3 credits 2V 3 credits

Abstract
This course provides an introduction to philosophical issues surrounding the concept of time. We will treat topics such as: the existence of past, present, and future; the possibility of time travel; the constitution of time consciousness and its possible neurophysiological counterparts; temporal biases in the conduct of our lives; responsibility to future and past generations.
Objective: By the end of the course students are able to describe and compare different theories and concepts of time (physical time, perceptual time, historical time ...). They are able to identify and examine issues concerning time as they occur in various philosophical sub-disciplines - especially in philosophy of science, philosophy of mind, metaphysics, and ethics. Students are in a position to critically discuss and evaluate the repercussions of these issues in broader scientific and social contexts.

Part of the course reflects on methods and contents from physics, neuroscience/cognitive science, and logic.

851-0101-53L Collections in Context: What Do Historians and Scientists Learn from Butterflies, Stones, and Bones?

**Abstract:** Zurich holds huge scientific collections. They contain objects from around the world, some of them dating back to the 18th century. This interdisciplinary seminar combines perspectives from the history of science and from current scientific disciplines. What do these objects tell us about Zurich’s place in the global history of science? What potentials do old collections hold for scientists today?

**Objective:** The aim of this seminar is threefold: Firstly, students will become familiarised with historiographical approaches to scientific collections. Among them are constructivist approaches that seek to understand scientific knowledge not primarily as a system of objective truths, but rather as an outcome of human ‘constructions’. Other approaches deal with the problem of how scientific objects are related to systems of power and oppression, namely in the case of objects collected during the time of European colonialism overseas. Secondly, students will become familiarized with how old collections can yeald new insights for current scientists working, e.g., on questions of ecology. Thirdly, the seminar shall serve as a plattform to discuss ways of dialogue and possible collaboration between these different approaches.

Students will be expected to read theoretical texts and case studies during semester, participate in discussions with external experts (historians, curators, and scientists), and to write a summarizing essay at the end of the term.

### D-BSSE

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<tr>
<td>851-0125-58L</td>
<td>Philosophy of the Environmental Sciences: An Introduction</td>
<td>W</td>
<td>3 credits</td>
<td>2S</td>
<td>A. Schwarz</td>
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<tr>
<td>851-0101-53L</td>
<td>Collections in Context: What Do Historians and Scientists Learn from Butterflies, Stones, and Bones?</td>
<td>W</td>
<td>3 credits</td>
<td>2S</td>
<td>B. Schär, M. Greeff</td>
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### D-CHAB

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<th>Hours</th>
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</thead>
<tbody>
<tr>
<td>851-0738-03L</td>
<td>Protecting Inventions in Chemistry</td>
<td>W</td>
<td>2 credits</td>
<td>2V</td>
<td>C. Soltmann</td>
</tr>
</tbody>
</table>

Data: 06.03.2019 12:57  Autumn Semester 2016  Page 649 of 1571
Objective

Research and development play an important role in chemistry-related technology sectors such as inorganic and organic chemistry or pharmacy.

Investments in the development of new substances and active components in these sectors are traditionally secured by patents because publicly known inventions, generally chemical substances, may easily be reproduced by others.

In the last years, the know-how about intellectual property has become increasingly important for chemists and engineers. Both in the production process and in the distribution sector, chemists and engineers are increasingly being confronted with questions concerning the patenting of technical inventions and the use of patent information. As more than three-quarters of all publicly available technical information are available only in patents, it is more and more important for researchers and engineers to be capable of extracting relevant information from the flood of patents.

Patents are not only a powerful measure to protect investments and inventions in chemistry-related sectors but also an important source of information about competitors and potential cooperation partners and about the development of markets. Accordingly, the know-how about patents and patent information has become a key qualification on the strategic level in companies and in the research sector.

The seminar is customised to the needs of chemists and students of related degree programs. Participants will become familiar with practice-oriented aspects of intellectual property and will be enabled to use the acquired knowledge in their future professional life.

Topics covered during the lecture will include:
- The importance of innovation in industrialised countries
- An overview of the different forms of intellectual property
- The protection of technical inventions and how to safeguard their commercialisation
- Patents as a source of technical and business information
- Practical aspects of intellectual property in day-to-day research, at the workplace and for the formation of start-ups
- Special aspects of protecting inventions in chemistry-related sectors, e.g. polymorphs and inventions in the field of nanotechnology.

Case studies will illustrate and deepen the topics addressed during the lecture.

The seminar will comprise practical exercises on how to use and search patent information. Basic knowledge of how to read and evaluate patent documents as well as how to use publicly available patent databases to obtain the required patent information will also be provided.

Prerequisites / notice

The lecture is coordinated in particular to the needs of the following degree programs: Agricultural science, biotechnology, chemical engineering, food science, pharmaceutical sciences.

For engineering and physics students, the lecture 'The Role of Intellectual Property in daily routine: A Practical Introduction' (851-0738-01) will be offered in the autumn semester.

851-0180-00L Research Ethics W 2 credits 2G G. Achermann

Abstract

This course has its focus on the responsible conduct of research (RCR) and the ethical dimensions of the biological and biomedical sciences.

Objective

The main goal of this course is to enhance the student's ability to:
- recognize and identify ethical issues and conflicts,
- analyze and develop well-reasoned responses to the kinds of ethical problems a scientist is likely to encounter.

Additionally, students will become familiar with regulations and ethical guidelines relevant for their research field on the international, governmental, institutional and professional level.

To achieve these objectives, teaching methods will include lectures, discussions, case study work (alone and in groups), moral games, paper work and exercises.
I. Ethics & the Process of Ethical Inquiry

Introduction in Ethics and Research Ethics
- What is ethics? What ethics is not...;
- Awareness: what constitutes an ethical question? Distinguishing ethical questions from other kinds of questions; Science & ethics: a comparison;
- The ethics movement in the biological and health sciences;
- What is research ethics and why is it important?
- Values (personal, cultural & ethical) in science & principles for ethical conduct in research;
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- How (not) to approach ethical issues...; Is there a correct method for answering moral questions?
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- Is there a right answer?

II. Research Ethics / Responsible Conduct of Research (RCR)

Integrity in Research & Research Misconduct
- What is "integrity" in scientific research? What is research misconduct (falsification, fabrication, plagiarism - FFP) and questionable research practices (QRP)?
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- The 3 R's (replacement, reduction, refinement);
- Ethical assessment of conflicting issues in animal experimentation;
- The dignity of animals in the Swiss constitution;

Research involving human subjects
- History & guidelines (Nuremberg Code; Declaration of Helsinki; Belmont Report; International Ethical Guidelines for Biomedical Research Involving Human Subjects (CIOMS Guidelines); Convention on Human Rights and Biomedicine (Oviedo Convention);
- Informed consent; confidentiality and anonymity; research risks and benefits; vulnerable subjects;
- Clinical trials;
- Biobanks
- Ethics Committees / Institutional Review Boards (IRB)

Authorship & Peer review
- Criteria for authorship;
- Plagiarism;
- Challenges to openness and freedom in scientific publication;
- Open access
- Peer review

Social responsibility
- What is social responsibility? Social responsibility: whose obligation?
- Public advocacy by researchers

Lecture notes
Course material (handouts, case studies, exercises, surveys and papers) will be available during the lectures and on the course homepage.

Literature
Recommended literature:
- "Introduction to the Responsible Conduct of Research" (http://ori.dhhs.gov/education/products/RCRintro/)

Detailed literature lists for the different topics of the course will be provided in the script/handout or on the course work space.
Abstract
This course introduces students to key statistical methods for analyzing social science data with a special emphasis on causal inference and policy evaluation. Students learn to choose appropriate analysis strategies for particular research questions and to perform statistical analyses with the statistical Software Stata.

Objective
Students
- have a sound understanding of linear and logit regression
- know strategies to test causal hypotheses using regression analysis and/or experimental methods
- are able to formulate and implement a regression model for a particular policy question and a particular type of data
- are able to critically interpret results of applied statistics, in particular, regarding causal inference
- are able to critically read and assess published studies on policy evaluation
- are able to use the statistical software STATA for data analysis

Content
The topics covered in the first part of the course are a revision of basic statistics and linear and logit regression analysis. The second part of the course focuses on causal inference and introduces methods such as panel data analysis, difference-in-difference methods, instrumental variable estimation, and randomized controlled trials mostly used for policy evaluation. The course shows how the various methods differ in terms of the required identifying assumptions to infer causality as well as the data needs.

Students will apply the methods from the lectures by solving weekly assignments using statistical software and data sets provided by the instructors. These data sets will cover topics at the interface of policy, technology and society. Solving the assignments contributes to the final grade with a weight of 30%. Students are assisted in solving the assignments during the exercises session.

851-0144-20L Philosophical Aspects of Quantum Physics
Particularly suitable for students of D-CHAB, D-PHYS

Abstract
This course provides an introduction to philosophical issues surrounding quantum physics. In particular, we will examine different interpretations of quantum mechanics (such as the many-world interpretation) and the transition between the quantum and the classical physical realm (here phenomena such as decoherence will be highlighted).

Objective
By the end of the course students are able to describe and compare different interpretations of quantum mechanics. They are able to identify and examine issues concerning these different interpretations and issues concerning the transition between quantum and classical descriptions in physics. Students are in a position to critically discuss and evaluate the repercussions of these issues in broader scientific contexts.

851-0125-58L Philosophy of the Environmental Sciences: An Introduction
Particularly suitable for students of D-ARCH, D-BSEE, D-CHAB, D-MTEC, D-USYS

Abstract
Environmental knowledge and management is quite common in different research fields and in everyday practice. We will be identifying those concepts, objects and methods that mainly construe what might be called the core of the environmental sciences. This will be done by using different philosophical tools and approaches.

Objective
The environmental sciences cover a wide range of scientific practices and objects and accordingly afford different kinds of scientific knowledge. Additionally, there is an important interplay between the scientific and the societal sphere. In this seminar we will examine likewise central and widespread concepts such as sustainable development or resilience by using philosophical tools that will allow to probe the different uses of those concepts, their semantic range in terms of historical depth and semantic fields and finally their logical coherence. Another important topic is the philosophical investigation of methods and objects that can be identified in the environmental sciences. Those methods are for instance Life Cycle Assessment or Adaptive Ecosystem Management, technological objects may be a wind engine or a hydropower plant. The latter raise questions of how renewable energies can be assessed and valued, including the more general issue of how values and norms can be embedded in technological objects. This leads us to the third and last complex of topics that focus on current deliberations about possible new ways of existence in the age of the Anthropocene and as a consequence the formation of adequate life styles in our societies. This refers to issues in philosophical and social anthropology and the challenge of climate change.

851-0125-51L Man and Machine
Does not take place this semester.
Particularly suitable for students of D-CHAB, D-HEST, D-MAVT, D-MATL

Abstract
The lecture gives an overview about the different Man-Machine-Relations since the 16th century. Different modells of machines will be important here: the clockwork, the steam engine and the computer.

Objective
On the one hand modells of machines had a heuristical value in research on man, e.g. in Harvey's discovery of blood circulation in the 17th century or in brain research in the 20th century. On the other hand these modells were always criticised, sometimes polemically, because they are supposedly not adequate for man.

Students should learn about the connections between the history of anthropology and technology and be able at the end of the course to evaluate the critical philosophical arguments that are connected with the metaphor of the machine.

D-ERDW

Number Title Type ECTS Hours Lecturers
851-0157-69L History of Astronomy
Particularly suitable for students of D-ERDW, D-MATH, D-PHYS

Abstract
Die Veranstaltung ist ausgebucht

Objective
The course aims at providing a working knowledge of astronomy and cosmology from the ancient world to the 16th century. Upon its completion the students will be able to describe how our knowledge of the heavens changed from Aristotle's system to the Copernican Revolution. In addition, they will also have acquired an appreciation of the debates about man's place in the cosmos and the philosophical principles underpinning cosmology.

701-0703-00L Environmental Ethics

Abstract
The lecture begins with an introduction to applied ethics in general. The main focus is on environmental ethics. Students learn to handle important concepts and positions of environmental ethics. They achieve a deeper understanding of these concepts and positions in applying them to ecological problems and discussing them in case studies.

Objective
On completion of this lecture course you will have acquired the ability to identify and process general and environmental ethical problems. You will be capable of recognizing and analysing environmental ethical problems and of working towards a solution. You will have acquired a fundamental knowledge of standpoints and arguments related to the metaphor of the machine. Students are in a position to critically discuss and evaluate the repercussions of these issues in broader scientific contexts.

Content
- Introduction to general and applied ethics.
- Overview and discussion of ethical theories relevant to the environment.
- Familiarisation with various basic standpoints within environmental ethics.
- Cross-section topics, such as sustainability, intergenerational justice, protection of species, etc.
- Practising of newly acquired knowledge in case studies (protection of species, climate change, etc.)
Lecture notes
Summaries of the individual sessions will be distributed, including the most important theories and keywords; reading list.
In the part of the course serving as an introduction to general and applied ethics, we shall be using the following textbook: Barbara Bleisch/Markus Huppenbauer: Ethische Entscheidungsfindung, Ein Handbuch für die Praxis, 2nd Edition Zürich 2014

Literature
- Andrew Light/Holmes Rolston III, Environmental Ethics. An Anthology, 2003
- John O’Neill et al., Environmental Values, 2008
- Klaus Peter Rippe, Ethik im ausserhumanen Bereich, Paderborn (mentis) 2008

General introductions:
- Marcus Düwell et. al (Hrg.), Handbuch Ethik, 2. Auflage, Stuttgart (Metzler Verlag), 2006
- Johann S. Ach et. al (Hrg.), Grundkurs Ethik 1. Grundlagen, Paderborn (mentis) 2008

Prerequisites /
notice
The procedure for accumulating CP will be explained at the start of term.
I expect participants to be motivated and contribute to discussions, keeping the course interesting and lively.


Abstract
This course introduces students to key statistical methods for analyzing social science data with a special emphasis on causal inference and policy evaluation. Students learn to choose appropriate analysis strategies for particular research questions and to perform statistical analyses with the statistical Software Stata.

Objective
Students
- have a sound understanding of linear and logit regression
- know strategies to test causal hypotheses using regression analysis and/or experimental methods
- are able to formulate and implement a regression model for a particular policy question and a particular type of data
- are able to critically interpret results of applied statistics, in particular, regarding causal inference
- are able to critically read and assess published studies on policy evaluation
- are able to use the statistical software STATA for data Analysis

Content
The topics covered in the first part of the course are a revision of basic statistics and linear and logit regression analysis. The second part of the course focuses on causal inference and introduces methods such as panel data analysis, difference-in-difference methods, instrumental variable estimation, and randomized controlled trials mostly used for policy evaluation. The course shows how the various methods differ in terms of the required identifying assumptions to infer causality as well as the data needs.

Students will apply the methods from the lectures by solving weekly assignments using statistical software and data sets provided by the instructors. These data sets will cover topics at the interface of policy, technology and society. Solving the assignments contributes to the final grade with a weight of 30%. Students are assisted in solving the assignments during the exercises session.

D-HEST

Number Title Type ECTS Hours Lecturers
851-0125-51L Man and Machine W 3 credits 2G M. Hampe

Abstract
The lecture gives an overview about the different Man-Machine-Relations since the 16th century. Different models of machines will be important here: the clockwork, the steam engine and the computer.

Objective
On the one hand models of machines had a heuristic value in research on man, e.g. in Harvey's discovery of blood circulation in the 17th century or in brain research in the 20th century. On the other hand these models were always criticized, sometimes polemically, because they are supposedly not adequate for man.

Students should learn about the connections between the history of anthropology and technology and be able at the end of the course to evaluate the critical philosophical arguments that are connected with the metaphor of the machine.

851-0180-00L Research Ethics ■ W 2 credits 2G G. Achermann

Abstract
This course has its focus on the responsible conduct of research (RCR) and the ethical dimensions of the biological and biomedical sciences.

Objective
The main goal of this course is to enhance the student's ability to:
- recognize and identify ethical issues and conflicts,
- analyze and develop well-reasoned responses to the kinds of ethical problems a scientist is likely to encounter.

Additionally, students will become familiar with regulations and ethical guidelines relevant for their research field on the international, governmental, institutional and professional level.

To achieve these objectives, teaching methods will include lectures, discussions, case study work (alone and in groups), moral games, paper work and exercises.
I. Ethics & the Process of Ethical Inquiry
---------------------------------------

Introduction in Ethics and Research Ethics
- What is ethics? What ethics is not...;
- Awareness: what constitutes an ethical question? Distinguishing ethical questions from other kinds of questions; Science & ethics: a comparison;
- The ethics movement in the biological and health sciences;
- What is research ethics and why is it important?
- Values (personal, cultural & ethical) in science & principles for ethical conduct in research;
- Professional codes of conduct: functions and limitations

Ethical approaches in the conduct of research (Normative Ethics)
- Overview over important theories for research ethics: virtue theories, duty-based theories (rights theory, categorical imperative, prima facie duties), consequentialist theories, other theories);
- The plurality of ethical theories and its consequences;
- The concept of dignity

Moral reasoning I: Arguments
- Why arguments? What is a good argument? The structure of (moral) arguments;
- Deductive and inductive arguments; Validity and soundness;
- Assessing moral arguments

Moral reasoning II: Decision-making
- How (not) to approach ethical issues...; Is there a correct method for answering moral questions?
- Models of method in Applied Ethics: a) Top-down approaches; b) the reflective equilibrium; c) a bottom-up approach: casuistry (or reasoning-by-analogy);
- Is there a right answer?

II. Research Ethics / Responsible Conduct of Research (RCR)
----------------------------------------------------------

Integrity in Research & Research Misconduct
- What is “integrity” in scientific research? What is research misconduct (falsification, fabrication, plagiarism - FFP) and questionable research practices (QRP)?
- Factors leading to misconduct; Procedure for responding to allegations of research misconduct;
- The confidant of ETH Zurich

Data Management
- Data collection and recordkeeping; Analysis and selection of data;
- Ownership of data; retention and sharing of data;
- Falsification and fabrication of data

Research involving animals
- The moral status of animals; Ethical approaches to animal experimentation: Animal welfare (Peter Singer) and Animal rights (Tom Regan);
- The 3 Rs (replacement, reduction, refinement);
- Ethical assessment of conflicting issues in animal experimentation;
- The dignity of animals in the Swiss constitution;

Research involving human subjects
- History & guidelines (Nuremberg Code; Declaration of Helsinki; Belmont Report; International Ethical Guidelines for Biomedical Research Involving Human Subjects (CIOMS Guidelines); Convention on Human Rights and Biomedicine (Oviedo Convention);
- Informed consent; confidentiality and anonymity; research risks and benefits; vulnerable subjects;
- Clinical trials;
- Biobanks
- Ethics Committees / Institutional Review Boards (IRB)

Authorship & Peer review
- Criteria for authorship;
- Plagiarism;
- Challenges to openness and freedom in scientific publication;
- Open access
- Peer review

Social responsibility
- What is social responsibility? Social responsibility: whose obligation?
- Public advocacy by researchers

Lecture notes
Course material (handouts, case studies, exercises, surveys and papers) will be available during the lectures and on the course homepage.

Literature
Recommended literature:
- "Introduction to the Responsible Conduct of Research" (http://ori.dhhs.gov/education/products/RCRintro/)

Detailed literature lists for the different topics of the course will be provided in the script/handout or on the course work space.

Postal Knowledge and the History of Digital Societies

W 3 credits 2S  
D. F. Zetti

Particularly suitable for students of D-ARCH, D-BAUG, D-NEST, D-INFK, D-ITET, D-MAVT

Abstract
In the second half of the 20th century, postal services have dramatically changed. Communication today is computerbased. The lecture offers problem oriented insights into this sociotechnical process of translation.

Objective
Students become familiar with the mutual interdependence of social and technological change that characterises the history of computing and communication.
The objective is knowing and understanding key legal concepts relevant for doing e-business, in particular understanding how e-business is regulated by law nationally and internationally, how contracts are concluded and performed electronically, which rules have to be obeyed implementing online projects and undertaking information technology activities.

Students are expected to contribute to presentations of foundational themes, methods and results of their chosen group project. In order to obtain course credit a written essay / report will be required (details to be specified in the introductory session of the course).

Students will apply the methods from the lectures by solving weekly assignments using statistical software and data sets provided by the instructors. These data sets will cover topics at the interface of policy, technology and society. Solving the assignments contributes to the final grade with a weight of 30%. Students are assisted in solving the assignments during the exercises session.

The topics covered in the first part of the course are a revision of basic statistics and linear and logit regression analysis. The second part focuses on causal inference and introduces methods such as panel data analysis, difference-in-difference methods, instrumental variable estimation, and randomized controlled trials mostly used for policy evaluation. The course shows how the various methods differ in terms of the required identifying assumptions to infer causality as well as the data needs.

Students are assisted in solving the assignments during the exercises session. The seminar will provide an opportunity to experience some of the methods in applied group projects.
Es wird mit Folien gearbeitet, die als PDF über die elektronische Dokumentenablage (ILIAS) auf dem System der ETHZ vorgängig abrufbar sind. Auf dem Termin- und Themenplan (ebenfalls online abrufbar) sind Links zu Gesetzesextenzen und weiteren Unterlagen abrufbar. Schliesslich wird jede Vorlesung auch als Podcast aufgezeichnet, der jedoch nur für die Studierenden mit einem Passwort (erhältlich beim Dozenten) zugänglich sind.


Die Demesterendprüfung ist in Form eines schriftlichen Kurztests (normalerweise MC) in voraussichtlich der letzten Doppelstunde geplant. Es wird angegeben, welche Unterlagen beim jeweiligen Thema den Prüfungsstoff definieren. Der Test wird möglicherweise elektronisch durchgeführt.


Ferner bietet Ursula Widmer eine Vorlesung zum Thema Informationssicherheit an, welche die rechtlichen Aspekte der Sicherheit von ICT-Infrastrukturen und Netzen und der transportierten und verarbeiteten Informationen.

**851-0591-00L Digital Sustainability in the Knowledge Society**

**W** 2 credits **2V** M. M. Dapp

**Particularly suitable for students of D-INFK, D-ITET, D-MATL, D-MAVT, D-MTEC, D-USYS.**

**Abstract**

How do various interest groups influence the methods of production, distribution, and use of digital resources? Current models focusing on strong intellectual property rights are contrasted with open models like, e.g. Open Source/Content/Access. The course discusses consequences from different models and introduces “digital sustainability” as an alternative vision for society.

**Objective**

At the heart of the discourse is the handling of digital goods and intellectual property in society. Digitization and the Internet allow handling knowledge in a way, which directly contrasts with the traditional understanding of “intellectual property” and the industries based on it.

Starting from economic and legal basics, we compare proprietary and open/free models. Sustainable development as a concept is transferred to digital goods, taking into account the particular nature of digital stuff.

After the lecture, you should (hopefully) be able to:

- characterize the nature of digital goods vs. physical goods
- critique the basic concepts of copyright and patent rights
- explain the political/legal and economic differences between proprietary and open approaches to the production and use of digital goods
- using an example, explain the meaning of digital sustainability and argue why it is relevant for a knowledge society
- transfer the ideas of the free/open source software model to other digital goods (e.g., open content, open access)

**Content**

Technical reality: Within minutes you can make perfect copies of high-value digital goods of knowledge or culture (as text, audio, video, image or software) and distribute them around the globe -- for free. “Digitization plus Internet” allows for the first time in humankind's history the (theoretically) free access and global exchange of knowledge at minimal cost. A tremendous opportunity for societal development, in north and south. «Cool, so what’s the problem?»

The problem is, that this reality poses a fundamental threat to today’s business model of the knowledge and culture industries (starting from the music label and Hollywood, via publishers, up to software vendors). Powerful commercial interests are at stake as “knowledge” (the fourth factor of production) will become ever more important in the 21st century. Accordingly, “piracy” and “file-sharing” are attacked with all means. At the core lies the question about the design of property in digital assets. For that, we apply a concept of “intellectual property”, which is several hundred years old and does not address digital reality in an adequate manner, sometimes leading to absurd situations. Its original goal seems to get forgotten: to help society develop by spreading knowledge as much as possible.

Using the PC becomes the new cultural technique of the 21st century. In contrast to «reading, writing and arithmetic», this new cultural technique cannot exist in isolation, but depends on a hard- and software infrastructure. This dependency extends to the provider of the infrastructure, who can dictate technical rules, which can take away or restrict the user’s freedom. Even advanced users may have difficulties in recognizing these, often hidden, restrictions and in evaluating their societal relevance. But exactly these invisible consequences we need to understand and investigate, because they decide about access, distribution and usage of digital knowledge.

Comparative to the environmentalist movement of the 60s and 70s, a growing political movement for “Free Software” exists today, with GNU/Linux as its most popular symbol. The movement fights against treating software code as private property but as a central cultural good available to all without private interests. Based on the success of the Free Software movement, new initiatives extend the concepts to other domains (e.g. scientific knowledge, music).

As a «teaser» to the lecture, you are invited to read the essay «ETH Zurich - A Pioneer in Digital Sustainability!». It can be downloaded from www.essays2010.ethz.ch.

More on teach.digisus.info starting from September. Stay tuned.

**Lecture notes**

Slides and other material (both usually in English) will be made available on a weekly basis as the lecture proceeds.
Content of the following books is covered (PDFs freely available online):

Other recommended books are:
1 (general) Chris DiBona et al., Open Sources: Voices from the Open Source Revolution, O'Reilly, 1999.

Prerequisites / notice
For administrative and didactic reasons (high level of interaction and credit group assignments on current hot topics), the number of participants is limited to 45. Of course, any interested person is invited to attend the lecture without doing the group assignment. The website is actively used for the lecture.

851-0585-04L Lecture with Computer Exercises: Modelling and Simulating Social Systems with MATLAB
W 3 credits 2S D. Helbing, L. Sanders, O. Woolley
Number of participants limited to 70.

Particularly suitable for students of D-MAVT, D-INFK, D-ITET, D-MTEC, D-PHYS.

Content This course introduces first the basic functionalities and features of the mathematical software package MATLAB, such as the simple operations with matrices and vectors, differential equations, statistical tools, the graphical representation of data in various forms, and video animations of spatio-temporal data. With this knowledge, students are expected to implement themselves in MATLAB, models of various social processes and systems, including agent-based models, e.g. models of interactive decision making, group dynamics, human crowds, or game-theoretical models.

Part of this course will consist of supervised programming exercises in a computer pool. Credit points are finally earned for the implementation of a mathematical model from the sociological literature in MATLAB and the documentation in a seminar thesis.

851-0549-00L WebClass Introductory Course History of Technology
W 3 credits 2V G. Hürlimann
Number of participants limited to 100.

Particularly suitable for students of D-BAUG, D-INFK, D-ITET, D-MATL, D-MAVT.

Content The number of participants is limited to the size of the available computer teaching room. The MATLAB code related to the seminar thesis should be well enough documented for further use by others and must be handed over to the Chair of Sociology, in particular of Modeling and Simulation, for further free and unrestricted use.

851-0551-03L Postal Knowledge and the History of Digital Societies
W 3 credits 2S D. F. Zetti
Particularly suitable for students of D-ARCH, D-BAUG, D-HEST, D-INFK, D-ITET, D-MAVT

Abstract In the second half of the 20th century, postal services have dramatically changed. Communication today is computerbased. The lecture offers problem oriented insights into this sociotechnical process of translation.

Objective Students become familiar with the mutual interdependence of social and technological change that characterises the history of computing and communication.


851-0144-19L Philosophy of Time
W 3 credits 2V N. Sieroka

Abstract This course provides an introduction to philosophical issues surrounding the concept of time. We will treat topics such as: the existence of past, present, and future; the possibility of time travel; the constitution of time consciousness and its possible neurophysiological counterparts; temporal biases in the conduct of our lives; responsibility to future and past generations.
Objective
By the end of the course students are able to describe and compare different theories and concepts of time (physical time, perceptual time, historical time ...). They are able to identify and examine issues concerning time as they occur in various philosophical subdisciplines - especially in philosophy of science, philosophy of mind, metaphysics, and ethics. Students are in a position to critically discuss and evaluate the repercussions of these issues in broader scientific and social contexts.
Part of the course reflects on methods and contents from physics, neuroscience/cognitive science, and logic.

851-0144-21L

Philosophical Issues and Problems in Theoretical Computer Science

Particularly suitable for students of D-INFK

Abstract
This course studies philosophical issues concerning computers and computing. Topics include: information (and information content), computational complexity, the Turing Test for computer thought; the "Chinese Room" argument against the possibility of strong AI; connectionist AI; consciousness; and the Church-Turing thesis; computational and hypercomputational models of mind; and free will.

Objective
- Exhibit a general understanding of the philosophy and history of computing.
- Explain central problems in the field and their potential solutions, independently and at a level requiring in-depth knowledge and critical understanding.
- Communicate clearly in writing about topics in this field.

851-0144-22L

Developments in Logic after Gödel: Applications to Theoretical Computer Science

Particularly suitable for students of D-INFK

Abstract
The course will start by presenting a modern logic, namely (propositional) modal logic, which has turned out to be extremely fruitful and to have numerous interesting applications in computer science, mathematics and philosophy. Subsequently, two of these applications to computer science, tense logic and dynamic logic, and one application to mathematics, provability logic, will be introduced.

Objective
- Learn the fundamental concepts of a range of propositional logics.
- Learn how to construct proofs in these logics.
- Study the interface between mathematical logic and computer science, and mathematical logic and mathematics.

860-0006-00L

Applied Statistics and Policy Evaluation

Number of participants limited to 20.

Science, Technology, and Policy MSc and MAS in Development and Cooperation have priority.

Abstract
This course introduces students to key statistical methods for analyzing social science data with a special emphasis on causal inference and policy evaluation. Students learn to choose appropriate analysis strategies for particular research questions and to perform statistical analyses with the statistical Software Stata.

Objective
Students
- have a sound understanding of linear and logit regression.
- know strategies to test causal hypotheses using regression analysis and/or experimental methods.
- are able to formulate and implement a regression model for a particular policy question and a particular type of data.
- are able to critically interpret results of applied statistics, in particular, regarding causal inference.
- are able to critically read and assess published studies on policy evaluation.
- are able to use the statistical software STATA for data Analysis.

Content
The topics covered in the first part of the course are a revision of basic statistics and linear and logit regression analysis. The second part of the course focuses on causal inference and introduces methods such as panel data analysis, difference-in-difference methods, instrumental variable estimation, and randomized controlled trials mostly used for policy evaluation. The course shows how the various methods differ in terms of the required identifying assumptions to infer causality as well as the data needs.

Students will apply the methods from the lectures by solving weekly assignments using statistical software and data sets provided by the instructors. These data sets will cover topics at the interface of policy, technology and society. Solving the assignments contributes to the final grade with a weight of 30%. Students are assisted in solving the assignments during the exercise session.

D-ITET

Number
Title
Type
ECTS
Hours
Lecturers

851-0591-00L
Digital Sustainability in the Knowledge Society
Particularly suitable for students of D-INFK, D-ITET, D-MATL, D-MAVT, D-MTEC, D-USYS.

Abstract
At the heart of the discourse is the handling of digital goods and intellectual property in society. Digitization and the Internet allow handling knowledge in a way, which directly contrasts with the traditional understanding of "intellectual property" and the industries based on it. Starting from economic and legal basics, we compare proprietary and open/"free" models. Sustainable development as a concept is transferred to digital goods, taking into account the particular nature of digital stuff. After the lecture, you should (hopefully) be able to:
- characterize the nature of digital goods vs. physical goods.
- critique the basic concepts of copyright and patent rights.
- explain the political/legal and economic differences between proprietary and open approaches to the production and use of digital goods.
- use an example, explain the meaning of digital sustainability and argue why it is relevant for a knowledge society.
- transfer the ideas of the free/open source software model to other digital goods (e.g., open content, open access).

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Content

Technical reality: Within minutes you can make perfect copies of high-value digital goods of knowledge or culture (as text, audio, video, image or software) and distribute them around the globe -- for free. «Digitization plus Internet» allows for the first time in humankind's history the (theoretically) free access and global exchange of knowledge at minimal cost. A tremendous opportunity for societal development, in north and south. «Cool, so what's the problem?»

The problem is that this reality poses a fundamental threat to today's business model of the knowledge and culture industries (starting from the music label and Hollywood, via publishers, up to software vendors). Powerful commercial interests are at stake as «knowledge» (the fourth factor of production) will become ever more important in the 21st century. Accordingly, «piracy» and «file-sharing» are attacked with all means. At the core lies the question about the design of property in digital assets. For that, we apply a concept of «intellectual property», which is several hundred years old and does not address digital reality in an adequate manner anymore. Sometimes leading to absurd situations. Its original goal seems to get forgotten: to help society develop by spreading knowledge as much as possible.

Using the PC becomes the new cultural technique of the 21st century. In contrast to «reading, writing and arithmetics», this new cultural technique cannot exist in isolation, but depends on a hard- and software infrastructure. This dependency extends to the provider of the infrastructure, who can define technical rules, which can take away or restrict the user's freedom. Even advanced users may have difficulties in recognizing these, often hidden restrictions and in evaluating their societal relevance. But exactly these invisible consequences we need to understand and investigate, because they decide about access, distribution and usage of digital knowledge.

Comparable to the environmentalist movement of the 60s and 70s, a growing political movement for «Free Software» exists today, with «GNU/Linux» as its most popular symbol. The movement fights against treating software code as private property but as a central cultural good available to all without private interests. Based on the success of the Free Software movement, new initiatives extend the concepts to other domains (e.g. scientific knowledge, music)...

As a «teaser» to the lecture, you are invited to read the essay «ETH Zurich - A Pioneer in Digital Sustainability!». It can be downloaded from www.essays2030.ethz.ch.

More on teach.digisus.info starting from September. Stay tuned.

Lecture notes

Slides and other material (both usually in English) will be made available on a weekly basis as the lecture proceeds.

Literature

Content of the following books is covered (PDFs freely available online):

Other recommended books are:
1 (general) Chris DiBona et al., Open Sources: Voices from the Open Source Revolution, O'Reilly, 1999.

Prerequisites / notice

For administrative and didactic reasons (high level of interaction and credit group assignments on current hot topics), the number of participants is limited to 45.

Of course, any interested person is invited to attend the lecture without doing the group assignment. The website is actively used for the participants.

851-0125-41L Introduction Into Philosophy of Technology

Particularly suitable for students of D-ITET, D-MATL, D-MAVT

W 3 credits 2V O. Müller

Abstract

Since antiquity philosophy reflects about and evaluates technology. The technical developments in the 19th and 20th century have led to an autonomous philosophy of technology, which had become important also for other philosophical disciplines (e.g. in Heidegger's philosophy).

Objective

The course gives an overview on the main schools in the philosophy of technology. Students should learn to analyse and evaluate different philosophies of technology (compensation, objectification, externalisation). For credit point a critical protocol is to be written.

851-0727-02L E-Business-Law

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

W 2 credits 2V D. Rosenthal

Abstract

The course deals with the basic legal framework for doing e-business as well as using information technology. It discusses a variety of legal concepts and rules to be taken into account in practice, be it when designing and planning new media business models, be it when implementing online projects and undertaking information technology activities.

Objective

The objective is knowing and understanding key legal concepts relevant for doing e-business, in particularly understanding how e-business is regulated by law nationally and internationally, how contracts are concluded and performed electronically, which rules have to be obeyed in particular in the Internet with regard to third party and own content and client data, the concept of liability applied in e-business and the role of the law in the practical implementation and operation of e-business applications.

Content

Vorgesehene Strukturierung der Vorlesung:

1) Welches Recht gilt im E-Business?
Internationa!ität des Internets
Regulierte Branchen
2) Gestaltung und Vermarktung von E-Business-Angeboten
Verwendung fremder und Schutz der eigenen Inhalte
Haftung im E-Business (und wie sie beschränkt werden kann)
Domain-Namen
3) Beziehung zu E-Business-Kunden
Verträge im E-Business, Konsumentenschutz
Elektronische Signaturen
Datenschutz
Spam
4) Verträge mit E-Business-Providern

Lecture notes

Es wird mit Folien gearbeitet, die als PDF über die elektronische Dokumentenablage (ILIAS) auf dem System der ETHZ vorgängig abrufbar sind. Auf dem Termin- und Themenplan (ebenfalls online abrufbar) sind Links zu Gesetzestexten und weiteren Unterlagen abrufbar. Schliesslich wird jede Vorlesung auch als Podcast aufgezeichnet, der jedoch nur für die Studierenden mit einem Passwort (erhältlich beim Dozenten) zugänglich sind.

Literature


Data: 06.03.2019 12:57 Autumn Semester 2016 Page 659 of 1571
851-0252-01L Human-Computer Interaction: Cognition and Usability

Prerequisites / notice
Die Semesterrprüfung ist in Form eines schriftlichen Kurztests (normalerweise MC) in voraussichtlich der letzten Doppelstunde geplant. Es wird angegeben, welche Unterlagen beim jeweiligen Thema den Prüfungsstoff definieren. Der Test wird möglicherweise elektronisch durchgeführt.


Ferner bietet Ursula Widmer eine Vorlesung zum Thema Informationssicherheit an, welche die rechtlichen Aspekte der Sicherheit von ICT-Infrastrukturen und Netzen und der transportierten und verarbeiteten Informationen.

851-0585-04L Lecture with Computer Exercises: Modelling and Simulating Social Systems with MATLAB

Prerequisites / notice
The number of participants is limited to 70.

Abstract
This course introduces first the basic functionalities and features of the mathematical software package MATLAB, such as the simple operations with matrices and vectors, differential equations, statistical tools, the graphical representation of data in various forms, and video animations of spatio-temporal data. With this knowledge, students are expected to implement themselves in MATLAB, models of various social processes and systems, including agent-based models, e.g. models of interactive decision making, group dynamics, human crowds, or game-theoretical models.

Part of this course will consist of supervised programming exercises in a computer pool. Credit points are finally earned for the implementation of a mathematical model from the sociological literature in MATLAB and the documentation in a seminar thesis.

851-0549-00L WebClass Introductory Course History of Technology

Prerequisites / notice
The number of participants is limited to the size of the available computer teaching room. The MATLAB code related to the seminar thesis should be well enough documented for further use by others and must be handed over to the Chair of Sociology, in particular of Modeling and Simulation, for further free and unrestricted use.

Further literature, in particular regarding computer models in the social sciences, will be provided in the course.

851-0735-10L Business Law

Prerequisites / notice
The students shall obtain a basic knowledge about business law. They shall be able to recognize and evaluate issues in the area of business law and suggest possible solutions.
The lectures provide an overview of the foundations of cognitive science and investigate processes of human cognition, especially perception, learning, memory and reasoning. This includes a comparison of cognitive processes in humans and technical systems, as well as an understanding of how to answer these kinds of questions concerning the legal domain and how these processes are effective and efficient. Based on theories of international political economy and theories of government regulation various examples of international environmental politics are discussed: the management of international water resources, the problem of unsafe nuclear power plants in eastern Europe, political responses to global warming, the protection of the stratospheric ozone layer, the reduction of long-range transboundary air pollution in Europe, the prevention of pollution of the oceans, etc.

The course is open to all ETH students. Participation does not require previous coursework in the social sciences. After passing an end-of-semester test (requirement: grade 4.0 or higher) students will receive 3 ECTS credit points. The workload is around 90 hours (meetings, reading assignments, preparation of test).

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

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

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

Prerequisites / notice
None

851-0594-00L International Environmental Politics W 3 credits 2V T. Bernauer

Objective
The objectives of this course are (1) to gain an overview of relevant questions in the area of international environmental politics from a scientific viewpoint; (2) learn how to identify interesting/innovative questions concerning this policy area and how to answer them in a methodologically sophisticated way; (3) gain an overview of important global and regional environmental problems.

Content
This course deals with how and why international cooperation in environmental politics emerges, and under what circumstances such cooperation is effective and efficient. Based on theories of international political economy and theories of government regulation various examples of international environmental politics are discussed: the management of international water resources, the problem of unsafe nuclear power plants in eastern Europe, political responses to global warming, the protection of the stratospheric ozone layer, the reduction of long-range transboundary air pollution in Europe, the prevention of pollution of the oceans, etc.

851-0738-01L The Role of Intellectual Property in Daily Routine: A Practical Introduction A W 2 credits 2V C. Soltmann

Objective
The lecture gives an overview of the fundamental aspects of intellectual property, which plays an important role in the daily routine of engineers. The lecture aims to make participants aware of the various methods of protection and to put them in a position to use this knowledge in the workplace.

Content
In recent years, knowledge about intellectual property has become increasingly important for engineers. Both in production and distribution and in research and development, engineers are increasingly being confronted with questions concerning the patenting of technical inventions and the use of patent information.

The lecture will acquaint students with practical aspects of intellectual property and enable them to use the acquired knowledge in their future professional life.

Topics covered during the lecture will include:
- The importance of innovation in industrialised countries
- An overview of the different forms of intellectual property
- The protection of technical inventions and how to safeguard their commercialisation
- Patents as a source of technical and business information
- Practical aspects of intellectual property in day-to-day research, at the workplace and for the formation of start-ups.

Case studies will illustrate and deepen the topics addressed during the lecture.

Prerequisites / notice
None

851-0252-02L Introduction to Cognitive Science W 3 credits 2V V. Schinazi, L. Konieczny, T. Thrash

Objective
Cognitive Science views human cognition as information processing and provides an inter-disciplinary integration of approaches from cognitive psychology, informatics (e.g., artificial intelligence), neuroscience and anthropology among others. The lectures provide an overview of basic mechanisms of human information processing and various application domains. A focus will be on matters of knowledge acquisition, representation and usage in humans and machines. Models of human perception, reasoning, memory and learning are presented and students will learn about experimental methods of investigating and understanding human cognitive processes and representation structures.

851-0738-00L Intellectual Property: Introduction W 2 credits 2V M. Schweizer

Objective
The students shall obtain the following competence:
- They shall obtain a working knowledge on the legal aspects involved in setting up and managing an enterprise.
- They shall be acquainted with corporate functions as contracting, negotiation, claims management and dispute resolution.
- They shall be familiar with the issues of corporate compliance, i.e. the system to ascertain that all legal and ethical rules are observed.
- They shall be able to contribute to the legal management of the company and to discuss legal issues.
- They shall have an understanding of the law as a part of the corporate strategy and as a valuable ressource of the company.
Abstract
The course provides an introduction to Swiss and European intellectual property law (trademarks, copyright, patent and design rights). Aspects of competition law are treated insofar as they are relevant for the protection of intellectual creations and source designations. The legal principles are developed based on current cases.

Objective
The aim of this course is to enable students at ETH Zurich to recognize which rights may protect their creations, and which rights may be infringed as a result of their activities. Students should learn to assess the risks and opportunities of intellectual property rights in the development and marketing of new products. To put them in this position, they need to know the prerequisites and scope of protection afforded by the various intellectual property rights as well as the practical difficulties involved in the enforcement of intellectual property rights. This knowledge is imparted based on current rulings and cases.

Another goal is to enable the students to participate in the current debate over the goals and desirability of protecting intellectual creations, particularly in the areas of copyright (keywords: fair use, Creative Commons, Copyleft) and patent law (software patents, patent trolls, patent thickets).

851-0585-15L Complexity and Global Systems Science
Prerequisites: solid mathematical skills
Particularly suitable for students of D-ITET, D-MAVT
Abstract
This course discusses complex technoc-socio-economic systems, their counter-intuitive behaviors, and how their theoretical understanding empowers us to solve some long-standing problems that are currently bothering the world.

Objective
Participants should learn to get an overview of the state of the art in the field, to present it in a well understandable way to an interdisciplinary scientific audience, to develop models for open problems, to analyze them, and to defend their results in response to critical questions. In essence, participants should improve their scientific skills and learn to think scientifically about complex dynamical systems.

Content
This course starts with a discussion of the typical and often counter-intuitive features of complex dynamical systems such as self-organization, emergence, (sudden) phase transitions at " tipping points", multi-stability, systemic instability, deterministic chaos, and turbulence. It then discusses phenomena in networked systems such as feedback, side and cascade effects, and the problem of radical uncertainty. The course progresses by demonstrating the relevance of these properties for understanding societal and, at times, global-scale problems such as traffic jams, crowd disasters, breakdowns of cooperation, crime, conflict, social unrests, political revolutions, bubbles and crashes in financial markets, epidemic spreading, and/or "tragedies of the commons" such as environmental exploitation, overfishing, or climate change. Based on this understanding, the course points to possible ways of mitigating technosoeco-economic-environmental problems, and what data science may contribute to their solution.

851-0306-05L Literature and Technology - Simulations, Prototypes, Machines
Prerequisites: solid mathematical skills
Particularly suitable for students of D-ITET, D-MAVT, D-MATL
Abstract
Literature about technology transposes models, products and procedures of scientific progress into the logic of poetry. This literature converts not only technology into fiction, but it also creates new cultural and social contextualisations, which reveal alternative readings of configurations of knowledge.

Objective
Students are familiar with different relations between literature and technology. They can verbalise and analyse central contents.

Content
Im Seminar lesen wir unter anderem Texte von E.T.A. Hoffmann, Franz Kafka, Georg Kaiser und Max Frisch.

851-0551-03L Postal Knowledge and the History of Digital Societies
Prerequisites: solid mathematical skills
Particularly suitable for students of D-ARCH, D-BAUG, D-MATH, D-HEST, D-INFK, D-ITET, D-MAVT
Abstract
In the second half of the 20th century, postal services have dramatically changed. Communication today is computer-based. The lecture offers problem oriented insights into this sociotechnical process of translation.

Objective
Students become familiar with the mutual interdependence of social and technological change that characterises the history of computing and communication.

Content

Data: 06.03.2019 12:57  Autumn Semester 2016  Page 662 of 1571
Since antiquity philosophy reflects about and evaluates technology. The technical developments in the 19th and 20th century have led to a critical reflection on the modern images of mathematics. These mathematical innovations did not only contribute to a progress amassing more and more knowledge. They very often changed how mathematicians conceived of their discipline. Even a contribution to a specific research question that appears at first sight to be minor can sometimes establish new connections to other fields, found a whole research field of its own or introduce new methods thereby changing the whole image of mathematics in the same way that a small addition to a picture can alter radically what we take it to represent.

The lecture series "Images of Mathematics" deals with a few moments in the history of the scientific discipline since the middle of the 19th century when the image of mathematics changed. In particular, it focuses on the consequences of the fact that in the 19th century mathematics started to not only reflect on their own conceptual and methodological foundations in a general manner (which had been done since the dawn of mathematics and was especially a philosophical task), but to formalize them in a strict, mathematical way: the objects of mathematics, its logical language and its proof procedures. Through Cantor's set theory, the mathematical treatment of logic since Boole and especially through Frege and the formalization of its axioms in a wide ranging discussion involving Zermelo, Fraenkel and others, this self-reflexive stance came to the fore. Yet, the deeper mathematics dug into its foundations, the more radical the problems became. Finally, the optimistic Hilbert program of laying the foundation of mathematics within mathematics and of proving its own consistency as well as its completeness contributed to clarifying of the foundation of mathematics primarily insofar as it was doomed to failure. Gödel proved his famous incompleteness theorems and thereby dismissed at the same time the formalist attempt to reduce mathematical truth to logical provability. His work resulted in detailed insights in the precariousness of the foundation of mathematics and further numerous of productive consequences within mathematics.

Moreover, Gödel's theorems open many far-reaching and intriguing questions in view of our image of mathematics, questions concerning the conception of mathematical practice and knowledge, the limits of calculability of mathematics and the possible role of computability and machines in mathematics, the relation between the logical proof procedures and the involved intuitive aspects. In short, the image of mathematics is not as static as we sometimes expect it to be, it was radically redrawn by the mathematicians of the 20th century and has since then again been open to diverging interpretations.

The aim of the course is to provide participants with an overview of international security politics with a special focus on dual-use technologies. Students will analyze the character of dual-use security risks and of risk-based security strategies and instruments. Thematic areas include the nuclear non-proliferation regime, biological and chemical weapons conventions, missile proliferation, the nuclear programs of Iran and North Korea, cyber and space technologies, as well as robotics and nanotechnology.

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The course provides an overview of the security implications of so-called "dual-use" technologies, i.e. technologies that can be used for both peaceful and military aims. The course will also cover various policies - in particular arms control - that are discussed and applied by the international community in dealing with such dual-use technologies.

Participants should gain a solid understanding of security challenges stemming from the use and control of dual-use technologies. In addition, the students should become aware of how researchers can deal with sensitive knowledge regarding research transparency and control.

The aim of the course is to provide participants with an overview of international security politics with a special focus on dual-use technologies. Students will analyze the character of dual-use security risks and of risk-based security strategies and instruments. Thematic areas include the nuclear non-proliferation regime, biological and chemical weapons conventions, missile proliferation, the nuclear programs of Iran and North Korea, cyber and space technologies, as well as robotics and nanotechnology.

Participants are expected to study the compulsory texts provided at the beginning of the semester via the online platform Moodle. An online learning platform serves as a supplement to the course.
At the heart of the discourse is the handling of digital goods and intellectual property in society. Digitization and the Internet allow handling digital goods and intellectual property in society.

2 credits

A. Diekmann

Learn the fundamentals, models, and logic of thinking about game theory.

Digital Sustainability in the Knowledge Society

Particularly suitable for students of D-INFK, D-ITET, D-MATL, D-MAVT, D-MTEC, D-USYS.

How do various interest groups influence the methods of production, distribution, and use of digital resources? Current models focusing on strong intellectual property rights are contrasted with open models like, e.g., Open Source/Content/Access. The course discusses consequences from different models and introduces «digital sustainability» as an alternative vision for society.

At the heart of the discourse is the handling of digital goods and intellectual property in society. Digitization and the Internet allow handling digital goods and intellectual property in society.

- characterize the nature of digital goods vs. physical goods
- critique the basic concepts of copyright and patent rights
- explain the political/legal and economic differences between proprietary and open approaches to the production and use of digital goods
- using an example, explain the meaning of digital sustainability and argue why it is relevant for a knowledge society
- transfer the ideas of the free/open source software model to other digital goods (e.g., open content, open access)

Weitere Informationen unter https://www.tg.ethz.ch/de/programme/
## Content

Technical reality: Within minutes you can make perfect copies of high-value digital goods of knowledge or culture (as text, audio, video, image or software) and distribute them around the globe -- for free. «Digitization plus Internet» allows for the first time in humankind's history the (theoretically) free access and global exchange of knowledge at minimal cost. A tremendous opportunity for societal development, in north and south. «Cool, so what's the problem?»

The problem is, that this reality poses a fundamental threat to today's business model of the knowledge and culture industries (starting from the music label and Hollywood, via publishers, up to software vendors). Powerful commercial interests are at stake as «knowledge» (the fourth factor of production) will become ever more important in the 21st century. Accordingly, «piracy» and «file-sharing» are attacked with all means. At the core lies the question about the design of property in digital assets. For that, we apply a concept of «intellectual property», which is new several hundred years old and does not address digital reality in an adequate way, sometimes leading to absurd situations. Its original goal seems to get forgotten: to help society develop by spreading knowledge as much as possible.

Using the PC becomes the new cultural technique of the 21st century. In contrast to «reading, writing and arithmetics», this new cultural technique cannot exist in isolation, but depends on a hard- and software infrastructure. This dependency extends to the provider of the infrastructure, who can define technical rules, which can take away or restrict the user's freedom. Even advanced users may have difficulties in recognizing these, often hidden, restrictions and in evaluating their societal relevance. But exactly these invisible consequences we need to understand and investigate, because they decide about access, distribution and usage of digital knowledge.

Comparative to the environmentalist movement of the 60s and 70s, a growing political movement for «Free Software» exists today, with «GNU/Linux» as its most popular symbol. The movement fights against treating software code as private property but as a central cultural good available to all without private interests. Based on the success of the Free Software movement, new initiatives extend the concepts to other domains (e.g. scientific knowledge, music)...

As a «teaser» to the lecture, you are invited to read the essay «ETH Zurich - A Pioneer in Digital Sustainability!». It can be downloaded from www.essays2020.ethz.ch.

Data: 06.03.2019 12:57

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credit Hours</th>
<th>Type</th>
<th>Objective</th>
</tr>
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<tbody>
<tr>
<td>851-0703-00L</td>
<td>2 credits</td>
<td>W</td>
<td>O. Streiff Gnoßpft</td>
</tr>
<tr>
<td>851-0306-05L</td>
<td>3 credits</td>
<td>W</td>
<td>E. Edelmann-Ohler</td>
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<tr>
<td>851-0738-00L</td>
<td>2 credits</td>
<td>W</td>
<td>M. Schweizer</td>
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<tr>
<td>851-0125-51L</td>
<td>3 credits</td>
<td>W</td>
<td>M. Hampé</td>
</tr>
</tbody>
</table>
Objective

On the one hand models of machines had a heuristic value in research on man, e.g. in Harvey's discovery of blood circulation in the 17th century or in brain research in the 20th century. On the other hand these models were always criticised, sometimes polemically, because they are supposedly not adequate for man.

Students should learn about the connections between the history of anthropology and technology and be able at the end of the course to evaluate the critical philosophical arguments that are connected with the metaphor of the machine.

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853-0060-00L

Course Issues in Security Policy

W 3 credits 2V A. Wenger, O. Thrüner

Abstract

This course provides an overview of the security implications of so-called "dual-use" technologies, i.e. technologies that can be used for both peaceful and military aims. The course will also cover various policies - in particular arms control - that are discussed and applied by the international community in dealing with such dual-use technologies.

Objective

Participants should gain a solid understanding of security challenges stemming from the use and control of dual-use technologies. In addition, the students should become aware of how researchers can deal with sensitive knowledge regarding research transparency and control.

Content

The aim of the course is to provide participants with an overview of international security politics with a special focus on dual-use technologies. Students will analyze the character of dual-use security risks and of risk-based security strategies and instruments. Thematic areas include the nuclear non-proliferation regime, biological and chemical weapons conventions, missile proliferation, the nuclear programs of Iran and North Korea, cyber and space technologies, as well as robotics and nanotechnology.

Lecture notes

The procedure for accumulating CP will be explained at the start of term.

Prerequisites / notice

An online learning platform serves as a supplement to the course.

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853-0047-01L

World Politics Since 1945: The History of International Relations (Without Exercises)

W 3 credits 2V A. Wenger

Abstract

This lecture series provides students with an overview of the development of international relations since the end of World War II. The first part of the series deals with the development of and changes in Cold War security policy structures. The second part deals with the period after the transformation of 1989/91; the focus here is on current issues in international security policy.

Objective

By the end of the semester, participants should have a solid knowledge of the history and theoretical foundations of International Relations since the end of the Second World War.

Content

cf. “Diploma Supplement”

Literature


Prerequisites / notice

The lecture is being supported by a website on Moodle. If you have any questions, please contact Lukas Meyer, lukas.meyer@sipo.gess.ethz.ch.

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701-0703-00L

Environmental Ethics

W 2 credits 2V M. Huppenbauer

Abstract

The lecture begins with an introduction to applied ethics in general. The main focus is on environmental ethics. Students learn to handle important concepts and positions of environmental ethics. They achieve a deeper understanding of these concepts and positions in applying them to ecological problems and discussing them in case studies.

Objective

On completion of this lecture course you will have acquired the ability to identify and process general and environmental ethical problems. You will be capable of recognising and analysing environmental ethical problems and of working towards a solution. You will have acquired a fundamental knowledge of standpoints and arguments to be found within the field of environmental ethics and will have practised these in small case studies.

Content

- Introduction to general and applied ethics.
- Overview and discussion of ethical theories relevant to the environment.
- Familiarisation with various basic standpoints within environmental ethics.
- Cross-section topics, such as sustainability, intergenerational justice, protection of species, etc.
- Practising of newly acquired knowledge in case studies. (protection of species, climate change, etc.)

Lecture notes

Summarised lecture notes will be distributed, including the most important theories and keywords; reading list.

Literature

- Andrew Light/Holmes Rolston III, Environmental Ethics. An Anthology, 2003
- John O'Neill et al., Environmental Values, 2008
- Klaus Peter Rippe, Ethik im ausserhumanen Bereich, Paderborn (mentis) 2008
- General introductions:
  - Marcus Düwell et. al (Hrsg.), Handbuch Ethik, 2. Auflage, Stuttgart (Metzler Verlag), 2006
  - Johann S. Ach et. al (Hrsg.), Grundkurs Ethik 1. Grundlagen, Paderborn (mentis) 2008

Prerequisites / notice

The procedure for accumulating CP will be explained at the start of term.

I expect participants to be motivated and contribute to discussions, keeping the course interesting and lively.

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701-0791-00L

Environmental History - Introduction and Overview

W 2 credits 2V D. Speich Chassé

Abstract

Our society faces a serious ecological crisis. Of what historical dimension is this crisis? How have human societies already in earlier times changed their environment, and, consequently, perhaps also ours? What were the main ecological challenges for societies and how did they change over time? And how did societies adapt to changing environmental conditions?

Objective

Introduction into environmental history; survey of long-term development of human-nature-interrelations; discussion of selected problems. Improved ability to assess current problems from a historical perspective and to critically interrogate one’s own standpoint.

Lecture notes


Literature

Uekötter, Frank (Ed.) 2010. The turning points of environmental history, Pittsburgh: University of Pittsburgh Press.


Prerequisites / notice

Students are asked to write an exam during the second last session (11.12.2015).

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701-0985-00L

Social Intercourse with Current Environmental Risks

W 1 credit 1V B. Nowack, C. M. Som-Koller

Abstract

The lecture treats the social intercourse with risks of technical systems. The notion of risk and the perception of risk are discussed by case studies (e.g. nanotechnology) and socio-political instruments for decision-making are presented. Methods are presented that can be applied to deal with environmental risks and how they can be used for sustainable innovation.
Within minutes you can make perfect copies of high-value digital goods of knowledge or culture (as text, audio, video,...) on technical reality: The problem is, that this reality poses a fundamental threat to today's business model of the knowledge and culture industries (starting from the music label and Hollywood, via publishers, up to software vendors). Powerful commercial interests are at stake as «knowledge» (the fourth factor of production) will become ever more important in the 21st century. Accordingly, «piracy» and «file-sharing» are attacked with all means. At the core lies the question about the design of property in digital assets. For that, we apply a concept of «intellectual property», which is several hundred years old and does not address digital reality in an adequate manner, sometimes leading to absurd situations. Its original goal seems to get forgotten: to help society develop by spreading knowledge as much as possible.

As a «teaser» to the lecture, you are invited to read the essay «ETH Zurich - A Pioneer in Digital Sustainability!». It can be downloaded from the website starting from September. Stay tuned.

- Getting acquainted to the extended risk concept
- Evaluation of the risks caused by technology within the societal context
- Knowledge about the mode science and society handle current environmental risks (examples gene- and nanotechnology)
- Knowledge about handling risks (e.g. precautionary principle, protection goal, damage definition, ethics)
- Risks and technical systems (risk categories, risk perception, risk management)
- Illustration with case studies (nanotechnology)
- Implementation (politics, science, media, etc.)
- Decision making (technology assessment, cost/benefit analysis etc.)
- The role of the media
- prospects for future developments

The lecture is held biweekly (for 2 hours). The dates are 26.9., 3.10. (out of schedule), 24.10, 7.11, 21.11, 5.12, 19.12

Prerequisites /
notice

The lecture will consist of supervised programming exercises in a computer pool. Credit points are finally earned for the implementation of a mathematical model from the sociological literature in MATLAB and the documentation in a seminar thesis.

Lecture content

This course introduces first the basic functionalities and features of the mathematical software package MATLAB, such as the simple operations with matrices and vectors, differential equations, statistical tools, the graphical representation of data in various forms, and video animations of spatio-temporal data. With this knowledge, students are expected to implement themselves in MATLAB, models of various social processes and systems, including agent-based models, e.g. models of interactive decision making, group dynamics, human crowds, or game-theoretical models.

Part of this course will consist of supervised programming exercises in a computer pool. Credit points are finally earned for the implementation of a mathematical model from the sociological literature in MATLAB and the documentation in a seminar thesis.

Lecture notes

Copies of slides and selected documents will be distributed

Content

- Getting acquainted to the extended risk concept
- Evaluation of the risks caused by technology within the societal context
- Knowledge about the mode science and society handle current environmental risks (examples gene- and nanotechnology)
- Knowledge about handling risks (e.g. precautionary principle, protection goal, damage definition, ethics)
- Risks and technical systems (risk categories, risk perception, risk management)
- Illustration with case studies (nanotechnology)
- Implementation (politics, science, media, etc.)
- Decision making (technology assessment, cost/benefit analysis etc.)
- The role of the media
- prospects for future developments
Further literature, in particular regarding computer models in the social sciences, will be provided in the course.

Prerequisites / notice

The number of participants is limited to the size of the available computer teaching room. The MATLAB code related to the seminar thesis should be well enough documented for further use by others and must be handed over to the Chair of Sociology, in particular of Modeling and Simulation, for further use and unrestricted use.

851-0125-SBL

Philosophy of the Environmental Sciences: An Introduction

Particularly suitable for students of D-ARCH, D-BSSE, D-CHAB, D-MTEC, D-USYS

A. Schwarz

Abstract

Environmental knowledge and management is quite common in different research fields and in everyday practice. We will be identifying those concepts, objects and methods that mainly construe what might be called the core of the environmental sciences. This will be done by using different philosophical tools and approaches.

Objective

The environmental sciences cover a wide range of scientific practices and objects and accordingly afford different kinds of scientific knowledge. Additionally, there is an important interplay between the scientific and the societal sphere. In this seminar we will examine likewise central and widespread concepts such as sustainable development or resilience by using philosophical tools that will allow to probe the different uses of those concepts, their semantic range in terms of historical depth and semantic fields and finally their logical coherence. Another important topic is the philosophical investigation of methods and objects that can be identified in the environmental sciences. Those methods are for instance Life Cycle Assessment or Adaptive Ecosystem Management, technological objects may be a wind engine or a hydropower plant. The latter raise questions of how renewable energies can be assessed and valued, including the more general issue of how values and norms can be embedded in technological objects. This leads us to the third and last complex of topics that focus on current deliberations about possible new ways of existence in the age of the Anthropocene and as a consequence the formation of adequate life styles in our societies. This refers to issues in philosophical and social anthropology and the challenge of climate change.

363-1050-00L

Conference of Disarmament: Simulation of Negotiations

Does not take place this semester.

M. Ambühl

Abstract

The Global Studies Institute (University of Geneva) is organizing a simulation seminar on nuclear disarmament in collaboration with the Chair of Negotiation and Conflict Management (ETH), experts from the United Nations Institute for Disarmament Research and the Geneva Center for Security Policy.

Objective

The simulation is conducted in collaboration with experts and students during a two days seminar at the University of Geneva.

Content

Students will have the possibility to participate in simulated diplomatic negotiations and to analyse and assess the negotiation logic behind the situations. They should gain insight in the basic information on disarmament issues and on the functioning of the Conference on Disarmament as well as on negotiation techniques in general.

The simulation project is intended for Master's or Doctoral students of the Global Studies Institute (GSI) of the University of Geneva, of the ETH and for interested students of the Centre for Security Policy (GCSP). The simulation will be in French and English and is conducted by Prof. Calmy-Rey, former President of Switzerland.

In the lectures, students will be provided with basic information on disarmament issues and on the functioning of the Conference on Disarmament as well as on negotiation techniques in general. Students will take the role of negotiators in the simulation (including the heads of the delegations), of keeper of the minutes or of observers and analysts.

Students will co-develop their mandates for the negotiation and be assisted by experts that are specialized in international negotiations as well as in the topic of disarmament. The negotiation tables will be chaired by former diplomats. Representatives of diplomatic missions in Geneva will play the role of the "Capitals" to which the heads of delegations will have to give account of the ongoing negotiations.

More details on the program, timetable, reading lists and performance assessment will be published here: https://chamilo.unige.ch/home/courses/M165/?id_session=0

The simulation will take place on the 26 and 27 November 2015 at the University of Geneva.

Languages: English and French

Dates/Time/Location (GE = University of Geneva)

22 Sept. | ETH HG D 22 | 10:15-12:00 | Introduction

29 Sept. | GE Uni Mail Salle 1170 | 10:15-12:00 | Introduction to Negotiation Techniques (Dr. Vitalija Butenko and Dr. Sibylle Zürcher, ETH)

6 Oct. | ETH HG D 16.2 | 10:15-12:00 | Distribution of the roles, composition of the negotiation tables, preparation of mandates for the HA (humanitarian approach)

13 Oct. | ETH HG D 22 | 10:15-12:00 | Preparation of the mandates for the FMCT (Fissile Material Cut-off Treaty)

20 Oct. | GE Uni Mail Salle 1170 | 10:15-12:00 | No session: Students deepen and summarize their mandates on one page (A4)

27 Oct. | GE Uni Mail Salle 1170 | 10:15-12:00 | Discussion of the Mandates I (FMCT)

1 Nov. | GE Uni Mail Salle 1170 | 10:15-12:00 | Discussion of the Mandates II (HA)

17 Nov. | GE Uni Mail Salle 1170 | 10:15-12:00 | Preparatory Meeting

26 Nov. | GE Salles 407 et 408 | 10:00-18:00 | Simulation at Uni Dufour

1 Dec. | GE Uni Mail Salle 1170 | 10:15-12:00 | Discussion of the results

Note:

The participation in the simulation on 26. and 27. November in Geneva is necessary.

The two hours lectures on the 22. September, 6. and 13. October have to be attended in Zürich via conference call (ETH HG D 16.2). The other lectures during the seminar can be attended via Skype.

To get the 3 ECTS, students have to participate at the 2 days simulation in Geneva, attend the 3 mandatory lecture parts via conference call an Zürich and write a report of 5 pages at the end of the course.

(Technical note for registration: At this stage all registered students are on the waiting list)

J.E. Sturm

Principles of Macroeconomics

This course examines the behaviour of macroeconomic variables, such as gross domestic product, unemployment and inflation rates. It tries to answer questions like: How can we explain fluctuations of national economic activity? What can economic policy do against unemployment and inflation. What significance do international economic relations have for Switzerland?

Objective

This lecture will introduce the fundamentals of macroeconomic theory and explain their relevance to every-day economic problems.

Further details on the program, timetable, reading lists and performance assessment will be published here: https://chamilo.unige.ch/home/courses/M165/?id_session=0

The simulation will take place on the 26 and 27 November 2015 at the University of Geneva.

Languages: English and French

Dates/Time/Location (GE = University of Geneva)

22 Sept. | ETH HG D 22 | 10:15-12:00 | Introduction

29 Sept. | GE Uni Mail Salle 1170 | 10:15-12:00 | Introduction to Negotiation Techniques (Dr. Vitalija Butenko and Dr. Sibylle Zürcher, ETH)

6 Oct. | ETH HG D 16.2 | 10:15-12:00 | Distribution of the roles, composition of the negotiation tables, preparation of mandates for the HA (humanitarian approach)

13 Oct. | ETH HG D 22 | 10:15-12:00 | Preparation of the mandates for the FMCT (Fissile Material Cut-off Treaty)

20 Oct. | GE Uni Mail Salle 1170 | 10:15-12:00 | No session: Students deepen and summarize their mandates on one page (A4)

27 Oct. | GE Uni Mail Salle 1170 | 10:15-12:00 | Discussion of the Mandates I (FMCT)

1 Nov. | GE Uni Mail Salle 1170 | 10:15-12:00 | Discussion of the Mandates II (HA)

17 Nov. | GE Uni Mail Salle 1170 | 10:15-12:00 | Preparatory Meeting

26 Nov. | GE Salles 407 et 408 | 10:00-18:00 | Simulation at Uni Dufour

1 Dec. | GE Uni Mail Salle 1170 | 10:15-12:00 | Discussion of the results

Note:

The participation in the simulation on 26. and 27. November in Geneva is necessary.

The two hours lectures on the 22. September, 6. and 13. October have to be attended in Zürich via conference call (ETH HG D 16.2). The other lectures during the seminar can be attended via Skype.

To get the 3 ECTS, students have to participate at the 2 days simulation in Geneva, attend the 3 mandatory lecture parts via conference call an Zürich and write a report of 5 pages at the end of the course.

(Technical note for registration: At this stage all registered students are on the waiting list)
I. Günther

This course introduces the foundations of game theory. It focuses on models of social interaction, conflict and cooperation, the emergence of institutions and norms, social dilemmas and cooperation. In the course, you learn to choose appropriate analysis strategies for particular research questions and to perform statistical analyses with the statistical software Stata.

Abstract

This course introduces students to key statistical methods for analyzing social science data with a special emphasis on causal inference and policy evaluation. Students learn to choose appropriate analysis strategies for particular research questions and to perform statistical analyses with the statistical software Stata.

Objective

Students should:
- develop a sound understanding of linear and logit regression
- acquire strategies to test causal hypotheses using regression analysis and/or experimental methods
- be able to formulate and implement a regression model for a particular policy question and a particular type of data
- be able to critically interpret results of applied statistics, in particular, regarding causal inference

Content

The topics covered in the first part of the course are a revision of basic statistics and linear and logit regression analysis. The second part of the course focuses on causal inference and introduces methods such as panel data analysis, difference-in-difference methods, instrumental variable estimation, and randomized controlled trials most used for policy evaluation. The course shows how the various methods differ in terms of the required identifying assumptions to infer causality as well as the data needs.

Lecture notes

The course webpage (to be found at https://moodle-app2.let.ethz.ch/course/view.php?id=2467) contains announcements, course information and lecture slides.

Literature


We advise you to also buy access to Aplia. This internet platform will support you in learning for this course. To save money, you should buy the book together with Aplia. This is sold as a bundle (ISBN: 9781473715998).

Besides this textbook, the slides and lecture notes will cover the content of the lecture and the exam questions.

860-0006-00L Applied Statistics and Policy Evaluation

Number: 860-0006-00L

W 3 credits
3G I. Günther, K. Harttgen

Number of participants limited to 20.

Science, Technology, and Policy MSC and MAS in Development and Cooperation have priority.

Objective

Students should:
- be able to use the statistical software STATA for data analysis
- be able to formulate and implement a regression model for a particular policy question and a particular type of data
- be able to critically interpret results of applied statistics, in particular, regarding causal inference

Content

The course covers topics in the interface of policy, technology and society. Students learn to analyse and evaluate different philosophies of technology (compensation, objectification, externalisation). For credit point a critical protocol is to be written.

Lecture notes

These data sets will cover topics at the interface of policy, technology and society. Solving the assignments contributes to the final grade with a weight of 30%. Students are assisted in solving the assignments during the exercises session.

D-MAVT

851-0125-41L Introduction to Philosophy of Technology

Number: 851-0125-41L

W 3 credits
2V O. Müller

Introduction suitable for students of D-ITET, D-MATL, D-MAVT

Abstract

Since antiquity philosophy reflects about and evaluates technology. The technical developments in the 19th and 20th century have led to an autonomous philosophy of technology, which had become important also for other philosophical disciplines (e.g. in Heidegger's philosophy).

Objective

The course gives an overview on the philosophy of technology. Students should learn to analyse and evaluate different philosophies of technology (compensation, objectification, externalisation). For credit point a critical protocol is to be written.

851-0588-00L Introduction to Game Theory. Models and Experimental Studies

Number: 851-0588-00L

W 2 credits
2V A. Diekmann

Introduction suitable for students of D-MAVT, D-MATL

Abstract

This course introduces the foundations of game theory. It focuses on models of social interaction, conflict and cooperation, the emergence of cooperation and concepts of strategic decision-making behaviour. Examples, applications and the contrast between theory and empirical results are particularly emphasized.

Objective

Learn the fundamentals, models, and logic of thinking about game theory.

Apply game theory models to strategic interaction situations and critically assess game theory's capabilities through a wide array of experimental results.

Content


In der Vorlesung wird Wert darauf gelegt, Modelle an Beispielen zu demonstrieren und empirische Untersuchungen ("experimentelle Spieltheorie") vorzustellen.

Lecture notes

Siehe die angegebene Literatur, Diekmann, A. (2016) zur Einführung; die Folien der Vorlesung werden auf eine Webseite zur Vorlesung gestellt. Weiterführende Literatur wird in der Vorlesung angegeben.
The lecture slides will be presented on the course web page after each lecture.

This course introduces first the basic functionalities and features of the mathematical software package MATLAB, such as the simple operations with matrices and vectors, differential equations, statistical tools, the graphical representation of data in various forms, and video animations of spatio-temporal data. With this knowledge, students are expected to implement themselves in MATLAB, models of various social processes and systems, including agent-based models, e.g. models of interactive decision making, group dynamics, human crowds, or game-theoretical models.

Part of this course will consist of supervised programming exercises in a computer pool. Credit points are finally earned for the implementation of a mathematical model from the sociological literature in MATLAB and the documentation in a seminar thesis.

Further literature, in particular regarding computer models in the social sciences, will be provided in the course.

The number of participants is limited to the size of the available computer teaching room. The MATLAB code related to the seminar thesis should be well enough documented for further use by others and must be handed over to the Chair of Sociology, in particular of Modeling and Simulation, for further free and unrestricted use.

The lecture gives an overview of the fundamental aspects of intellectual property, which plays an important role in the daily routine of engineers. The lecture aims to make participants aware of the various methods of protection and to put them in a position to use this knowledge in the workplace.

Die folgenden Einführungen unterscheiden sich nach Anwendungen und Grad der Formalisierung. Zur Einführung kann man sich eines der folgenden Bücher ansehen, die ab Januar im Handapparat der D-GESS-Bibliothek stehen werden:


Weitere Literatur und Übungsaufgaben zum Download unter:

http://www.socio.ethz.ch/publications/spieltheorie

Prerequisites / notice

Um Missverständnisse zu vermeiden: Die Vorlesung ist für Hörerinnen und Hörer aller Departemente geeignet. (Nicht nur für D-MATL, D-MAVT)

851-0549-00L WebClass Introductory Course History of Technology W 3 credits 2V G. Hürlimann

Number of participants limited to 100.

Abstract

WebClass Introductory Course History of Technology is an introductory course to the history of technology. The students are challenged to discover how technological innovations take place within complex economical, political and cultural contexts. They get introduced into basic theories and practices of the field.

Objective

Students are introduced into how technological innovations take place within complex economical, political and cultural contexts. They get to know basic theories and practices of the field.

Content


Lecture notes


851-0585-04L Lecture with Computer Exercises: Modelling and Simulating Social Systems with MATLAB W 3 credits 2S D. Helbing, L. Sanders, O. Woolley

Number of participants limited to 70.

Abstract

This course introduces first the basic functionalities and features of the mathematical software package MATLAB, such as the simple operations with matrices and vectors, differential equations, statistical tools, the graphical representation of data in various forms, and video animations of spatio-temporal data. With this knowledge, students are expected to implement themselves in MATLAB, models of various social processes and systems, including agent-based models, e.g. models of interactive decision making, group dynamics, human crowds, or game-theoretical models.

Part of this course will consist of supervised programming exercises in a computer pool. Credit points are finally earned for the implementation of a mathematical model from the sociological literature in MATLAB and the documentation in a seminar thesis. Further literature, in particular regarding computer models in the social sciences, will be provided in the course.

The number of participants is limited to the size of the available computer teaching room. The MATLAB code related to the seminar thesis should be well enough documented for further use by others and must be handed over to the Chair of Sociology, in particular of Modeling and Simulation, for further free and unrestricted use.

851-0738-01L The Role of Intellectual Property in Daily Routine: A Practical Introduction A 2 credits 2V C. Soltmann

Particularly suitable for students of D-BAUG, D-ITET, D-MAVT

Abstract

The lecture gives an overview of the fundamental aspects of intellectual property, which plays an important role in the daily routine of engineers. The lecture aims to make participants aware of the various methods of protection and to put them in a position to use this knowledge in the workplace.
Objective

In recent years, knowledge about intellectual property has become increasingly important for engineers. Both in production and distribution and in research and development, engineers are increasingly being confronted with questions concerning the patenting of technical inventions and the use of patent information.

The lecture will acquaint students with practical aspects of intellectual property and enable them to use the acquired knowledge in their future professional life.

Topics covered during the lecture will include:
- The importance of innovation in industrialised countries
- An overview of the different forms of intellectual property
- The protection of technical inventions and how to safeguard their commercialisation
- Patents as a source of technical and business information
- Practical aspects of intellectual property in day-to-day research, at the workplace and for the formation of start-ups.

Case studies will illustrate and deepen the topics addressed during the lecture.

Prerequisites / notice

The lecture is in particular tailored to the needs of the following degree programs: Agricultural science, architecture, civil engineering, computational science and engineering, computer science, electrical engineering and information technology, environmental engineering, geomatic engineering and planning, interdisciplinary sciences, materials science, mathematics, mechanical engineering, physics.

For students of chemistry-related degree programs, the lecture 'Protecting inventions in chemistry' (851-0738-03) will be offered in the autumn semester.

851-0591-00L Digital Sustainability in the Knowledge Society

| Credits | 2 | 2V | M. M. Dapp |

Abstract

How do various interest groups influence the methods of production, distribution, and use of digital resources? Current models focusing on strong intellectual property rights are contrasted with open models like, e.g. Open Source/Content/Access. The course discusses consequences from different models and introduces «digital sustainability» as an alternative vision for society.

Objective

At the heart of the discourse is the handling of digital goods and intellectual property in society. Digitalization and the Internet allow handling knowledge in a way, which directly contrasts with the traditional understanding of “intellectual property” and the industries based on it. Starting from economic and legal basics, we compare proprietary and open/*free* models. Sustainable development as a concept is transferred to digital goods, taking into account the particular nature of digital stuff.

After the lecture, you should (hopefully) be able to
- characterize the nature of digital goods vs. physical goods
- critique the basic concepts of copyright and patent rights
- explain the legal/economic differences between proprietary and open approaches to the production and use of digital goods
- use an example, explain the meaning of digital sustainability and argue why it is relevant for a knowledge society
- transfer the ideas of the free/open source software model to other digital goods (e.g., open content, open access)

Content

Technical reality: Within minutes you can make perfect copies of high-value digital goods of knowledge or culture (as text, audio, video, image or software) and distribute them around the globe -- for free. «Digitalization plus Internet» allows for the first time in human kind's history the (theoretically) free access and global exchange of knowledge at minimal cost. A tremendous opportunity for societal development, in north and south. «Cool, so what’s the problem?»

The problem is, that this reality poses a fundamental threat to today's business model of the knowledge and culture industries (starting from the music label and Hollywood, via publishers, up to software vendors). Powerful commercial interests are at stake as «knowledge» (the fourth factor of production) will become ever more important in the 21st century. Accordingly, «piracy» and «file-sharing» are attacked with all means. At the core lies the question about the design of property in digital assets. For that, they apply a concept of «intellectual property», which is several hundred years old and does not address digital reality in an adequate manner, sometimes leading to absurd situations. Its original goal seems to get forgotten: to help society develop by spreading knowledge as much as possible.

Using the PC becomes the new cultural technique of the 21st century. In contrast to «reading, writing and arithmetic», this new cultural technique cannot exist in isolation, but depends on a hard- and software infrastructure. This dependency extends to the provider of the infrastructure, who can define technical rules, which can take away or restrict the user's freedom. Even advanced users may have difficulties in recognizing these, often hidden, restrictions and in evaluating their societal relevance. But exactly these invisible consequences we need to understand and investigate, because they decide about access, distribution and usage of digital knowledge.

Comparable to the environmentalist movement of the 60s and 70s, a growing political movement for «Free Software» exists today, with «GNU/Linux» as its most popular symbol. The movement fights against treating software code as private property but as a central cultural good available to all without private interests. Based on the success of the Free Software movement, new initiatives extend the concepts to other domains (e.g. scientific knowledge, music)... As a «teaser» to the lecture, you are invited to read the essay «ETH Zurich - A Pioneer in Digital Sustainability!». It can be downloaded from www.essays2030.ethz.ch.

More on teach.digisus.info starting from September. Stay tuned.

Lecture notes

Slides and other material (both usually in English) will be made available on a weekly basis as the lecture proceeds.

Literature

Content of the following books is covered (PDFs freely available online):

Prerequisites / notice

For administrative and didactic reasons (high level of interaction and credit group assignments on current hot topics), the number of participants is limited to 45. Of course, any interested person is invited to attend the lecture without doing the group assignment. The website is actively used for the participants is limited to 45.

851-0703-00L Introduction to Law

| Credits | 2 | 2V | O. Streiff Gnöpff |

Abstract

This class introduces students into basic features of the legal system. Fundamental issues of constitutional law, administrative law, private law and the law of the EU are covered.

Data: 06.03.2019 12:57  Autumn Semester 2016  Page 671 of 1571
### Objective
Students are able to identify basic structures of the legal system. They understand selected topics of public and private law and are able to apply the fundamentals in more advanced law classes.

### Content
- Basic concepts of law, sources of law.
- Private law: Contract law (particularly contract for work and services), tort law, property law.
- Public law: Human rights, administrative law, procurement law, procedural law.
- Insights into the law of the EU and into criminal law.

### Literature
- Jaap Hage, Bram Akkermans (Eds.), Introduction to Law, Cham 2014 (Online Resource ETH Library)
- Further documents will be available online (see https://moodle-app2.let.ethz.ch/course/view.php?id=2170).

### 851-0738-00L Intellectual Property: Introduction

<table>
<thead>
<tr>
<th>W</th>
<th>2 credits</th>
<th>2V</th>
<th>M. Schweizer</th>
</tr>
</thead>
</table>

**Abstract**
The course provides an introduction to Swiss and European intellectual property law (trademarks, copyright, patent and design rights). An overview of competition law is treated as well as they are relevant for the protection of intellectual creations and source designations. The legal principles are developed based on current cases.

**Objective**
The aim of this course is to enable students at ETH Zurich to recognize which rights may protect their creations, and which rights may be infringed as a result of their activities. Students should learn to assess the risks and opportunities of intellectual property rights in the development and marketing of new products. To put them in this position, they need to know the prerequisites and scope of protection afforded by the various intellectual property rights as well as the practical difficulties involved in the enforcement of intellectual property rights. This knowledge is imparted based on current rulings and cases.

Another goal is to enable the students to participate in the current debate over the goals and desirability of protecting intellectual creations, particularly in the areas of copyright (keywords: fair use, Creative Commons, Copyleft) and patent law (software patents, patent trolls, patent thickets).

### 851-0125-51L Man and Machine

<table>
<thead>
<tr>
<th>W</th>
<th>3 credits</th>
<th>2G</th>
<th>M. Hampe</th>
</tr>
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</table>

**Abstract**
The lecture gives an overview about the different Man-Machine-Relations since the 16th century. Different modells of machines will be important here: the clockwork, the steam engine and the computer.

**Objective**
On the one hand modells of machines had a heuristical value in research on man, e.g. in Harvey's discovery of blood circulation in the 17th century or in brain research in the 20th century. On the other hand these modells were always criticised, sometimes polemically, because they are supposedly not adequate for man.

Students should learn about the connections between the history of anthropology and technology and be able at the end of the course to evaluate the critical philosophical arguments that are connected with the metaphor of the machine.

### 851-0306-05L Literature and Technology - Simulations, Prototypes, Machines

<table>
<thead>
<tr>
<th>W</th>
<th>3 credits</th>
<th>2S</th>
<th>E. Edelmann-Oehler</th>
</tr>
</thead>
</table>

**Abstract**
Literature about technology transposes models, products and procedures of scientific progress into the logic of poetry. This literature converts not only technology into fiction, but it also creates new cultural and social contextualisations, which reveal alternative readings of configurations of knowledge.

**Objective**
Students are familiar with different relations between literature and technology. They can verbalise and analyse central contentions.

**Content**

### 851-0551-03L Postal Knowledge and the History of Digital Societies

<table>
<thead>
<tr>
<th>W</th>
<th>3 credits</th>
<th>2S</th>
<th>D. F. Zetti</th>
</tr>
</thead>
</table>

**Abstract**
In the second half of the 20th century, postal services have dramatically changed. Communication today is computerbased. The lecture offers problem oriented insights into this sociotechnical process of translation.

**Objective**
Students become familiar with the mutual interdependence of social and technological change that characterises the history of computing and communication.

**Content**

### 853-0047-01L World Politics Since 1945: The History of International Relations (Without Exercises)

<table>
<thead>
<tr>
<th>W</th>
<th>3 credits</th>
<th>2V</th>
<th>A. Wenger</th>
</tr>
</thead>
</table>

**Abstract**
This lecture series provides students with an overview of the development of international relations since the end of World War II. The first part of the series deals with the development of and changes in Cold War security policy structures. The second part deals with the period after the transformation of 1989/91; the focus here is on current issues in international security policy.

**Objective**
By the end of the semester, participants should have a solid knowledge of the history and theoretical foundations of International Relations since the end of the Second World War.

**Content**
- "Diploma Supplement"

**Literature**
- Reading:
  - Die lecure is being supported by a website on Moodle. If you have any questions, please contact Lukas Meyer, lukas.meyer@sipo.gess.ethz.ch.

**Prerequisites / notice**

### 701-0703-00L Environmental Ethics

<table>
<thead>
<tr>
<th>W</th>
<th>2 credits</th>
<th>2V</th>
<th>M. Huppenbauer</th>
</tr>
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</table>

**Abstract**
The lecture begins with an introduction to applied ethics in general. The main focus is on environmental ethics. Students learn to handle important concepts and positions of environmental ethics. They achieve a deeper understanding of these concepts and positions in applying them to ecological problems and discussing them in case studies.

**Objective**
On completion of this lecture course you will have acquired the ability to identify and process general and environmental ethical problems. You will be capable of recognising and analysing environmental ethical problems and of working towards a solution. You will have acquired a fundament knowledge of standpoints and arguments to be found within the field of environmental ethics and will have practised these in small case studies.
<table>
<thead>
<tr>
<th>Content</th>
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<tbody>
<tr>
<td>- Introduction to general and applied ethics.</td>
<td></td>
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<tr>
<td>- Overview and discussion of ethical theories relevant to the environment.</td>
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<tr>
<td>- Familiarisation with various basic standpoints within environmental ethics.</td>
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<tr>
<td>- Cross-section topics, such as sustainability, intergenerational justice, protection of species, etc.</td>
<td></td>
</tr>
<tr>
<td>- Practising of newly acquired knowledge in case studies (protection of species, climate change, etc.)</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Lecture notes</th>
<th>Summaries of the individual sessions will be distributed, including the most important theories and keywords; reading list.</th>
</tr>
</thead>
<tbody>
<tr>
<td>In the part of the course serving as an introduction to general and applied ethics, we shall be using the following textbook: Barbara Bleisch/Markus Huppenbauer: Ethische Entscheidungsfundung. Ein Handbuch für die Praxis, 2nd Edition Zürich 2014</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Literature</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>- Andrew Light/Holmes Rolston III, Environmental Ethics. An Anthology, 2003</td>
<td></td>
</tr>
<tr>
<td>- John O'Neill et al., Environmental Values, 2008</td>
<td></td>
</tr>
<tr>
<td>- Klaus Peter Rippe, Ethik im ausserhumanen Bereich, Paderborn (mentis) 2008</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Prerequisites / notice</th>
<th>The procedure for accumulating CP will be explained at the start of term. I expect participants to be motivated and contribute to discussions, keeping the course interesting and lively.</th>
</tr>
</thead>
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<table>
<thead>
<tr>
<th>701-0791-00L</th>
<th>Environmental History - Introduction and Overview</th>
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<tbody>
<tr>
<td>W</td>
<td>2 credits</td>
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</table>

<table>
<thead>
<tr>
<th>Abstract</th>
<th>Our society faces a serious ecological crisis. Of what historical dimension is this crisis? How have human societies already in earlier times changed their environment, and, consequently, perhaps also ours? What were the main ecological challenges for societies and how did they change over time? And how did societies adapt to changing environmental conditions?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective</td>
<td>Introduction into environmental history; survey of long-term development of human-nature-interrelations; discussion of selected problems.</td>
</tr>
</tbody>
</table>

| Lecture notes | Course material is provided on OLAT. |


<table>
<thead>
<tr>
<th>701-0985-00L</th>
<th>Social Intercourse with Current Environmental Risks</th>
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</thead>
<tbody>
<tr>
<td>W</td>
<td>1 credit</td>
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</table>

<table>
<thead>
<tr>
<th>Abstract</th>
<th>The lecture treats the social intercourse with risks of technical systems. The notion of risk and the perception of risk are discussed by case studies (e.g. nanotechnology) and socio-political instruments for decision-making are presented. Methods are presented that can be applied to deal with environmental risks and how they can be used for sustainable innovation.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective</td>
<td>- Getting acquainted to the extended risk concept; - Evaluation of the risks caused by technology within the societal context; - Knowledge about the mode science and society handle current environmental risks (examples gene- and nanotechnology); - Knowledge about handling risks (e.g. precautionary principle, protection goal, damage definition, ethics); Knowledge about possibilities for sustainable innovation</td>
</tr>
<tr>
<td>Content</td>
<td>- Risks and technical systems (risk categories, risk perception, risk management) - Illustration with case studies (nanotechnology) - Implementation (politics, science, media, etc.) - Decision making (technology assessment, cost/benefit analysis etc.) - The role of the media - prospects for future developments</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Lecture notes</th>
<th>Copies of slides and selected documents will be distributed</th>
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<tbody>
<tr>
<td>Prerequisites / notice</td>
<td>The lecture is held biweekly (for 2 hours). The dates are 26.9., 3.10. (out of schedule), 24.10, 7.11, 21.11, 5.12, 19.12</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>853-0725-00L</th>
<th>History Part One: Europe (The Cradle of Modernity, Britain ca. 1789-1939)</th>
</tr>
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<tbody>
<tr>
<td>W</td>
<td>3 credits</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Abstract</th>
<th>Using the concrete example of Britain, the &quot;cradle of modernity&quot;, this lecture offers a survey and analysis of the crucial historical transformations that engendered &quot;modernity&quot; in Europe from the late 18th to the mid 20th centuries.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective</td>
<td>At the end of this lecture course, students can: (a) highlight the most important changes in the &quot;long nineteenth century&quot; in Europe (b) explain their long-term effects; and (c) relate these changes to global developments.</td>
</tr>
<tr>
<td>Content</td>
<td>The thematic foci include: the economic and social consequences of the industrial revolution, the genesis of political ideologies and social movements, shifts in gender roles, colonialism and imperialism, as well as the emergence of consumerism and a &quot;leisure society.&quot;</td>
</tr>
</tbody>
</table>

| Lecture notes | Power Point Slides and sources will be made available at POLYBOX in the course of the semester. |

<table>
<thead>
<tr>
<th>Literature</th>
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<table>
<thead>
<tr>
<th>853-0735-10L</th>
<th>Business Law</th>
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</thead>
<tbody>
<tr>
<td>W</td>
<td>2 credits</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Abstract</th>
<th>The students shall obtain a basic knowledge about business law. They shall be able to recognize and evaluate issues in the area of business law and suggest possible solutions.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective</td>
<td>The students shall obtain the following competence: - They shall obtain a working knowledge on the legal aspects involved in setting up and managing an enterprise. - They shall be acquainted with corporate functions as contracting, negotiation, claims management and dispute resolution - They shall be familiar with the issues of corporate compliance, i.e. the system to ascertain that all legal and ethical rules are observed. - They shall be able to contribute to the legal management of the company and to discuss legal issues. - They shall have an understanding of the law as a part of the corporate strategy and as a valuable resource of the company.</td>
</tr>
</tbody>
</table>

| Lecture notes | A comprehensive script will be made available online on the moodle platform. |

<table>
<thead>
<tr>
<th>853-0060-00L</th>
<th>Current Issues in Security Policy</th>
</tr>
</thead>
<tbody>
<tr>
<td>W</td>
<td>3 credits</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Abstract</th>
<th>This course provides an overview of the security implications of so-called &quot;dual-use&quot; technologies, i.e. technologies that can be used for both peaceful and military aims. The course will also cover various policies - in particular arms control - that are discussed and applied by the international community in dealing with such dual-use technologies.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective</td>
<td>Participants should gain a solid understanding of security challenges stemming from the use and control of dual-use technologies. In addition, the students should become aware of how researchers can deal with sensitive knowledge regarding research transparency and control.</td>
</tr>
</tbody>
</table>
The aim of the course is to provide participants with an overview of international security politics with a special focus on dual-use technologies. Students will analyze the character of dual-use security risks and of risk-based security strategies and instruments. Thematic areas include the nuclear non-proliferation regime, biological and chemical weapons conventions, missile proliferation, the nuclear programs of Iran and North Korea, cyber and space technologies, as well as robotics and nanotechnology.

Participants are expected to study the compulsory texts provided at the beginning of the semester via the online platform Moodle. A reading list will be distributed at the beginning of the semester.

An online learning platform serves as a supplement to the course.

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
<th>Notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0585-15L</td>
<td>Complexity and Global Systems Science</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>D. Helbing, N. Antulov-Fantulin</td>
<td>Particularly suitable for students of D-ITET, D-MAVT</td>
</tr>
<tr>
<td>851-0144-20L</td>
<td>Philosophical Aspects of Quantum Physics</td>
<td>W</td>
<td>3</td>
<td>2S</td>
<td>N. Sieroka, R. Renner</td>
<td>Particularly suitable for students of D-CHAB, D-PHYS</td>
</tr>
<tr>
<td>851-0157-69L</td>
<td>History of Astronomy</td>
<td>W</td>
<td>3</td>
<td>2S</td>
<td>S. Mastorakou</td>
<td>Die Veranstaltung ist ausgebucht</td>
</tr>
</tbody>
</table>

Particularly suitable for students of D-CHAB, D-PHYS

Prerequisites / notice

Mathematical skills can be helpful

<table>
<thead>
<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
<th>Notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0144-19L</td>
<td>Philosophy of Time</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>N. Sieroka</td>
<td>Does not take place this semester.</td>
</tr>
</tbody>
</table>

Prerequisites / notice

An online learning platform serves as a supplement to the course.

Particularly suitable for students of D-MAVT, D-MAF, D-ITET, D-MTEC, D-PHYS

Content

Part of the course reflects on methods and contents from physics, neuroscience/cognitive science, and logic.

Mathematical skills can be helpful

Particularly suitable for students of D-MAVT, D-MAF, D-ITET, D-MTEC, D-PHYS

Prerequisites / notice

An online learning platform serves as a supplement to the course.

Particularly suitable for students of D-MAVT, D-MAF, D-ITET, D-MTEC, D-PHYS

Content

Part of the course will consist of supervised programming exercises in a computer pool. Credit points are finally earned for the implementation of a mathematical model from the sociological literature in MATLAB and the documentation in a seminar thesis.

Lecture notes

The lecture slides will be presented on the course web page after each lecture.

Data: 06.03.2019 12:57  Autumn Semester 2016  Page 674 of 1571
Further literature, in particular regarding computer models in the social sciences, will be provided in the course.

The number of participants is limited to the size of the available computer teaching room. The MATLAB code related to the seminar thesis should be well enough documented for further use by others and must be handed over to the Chair of Sociology, in particular of Modeling and Simulation, for further free and unrestricted use.

**D-USYS**

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0125-5BL</td>
<td>Philosophy of the Environmental Sciences: An Introduction</td>
<td>W</td>
<td>3</td>
<td>2S</td>
<td>A. Schwarz</td>
</tr>
<tr>
<td>851-0591-00L</td>
<td>Digital Sustainability in the Knowledge Society</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>M. M. Dapp</td>
</tr>
</tbody>
</table>

**Literature**

2. MATLAB kompakt, Wolfgang Schweizer, (Oldenbourg, 2006)

**Prerequisites / notice**

The environmental sciences cover a wide range of scientific practices and objects and accordingly afford different kinds of scientific knowledge. Additionally, there is an important interplay between the scientific and the societal sphere. In this seminar we will examine likewise central and widespread concepts such as sustainable development or resilience by using philosophical tools that will allow to probe the different uses of those concepts, their semantic range in terms of historical depth and semantic fields and finally their logical coherence. Another important topic is the philosophical investigation of methods and objects that can be identified in the environmental sciences. Those methods are for instance Life Cycle Assessment or Adaptive Ecosystem Management, technological objects may be a wind engine or a hydropower plant. The latter raise questions of how renewable energies can be assessed and valued, including the more general issue of how values and norms can be embedded in technological objects. This leads us to the third and last complex of topics that focus on current deliberations about possible new ways of existence in the age of the Anthropocene and as a consequence the formation of adequate life styles in our societies. This refers to issues in philosophical and social anthropology and the challenge of climate change.

**Prerequisites / Literature**

Lecture notes

Slides and other material (both usually in English) will be made available on a weekly basis as the lecture proceeds.

Content of the following books is covered (PDFs freely available online):

4. Other recommended books are:

**Prerequisites / notice**

For administrative and didactic reasons (high level of interaction and credit group assignments on current hot topics), the number of participants is limited to 45. Of course, any interested person is invited to attend the lecture without doing the group assignment. The website is actively used for the lecture.
This course focuses on the conditions under which cooperation in international environmental politics emerges and the conditions under which such cooperation and the respective public policies are effective and/or efficient.

The objectives of this course are to (1) gain an overview of relevant questions in the area of international environmental politics from a social sciences viewpoint; (2) learn how to identify interesting/innovative questions concerning this policy area and how to answer them in a methodologically sophisticated way; (3) gain an overview of important global and regional environmental problems.

This course deals with how and why international cooperation in environmental politics emerges, and under what circumstances such cooperation is effective and efficient. Based on theories of international political economy and theories of government regulation various examples of international environmental politics are discussed: the management of international water resources, the problem of unsafe nuclear power plants in eastern Europe, political responses to global warming, the protection of the stratospheric ozone layer, the reduction of long-range transboundary air pollution in Europe, the prevention of pollution of the oceans, etc.

The course is open to all ETH students. Participation does not require previous coursework in the social sciences. After passing an end-of-semester test (requirement: grade 4.0 or higher) students will receive 3 ECTS credit points. The workload is around 90 hours (meetings, reading assignments, preparation of test).

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

None

Environmental Law: Topics and Case Studies

Prerequisites: Environmental Law: Conceptions and Fields (851-0705-02L) offered in spring semester.

This workshop offers to the students the opportunity to intensify their environmental legal knowledge on the basis of individual topics or cases of their respective programme or professional interest in a guided self-study. They develop a better understanding for the practical application of legal regulations on environmental matters.

At the beginning of the workshop the students are introduced to the legal methods and sources as well as in the aim and the process of the workshop. The participants will organize themselves in a team of two persons giving themselves an inquiry on topics of the environmental law. It is also possible to choose questions at the interfaces of e.g. zoning law, energy law, transport law. A proposal, which will be presented to the lecturer, as well as an optional Q&A-session in class will facilitate the start. Next the working on topics will follow by self-study. The results will be presented in form of a memo/paper with a maximum of ten pages (excluding graphs and tables). At the end of the workshop, a presentation of ten minutes will be made to the plenum including a question-and-answer session. Class language will be German.

Den Studierenden werden Unterlagen zur juristischen Methoden- und Quellenlehre sowie zum Inhalt und Ablauf des Kurses zu Beginn der Veranstaltung kostenlos abgegeben.

Rechtgrundlagen, Literatur und Gerichtsentscheide werden themenspezifisch selber rechechiet, unter Mithilfe und Beratung des Dozenten.

Die Veranstaltung erfordert die Bereitschaft, sich aktiv und selbständig mit einer selbstgewählten Fragestellung oder einem eigenen Fallbeispiel aus dem Gebiet des Umweltrechts und allenfalls aus Schmittenstellengebieten auseinanderzusetzen. Damit die Interaktivität und die Begleitung der Teams gewährleistet werden kann, ist die Teilnehmerzahl auf maximal 16 Personen beschränkt. Es handelt sich um eine Vertiefungsveranstaltung. Der Besuch der Vorlesung "Umweltrecht: Konzepte und Rechtsgebiete" (851-0705-01L) ist Voraussetzung.

Number of participants limited to 20.

Does not take place this semester.

System of swiss planning law, Constitutional and statutory provisions, Space planning and fundamental rights, Instruments, Application, legal protection, enforcement, Practical training.

Basic understanding of nature and function of space planning from a legal point of view. Basic knowledge of space planning instruments, relationship between space planning and constitutional law (especially property rights), solving of practical cases.


Haller, Walter/Karlen, Peter, Raumplanung-, Bau- und Umweltrecht, 3.A., Zürich 1999

Hänni, Peter, Planungs-, Bau- und besonderes Umweltschutzrecht, 6.A., Bern 2006

Particularly suitable for students of D-ARCH, D-BAUG, D-USYS

Prerequisites / notice

Particularly suitable for students of D-ARCH, D-BAUG, D-USYS

None

Space Planning Law and Environment

System of swiss planning law, Constitutional and statutory provisions, Space planning and fundamental rights, Instruments, Application, legal protection, enforcement, Practical training.

Basic understanding of nature and function of space planning from a legal point of view. Basic knowledge of space planning instruments, relationship between space planning and constitutional law (especially property rights), solving of practical cases.


Haller, Walter/Karlen, Peter, Raumplanung-, Bau- und Umweltrecht, 3.A., Zürich 1999

Hänni, Peter, Planungs-, Bau- und besonderes Umweltschutzrecht, 6.A., Bern 2006

Particularly suitable for students of D-ARCH, D-BAUG, D-USYS

Number of participants limited to 20.

Does not take place this semester.
Abstract
Fundamental concepts of Land Register Law and Land Surveying Law (substantive and procedural rules of Land Register Law, the parts and the relevance of the Land Register, process of registration with the Land Register, legal problems of land surveying, reform of the official land surveying).

Objective
Overview of the legal norms of land registry and surveying law.

Content
Basic principles of material and formal land registry law, components of the land register, consequences of the land register, the registration process, legal problems of surveying, the reform of official surveying, liability of the problem-locator. The lecture unit is carried out within a frame of 8 sessions (2 hours): the first hour of each is given in the form of a lecture, the second in the form of a case-study.

Lecture notes
Abgegebene Unterlagen: Skript in digitaler Form

Literature
- Meinrad Huser, Schweizerisches Vermessungsgesetz, unter besonderer Berücksichtigung des Geoinformationsrechts und des Grundbuchrechts, Beiträge aus dem Institut für schweizerisches und internationales Baurecht der Universität Freiburg/Schweiz, Zürich 2014
- Meinrad Huser, Geo-Informationsgesetz, Reichs- und Ländergesetz, Zürich 2005
- Meinrad Huser, Kurzlehrbuch der Grundbuchrechts, Zürich 2003

Prerequisites / notice
Requirements: Property Law (12-722)

851-0101-53L Collections in Context: What Do Historians and Scientists Learn from Butterflies, Stones, and Bones?

Objective
The aim of this seminar is threefold: Firstly, students will become familiarised with historiographical approaches to scientific collections. Among them are constructivist approaches that seek to understand scientific knowledge not primarily as a system of objective truths, but rather as an outcome of human 'constructions'. Other approaches deal with the problem of how scientific objects are related to systems of power and oppression, namely in the case of objects collected during the time of European colonialism overseas. Secondly, students will become familiarized with how old collections can yeald new insights for current scientists working, e.g., on questions of ecology. Thirdly, the seminar shall serve as a platform to discuss ways of dialogue and possible collaboration between these different approaches.

Content
Students will be expected to read theoretical texts and case studies during semester, participate in discussions with external experts (historians, curators, and scientists), and to write a summarizing essay at the end of the term.

851-0735-11L Environmental Regulation: Law and Policy

Objective
The aim of this course is to equip students with a legal and regulatory skill-set that allows them to translate their technical knowledge into a policy brief directed at legally trained regulators. More generally, it aims to inform students with a technical scientific background of the legal and political context of environmental policy. The focus of the course will be on international and European issues and regulatory frameworks - where relevant, the position of Switzerland within these international networks will also be discussed.

Content
- Environmental Regulation
  a. Perspectives
  b. Regulatory Challenges of Environment Problems
  c. Regulatory Tools
- Law: International, European and national laws
  a. International law
  b. European law
  c. National law
- Policy: Case studies

Assessment:
(i) Class participation (25%): Students will be expected to contribute to class discussions and prepare short memos on class readings.
(ii) Exam (75%) consisting of three parts:
  a. Policy brief - a maximum of 2 pages (including graphs and tables);
  b. Background document to the policy brief - this document sets out a more detailed and academic overview of the topic (maximum 8 pages including graphs and tables);
  c. Presentation of the policy brief: presentations can use a maximum of 5 slides and can last 7 minutes.

Lecture notes
The course is taught as a small interactive seminar and significant participation is expected from the students. Participation will be capped at 15 in order to maintain the interactive nature of the classes. All classes, readings, and assignments, are in English.

Literature
An electronic copy of relevant readings will be provided to the students at no cost before the start of the lectures.

The course is (inter)related to materials discussed in Politikwissenschaft: Grundlagen (851-0577-00 V), Ressourcen- und Umweltökonomie (751-1551-00 V), Umweltrecht: Konzepte und Rechtsgebiete (851-0705-01 V), Rechtlicher Umgang mit natürlichen Ressourcen (751-0743-01 V), Environmental Governance (701-1651-00 G), Policy and Economics of Ecosystem Services (701-1653-00 G), International Environmental Politics: Part I (851-0594-00 V).

701-0727-00L Politics of Environmental Problem Solving

Objective
The course is (inter)related to materials discussed in Politikwissenschaft: Grundlagen (851-0577-00 V), Ressourcen- und Umweltökonomie (751-1551-00 V), Umweltrecht: Konzepte und Rechtsgebiete (851-0705-01 V), Rechtlicher Umgang mit natürlichen Ressourcen (701-0743-01 V), Environmental Governance (701-1651-00 G), Policy and Economics of Ecosystem Services (701-1653-00 G), International Environmental Politics: Part I (851-0594-00 V).

Content
During the second week of the teaching period, students will have individual 30-minute meetings with the lecturer to discuss their project.

Assessment:
(i) Class participation (25%): Students will be expected to contribute to class discussions and prepare short memos on class readings.
(ii) Exam (75%) consisting of three parts:
  a. Policy brief - a maximum of 2 pages (including graphs and tables);
  b. Background document to the policy brief - this document sets out a more detailed and academic overview of the topic (maximum 8 pages including graphs and tables);
  c. Presentation of the policy brief: presentations can use a maximum of 5 slides and can last 7 minutes.

Lecture notes
The course is taught as a small interactive seminar and significant participation is expected from the students. Participation will be capped at 15 in order to maintain the interactive nature of the classes. All classes, readings, and assignments, are in English.

Literature
An electronic copy of relevant readings will be provided to the students at no cost before the start of the lectures.

The course is (inter)related to materials discussed in Politikwissenschaft: Grundlagen (851-0577-00 V), Ressourcen- und Umweltökonomie (751-1551-00 V), Umweltrecht: Konzepte und Rechtsgebiete (851-0705-01 V), Rechtlicher Umgang mit natürlichen Ressourcen (701-0743-01 V), Environmental Governance (701-1651-00 G), Policy and Economics of Ecosystem Services (701-1653-00 G), International Environmental Politics: Part I (851-0594-00 V).
Developing Countries

Abstract
The course focuses on processes and drivers of decision-making on natural resources management issues in developing countries. It gives insights into the relevance of ecological aspects in developing countries. It covers concepts, instruments, processes and actors in environmental politics at the example of specific environmental challenges of global importance.

Objective
After completion of the module, students will be able to:
- Identify and appraise ecological aspects in development cooperation, development policies and developing countries’ realities
- Analyze the forces, components and processes, which influence the design, the implementation and the outcome of ecological measures
- Characterize concepts, instruments and drivers of environmental politics and understand, how policies are shaped, both at national level and in multilateral negotiations
- Study changes (improvements) in environmental politics over time as the result of the interaction of processes and actors, including international development organizations
- Analyze politics and design approaches to influence them, looking among others at governance, social organization, legal issues and institutions

Content
Key issues and basic concepts related to environmental politics are introduced. Then the course predominantly builds on case studies, providing information on the context, specifying problems and potentials, describing processes, illustrating the change management, discussing experiences and outcomes, successes and failures. The analysis of the cases elucidates factors for success and pitfalls in terms of processes, key elements and intervention strategies.

Different cases not only deal with different environmental problems, but also focus on different levels and degrees of formality. This ranges from local interventions with resource user groups as key stakeholders, to country level policies, to multi- and international initiatives and conventions. Linkages and interaction of the different system levels are highlighted. Special emphasis is given to natural resources management.

The cases address the following issues:
- Land use and soil fertility enhancement: From degradation to sustainable use
- Common property resource management (forest and pasture): Collective action and property rights, community-based management
- Ecosystem health (integrated pest management, soil and water conservation)
- Payment for environmental services: Successes in natural resources management
- Climate change and agriculture: Adaptation and mitigation possibilities
- Biodiversity Convention: Implications for conservations and access to genetic resources
- Biodiversity as a means for more secure livelihoods: Agroforestry and intercropping
- The Millennium Development Goals: Interactions between poverty and the environment
- Poverty and natural resources management: Poverty reduction strategies, the view of the poor themselves
- Food security: Policies, causes for insecurity, the role of land grabbing
- Biofuels and food security: Did politics misfire?
- Strategy development at global level: IAASTD and World Development Report 2008

Literature
Griffel, A.; Raumplanungs- und Baurecht in a nutshell, Dike Verlag, Zürich/St. Gallen 2012
Keel/Zimmermann; Bundesgerichtliche Rechtsprechung zur Waldgesetzgebung. In URP 2009/3
Rausch/Marti/Griffel; Umweltrecht - Natur- und Landschaftsschutzrecht - Wasserrecht - Raumplanungsrecht - Umweltschutzrecht - Verfahrensrecht - Strategisches Konzept - Weltversammlung
Keel/Zimmermann; Bundesgerichtliche Rechtsprechung zur Waldgesetzgebung. In URP 2009/3
Griffel A.; Raumplanungs- und Baurecht. Entwicklungen 2007, Bern 2008
Diese Literaturangaben gibt es in der ersten Veranstaltung.

Prerequisites / notice

Lecture notes

Information concerning the case studies and specific issues illustrated therein will be provided during the course (uploaded on Moodle)

Lecture notes

Griffel, A.; Raumplanungs- und Baurecht in a nutshell, Dike Verlag, 2012, Zürich/St. Gallen
Rausch, H.; Panorama des Umweltrechts - Kompendium der Umwelt- und Naturschutzrechtlichen Regelungen des Schengen-Agreements
Keel/Zimmermann; Bundesgerichtliche Rechtsprechung zur Waldgesetzgebung. In URP 2009/3
Griffel A.; Raumplanungs- und Baurecht. Entwicklungen 2007, Bern 2008

Prerequisites / notice

The performance assessment will consist of an individual essay to be written by each student based on at least five references in addition to the sources provided in the course. Students can choose from a list of topics. Criteria for assessment will be communicated at the beginning of the course.

701-0743-01L Law and Natural Resources

W 2 credits 2V

Abstract
This course teaches the possibilities and limits of the law in order to protect natural resources and landscapes against harm and nuisance. The learning concept is based on the co-ordinated implementation of the relevant legislations. The complexity of the legal situation will be discussed by analysing virtual and real law cases focused on spatial projects and planning.

Objective
The students know the opportunities and restrictions which are given by the law when using natural resources. They have insights into the important concepts and positions of environmental ethics. They achieve a deeper understanding of these concepts and positions in applying them to ecological problems and discussing them in case studies.

701-0703-00L Environmental Ethics

W 2 credits 2V

Abstract
The lecture begins with an introduction to applied ethics in general. The main focus is on environmental ethics. Students learn to handle important concepts and positions of environmental ethics. They achieve a deeper understanding of these concepts and positions in applying them to ecological problems and discussing them in case studies.
Objective

On completion of this lecture course you will have acquired the ability to identify and process general and environmental ethical problems. You will be capable of recognising and analysing environmental ethical problems and of working towards a solution. You will have acquired a fundamental knowledge of standpoints and argumentations to be found within the field of environmental ethics and will have practised these in small case studies.

Content

- Introduction to general and applied ethics.
- Overview and discussion of ethical theories relevant to the environment.
- Familiarisation with various basic standpoints within environmental ethics.
- Cross-section topics, such as sustainability, intergenerational justice, protection of species, etc.
- Practising of newly acquired knowledge in case studies (protection of species, climate change, etc.)

Lecture notes

Summaries of the individual sessions will be distributed, including the most important theories and keywords; reading list.

In the course of the course serving as an introduction to general and applied ethics, we shall be using the following textbook: Barbara Bleisch/Markus Huppenbauer: Ethische Entscheidungsfindung. Ein Handbuch für die Praxis, 2nd Edition Zürich 2014

Literature

- Andrew Light/Holmes Rolston III, Environmental Ethics. An Anthology, 2003
- John O'Neill et al., Environmental Values, 2008
- Klaus Peter Rippe, Ethik im ausserhumamen Bereich, Paderborn (mentis) 2008

General introductions:

- Marcus Düwell et. al. (Hrg.), Handbuch Ethik, 2. Auflage, Stuttgart (Metzler Verlag), 2006
- Johann S. Ach et. al. (Hrg.), Grundkurs Ethik 1. Grundlagen, Paderborn (mentis) 2008

Prerequisites / notice

The procedure for accumulating CP will be explained at the start of term.

I expect participants to be motivated and contribute to discussions, keeping the course interesting and lively.

701-0731-00L Environmental Behavior in Social Context W 2 credits 2S H. Bruderer Enzler

Abstract

This introductory class in the environmental social sciences covers topics such as environmental behavior, environmental concern, social dilemmas and social norms.

Objective

- Basic knowledge of the environmental social sciences
- Overview on current fields of research and their relevance for practical application

Content


- Fragen, die uns während des Semesters beschäftigen:
  - Wie kommen es zu Umwelt schä digungen, obwohl niemand diese beabsichtigt?
  - Wer verhält sich besonders umweltschonend? Wie wird dies gemessen?
  - Welche Rolle spielt das Umwelt bewusstsein?
  - Welche Rolle spielen äussere Faktoren (Möglichkeiten, Kosten etc.)?
  - Wie sehr lassen wir uns dadurch beeinflussen, was andere machen?
  - Kooperieren wir nur, wenn auch andere dies tun?

Literature


701-0747-00L Environmental Policy of Switzerland I W 3 credits 2V E. Lieberherr

Abstract

This course presents the basics of policy analysis and the specific characteristics of Swiss environmental policy. Policy instruments, actors and processes are addressed both theoretically as well as by means of current Swiss environmental policy examples.

Objective

- Beyond acquiring basic knowledge about policy analysis, this course teaches students how to analytically address current and concrete questions of environmental policy. Through exercises the students learn about political science concepts and frameworks as well as real-life political decision-making processes. The well-grounded examination of complex political conflict situations is an important precondition for the entry into the (environmental policy) workforce or a future research career.

Content

- The processes of change, overuse or destruction of the natural environment through humans have historically placed high demands on social and political institutions. In the interplay between the environment, society and economy, the environmental policy field encompasses the sum of public measures that have the goal to eliminate, reduce or avoid environmental degradation. The course systematically presents the basics of environmental policy instruments, actors, programs and processes as well as the their change over time. A key aspect is the distinction between politics and political science and specifically environmental policy.

Lecture notes

Instead of lecture notes different texts on policy analysis and Swiss environmental policy are made available to the students.

Literature

The lecture is based on the following book to be published in the summer of 2016:

Prerequisites / notice

The detailed semester program (syllabus) is made available to the students at the beginning of the semester.

701-0791-00L Environmental History - Introduction and Overview W 2 credits 2V D. Speich Chassé

Abstract

Our society faces a serious ecological crisis. Of what historical dimension is this crisis? How have human societies already in earlier times changed their environment, and, consequently, perhaps also ours? What were the main ecological challenges for societies and how did they change over time? And how did societies adapt to changing environmental conditions?

Objective

- Course material is provided on OLAT.
- Introduction into environmental history; survey of long-term development of human-nature-interrelations; discussion of selected problems. Improved ability to assess current problems from a historical perspective and to critically interrogate one’s own standpoint.

Lecture notes


Literature

Uekötter, Frank (Ed.) 2010. The turning points of environmental history, Pittsburgh: University of Pittsburgh Press.

Prerequisites / notice


Students are asked to write an exam during the second last session (11.12.2015).

701-0985-00L Social Intercourse with Current Environmental Risks W 1 credit 1V B. Nowack, C. M. Som-Koller

Abstract

The lecture treats the social intercourse with risks of technical systems. The notion of risk and the perception of risk are discussed by case studies (e.g. nanotechnology) and socio-political instruments for decision-making are presented. Methods are presented that can be applied to deal with environmental risks and how they can be used for sustainable innovation.
Objective
- Getting acquainted to the extended risk concept
- Evaluation of the risks caused by technology within the societal context
- Knowledge about the mode science and society handle current environmental risks (examples gene- and nanotechnology)
- Knowledge about handling risks (e.g. precautionary principle, protection goal, damage definition, ethics)

Content
- Risks and technical systems (risk categories, risk perception, risk management)
- Illustration with case studies (nanotechnology)
- Implementation (politics, science, media, etc.)
- Decision making (technology assessment, cost-benefit analysis etc.)
- The role of the media
- Prospects for future developments

Lecture notes
Copies of slides and selected documents will be distributed

Prerequisites / notice
The lecture is held biweekly (for 2 hours). The dates are 26.9., 3.10. (out of schedule), 24.10, 7.11, 21.11, 5.12, 19.12


Number of participants limited to 20.

Science, Technology, and Policy MSc and MAS in Development and Cooperation have priority.

Abstract
This course introduces students to key statistical methods for analyzing social science data with a special emphasis on causal inference and policy evaluation. Students learn to choose appropriate analysis strategies for particular research questions and to perform statistical analyses with the statistical Software Stata.

Objective
Students
- have a sound understanding of linear and logit regression
- know strategies to test causal hypotheses using regression analysis and/or experimental methods
- are able to formulate and implement a regression model for a particular policy question and a particular type of data
- are able to critically interpret results of applied statistics, in particular, regarding causal inference
- are able to critically read and assess published studies on policy evaluation
- are able to use the statistical software StATA for data Analysis

Content
The topics covered in the first part of the course are a revision of basic statistics and linear and logit regression analysis. The second part of the course focuses on causal inference and introduces methods such as panel data analysis, difference-in-difference methods, instrumental variable estimation, and randomized controlled trials mostly used for policy evaluation. The course shows how the various methods differ in terms of the required identifying assumptions to infer causality as well as the data needs. Students will apply the methods from the lectures by solving weekly assignments using statistical software and data sets provided by the instructors. These data sets will cover topics at the interface of policy, technology and society. Solving the assignments contributes to the final grade with a weight of 30%. Students are assisted in solving the assignments during the exercises session.

Language Courses ETH/ UZH
Please be advised that your online-registration at the language centre has to be simultaneous (www.sprachenzentrum.uzh.ch) as otherwise your registration for the course will not be valid.

Number of participants limited to 20.

Objective
The course will help students to improve their French, whilst developing greater discrimination in reading. It will also offer them the opportunity to increase their awareness of different literary genres and contemporary cultural issues.

Content
This course focuses on modern and contemporary literary texts.

Abstract
This course targets B2/C1 French learners. It is not open to French native speakers.

Objective
The main objective of this course is to practice and improve the four language skills of participants (listening, speaking, reading and writing). Students will have to make a presentation in French on a complex subject, interact in a group, defend a point of view and answer to objections.

Number of participants limited to 20.

Objective
The main emphasis is on spoken skills, with the aim of enabling students to develop their own voice in expressing their views and developing arguments efficiently. The course also nurtures the ability to understand a general meaning in documents concerning aspects of society at large.

Abstract
With a textual approach this course focuses on some complex topics such as the past tense, indirect speech and the subjunctive. The course does not aim at a systematic revision of grammar.

Objective
This course focuses on some complex topics such as the past tense, indirect speech and the subjunctive. The course does not aim at a systematic revision of grammar.
Participants should already have reached a level of C1 (advanced), as defined in the Council of Europe Global Scale. This course is designed for Bachelor and Master students from all disciplines, who wish to improve their English from C1 towards C2 level. A variety of texts, including classical and modern poetry, short stories, and one short novel, are analyzed. Classwork is interactive, with no script. Handouts will be delivered weekly and published on Moodle.

Participants will be expected to make a contribution of CHF 5.00 at the beginning of the course to cover the costs of photocopying.

The course presents des activités de repérage des difficultés, de mise en commun des résultats, ainsi que des exercices d'écriture.

The course is designed for Bachelor and Master students from all disciplines who wish to gain an insight into New Zealand culture, history, society, and politics through New Zealand's rich tradition in literature and film while improving their English language skills further towards C2.

Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.unizh.ch).

The course covers: a review of vocabulary building and extension, including the Academic Word List and formulaic language; input on academic reading, writing and listening comprehension; and improvement of grammatical accuracy. Special emphasis is placed on individual speaking, argumentative discourse and group discussions, to enhance fluency and confidence. Where possible, students will be asked to reflect on how the course content relates to their own academic disciplines.

The course is only open to students who register on-line via the Sprachenzentrum website during the registration period (review the SZ website) and who receive on-line confirmation that they have been accepted on this course.

Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.unizh.ch).

The course aims to train and develop linguistic skills at Mastery level, with a focus on formal and informal lexis, on listening and oral communication skills, increasing fluency, accuracy and complexity of spoken language; writing well-structured descriptive texts and argumentative essays, with the aim to fulfill the language requirements for study at an English speaking university or follow University Masters Courses held in English.

Materials: Texts are available online (Moodle) and as handouts.

Participants will be expected to:
- Attend regularly throughout the semester;
- Take part actively in class discussions, group work and pair work;
- Do at least 2 hours' work per week outside class, including reading and writing;
- Use the electronic tools provided.

Complete a portfolio report of four key tasks, aiming to practice the skills focussed on during the semester.

The course is designed for Bachelor and Master students from all disciplines who wish to reach a level of C1 (advanced), as defined in the Council of Europe Global Scale. It proposes a descriptive approach of new linguistic means that permit the development of the reading of academic texts (compte rendu, synthèse) or administrative texts in general (lettre de motivation), as well as the exercises cited.

The points studied are not the usual points in the past, but the content, the cohesion and text, as well as the discourses. They are submitted to the help of the authentic and without recourse systematic to exercises of drill.
The aim is to explore the following questions through texts and film to introduce students to New Zealand and, in a broader sense, to raise their awareness of some of the key issues affecting former colonies from early settlement to the present day: What did New Zealand mean to its early settlers? Where did the settlers come from? How did they live? What is the Treaty of Waitangi, and what is its status today? What does it mean to live in multi-cultural New Zealand today?

Students will learn the discourse used, and issues under consideration, in the analysis and discussion of poetry, prose, and film. They will become aware of various ways of "reading" texts and film, and will improve their skills in planning and writing cohesive essays in which they marshal their views in a convincing and formal manner. Overall, the aims are that students become more discerning readers, improve their skills in expressing their views in written and spoken form clearly and concisely, and gain an understanding of the importance of literature and film to the development of a uniquely New Zealand identity.

The course gives a roughly chronological view of New Zealand's literary heritage, from Maori settlement to the present day, using selected poems, a short novel, short stories, articles, and films. A key focus is the way New Zealanders' notion of their own identity has shifted over the years, as expressed by the country's film-makers and writers working in English, and to a limited degree, in Maori (English translations are provided).

We work out some interaction forms focused on observation, presentation and debate. Each student does a presentation of one of the films chosen, pointing out aspects that give path to a discussion. On the other hand, he/she creates a specific glossary to be used during the directed discussion will be enhanced. We will read diverse text forms from Spanish and Latin American Authors.

Handouts, online resources, Moodle platform, and DVDs of a wide range of NZ films (available in the Self-Access Center -- NB: No hobbies!)

Important note:
The course is only open to students who register on-line via the Sprachenzentrum website during the registration period (review the SZ website) and who receive on-line confirmation that they have been accepted on this course.

The course aims towards integrating grammar and oral/written communication. We will present new grammar topics and will introduce them into the oral practice.

The most important grammatical topic will be the imperfecto and pluscuamperfecto of subjunctive in subordinate structures. Free and directed discussion will be enhanced. We will read diverse text forms from Spanish and Latin American Authors.

The teacher will provide the script. A fee of CHF 4.00 for photocopies be collected.

Important information for ETH students: The enrollment in this course at the Sprachenzentrum does not enrol the student automatically for the granting of the D-GESS points. Please inform yourself.

The course targets are:
- to understand complex texts namely literary short stories.
- to capture lexical and syntactic meanings in texts.
- to be able to express oneself in a clear and differentiated way in using formulations and structures taken from the texts.
- to become acquainted with the cultural and social realities characteristic of Italy as described in the short stories.

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Content
Durante il corso vengono letti e commentati testi narrativi brevi particolarmente significativi sia per il lessico e le strutture linguistiche impiegate sia per i contenuti strettamente collegati a realtà culturali e sociali tipiche per l'Italia. A presentazioni, orali e scritte, s'alterranno discussioni sui testi e riflessioni sulla costruzione dei racconti e sulle scelte lessicali e sintattiche.

Lecture notes
Materiale didattico
Il materiale didattico (testi letterari, schede lessicali e grammatiche, materiale audiovisivo ecc.) sarà messo a disposizione dall'insegnante. Verrà richiesto un contributo di CHF 5.- per le fotocopie.

Prerequisites / notice
Livello linguistico richiesto
Il corso si rivolge a persone che già possiedono una buona conoscenza della lingua italiana (livello B2-C1): sono in grado di seguire un intervento orale complesso, sanno estrarre le informazioni principali da un testo narrativo, prendono parte attivamente e senza preparazione ad una discussione, sanno comporre un testo semplice in italiano senza grandi difficoltà.

Prima di iscriversi i partecipanti sono tenuti a verificare il proprio livello di competenza linguistica sia seguendo le indicazioni alla pagina http://www.sprachenzentrum.uzh.ch/angebot/kurse_ba/niveau.php sia effettuando il dettagliato testo di autovalutazione di Dialang (http://www.lancs.ac.uk/researchenterprise/dialang/about) scaricabile sul proprio ordinatore.

851-0826-05L Italian for Academic Purposes (B2) W 2 credits 1U A. Dal Negro
Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.uzh.ch).

Abstract
In the course, different textforms will be practiced which are used in the academic domain. This includes the scientific essay, the abstract, the oral presentation, and the handout.

Objective
Mastering the structures of the academic communication in Italian.

851-0849-00L Basic Course A1 (Brazilian-Portuguese) W 2 credits 2U P. de Avila Widauer
Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.uzh.ch).

Abstract
This course is designed for participants with no previous knowledge of Portuguese.

The course deals with everyday topics. Participants practice simple forms of communication as these occur in daily life. Lexical and linguistic structures are taught within these contexts. Intercultural and socio-cultural issues relating to Brazil are also taken into consideration.

Objective
Participants can understand and form simple questions, messages, and requests.

851-0849-01L Basic Course A2 (Brazilian-Portuguese) W 2 credits 2U P. de Avila Widauer
Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.uzh.ch).

Abstract
This course is designed for participants with a basic knowledge of Portuguese (level A1).

Objective
Participants can talk and write about themselves and everyday topics using simple sentences. They can take part in simple daily conversations, understand and write simple messages, describe an event in a time sequence, and express wishes, assumptions, and recommendations.

851-0885-07L Greek Basic Course Part I W 3 credits 5U R. Harder
Language course for beginners. We will work with a textbook which contains easy original Greek texts. Basic knowledge of Greek grammar, vocabulary and of some characteristics of the Greek language and culture.

Objective
Basic knowledge of Greek grammar, vocabulary and of some characteristics of the Greek language and culture.

851-0885-08L Greek Basic Course Part III W 3 credits 4U F. Egli Uitzinger
In this third semester "Graecum" we consolidate the knowledge of the language. The course focusses on the lecture of a Platonic dialog and of Homer's Odyssey. The course prepares the students for the final exam in January.

Objective
The students should be able to translate a Greek text on a higher level. They should have a sound knowledge of the Homeric Epos and the Platonic philosophy.

851-0885-09L Modern Greek Language I (A1.1) W 2 credits 2U A. Rassidakis Kastrinidis
Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.uzh.ch).

Abstract
This course is the first part of a language course which runs over four semesters, covering levels A1 and A2 of the Global European Framework. Modern Greek Language I is designed for students who have no or very little command of Modern Greek and covers level A1.1.

Objective
Practice of oral communication and study of basic vocabulary and grammar; focus on noun and adjective structures, personal and possessive pronouns, active verbs (Present Tense) and the use of adverbs. Initiation to web-based activities in Greek and enhancement of interest and activities in Greek language and culture.

Content
- The course book by D. Dimitra & M. Papacheimona, Ellinika tora 1+1 (Greek now 1+1, including 2 audio-CD), units 1-5, Athens 2002, and workbook one, Tetradio Askiseon 1, have been ordered for the course members and are available at "Bücherladen der Stiftung Zentralstelle der Studentenschaft", Schönberggasse 2.
- Web-based activities to support and enhance classroom teaching will be accessible via Moodle, an electronic platform offered by LET of ETHZ (http://moodle.let.ethz.ch/).
- Additional course materials and handouts will be distributed in class.
- A set of 1400 vocabulary cards for the entire coursebook (Ellinika tora 1+1) is available and can be ordered at the beginning of the semester.
Modern Greek Language III (A2.1)  
Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.uzh.ch).

Abstract
This is Part III of the Modern Greek language course, running over four semesters. Modern Greek III covers level A2.1 of the Global European Framework and is designed for students who have already attended courses I and II at the Sprachenzentrum UNI/ETHZ, or whose language proficiency is equivalent to level A1.2.

Objective
Extensive vocabulary work (approx. 400 new words); reading of elementary texts; additional practice through speaking only Greek in class; improving listening comprehension; writing short essays (about the past and the future, describing events and personal experience). Grammar work will focus on verbs (simple past, simple future, subjunctive and imperative; active and passive voice).

Content
Challenging everyday situations; discussion of specific topics (eg. describing pictures and photographs; talking about daily chores); elementary listening comprehension practice (dialogues, talking about events, advertisements); reading comprehension (advertisements, cooking recipes, poems).

Lecture notes
Keines

Literature
- Audio-visual materials and handouts (photocopies) will be used. Photocopies will be distributed during the semester.
- Web-based activities can be accessed via Moodle platform, supported by LET of ETHZ (http://moodle.let.ethz.ch/).

Prerequisites /
notice
All course participants are expected to
- attend regularly and participate actively in class
- do at least 3 hours’ work at home
- submit all their written work for correction
- commit themselves to online-activities in the Moodle-LET online-classroom
- pass all semester-tests.

All candidates who fulfill the course requirements will receive a language certificate, issued by the Language Center, awarding 2 ECTS credits.

D-GESS students will receive on-line credit points and marks, in addition to the LC-certificate.

The course is only open to students who register on-line via the Sprachenzentrum-website and who receive online confirmation that they have been accepted on this course. Please note the limited online-registration period!


Swedish I (A1)  
Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.uzh.ch).

Abstract
This is the first of a two part Swedish-course, run over two semesters. The aim of the course is to achieve basic language skills in speaking, listening, reading and writing (Level A1). The focus is based on oral skills.

Objective
The participants learn how to express themselves adequately in different everyday situations. Everyday conversation will be worked on and practised. The students will work on basic grammar structures and basic pronunciation.

Literature

A printed wordlist and additional material is distributed during the lessons. You will be asked to pay CHF 9.00 to cover the cost of the material.

Prerequisites /
notice
Regular attendance (max 3 absences), active participation in class and a minimum of 3 hours work outside class is expected per week.

The course is only open to students who registered online via the Language Center website and who received an e-mail confirmation that they have been accepted in this course.

Swedish II (A2.1)  
Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.uzh.ch).

Abstract
This is a direct continuation of the first part of the Swedish-course. Participants should already have reached level A1. The course aims to work on grammar skills, vocabulary and oral as well as writing skills. Furthermore, Swedish pronunciation should be improved (level A2.1).

Objective
The participants learn to express themselves in a variety of everyday-situations. The course provides knowledge on characteristics of Swedish culture and society.

Literature

A printed wordlist and additional material is distributed during the lessons. You will be asked to pay CHF 9.00 to cover the cost of the material.

Prerequisites /
notice
Regular attendance (max 3 absences), active participation in class and a minimum of 3 hours work outside class is expected per week.

The course is only open to students who registered online via the Language Center website and who received an e-mail confirmation that they have been accepted in this course.

Polish I (A 1.1)  
Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.uzh.ch).

Abstract
The participants learn how to express themselves in a variety of everyday situations. The course provides knowledge on characteristics of Polish culture and society.

Literature
We are working with Polish I (ISBN 978-83-7486-203-5); publisher: Polish Institute Foundation, Warsaw 2014.

A printed wordlist and additional material is distributed during the lessons. You will be asked to pay CHF 9.00 to cover the cost of the material.

Prerequisites /
notice
Regular attendance (max 3 absences), active participation in class and a minimum of 3 hours work outside class is expected per week.

The course is only open to students who registered online via the Language Center website and who received an e-mail confirmation that they have been accepted in this course.
Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.uzh.ch).

Abstract
Credits: 2
The course is planned as the first part of a two-semester crash course in Polish at level A1.1. The course covers the four core skills of listening, speaking, reading and writing. We focus on oral communicative skills as well as pronunciation and grammatical structures.

Objective
Target audience: This is a course for beginners who have no prior knowledge of Polish. Therefore no diagnostic test is required.

Content
Everyday situations will be covered, for instance introducing yourself and others, living and working in an academic context, personal interests), to ask for information and services (in restaurants, coffeeshops, shops) etc.

The students learn the principles of Polish pronunciation and intonation as well as basic Polish grammar needed to master the course goals.

Literature
Coursebook
POLSKI krok po kroku 1 (Iwna Stempek, Anna Steinmach, Sylwia Dawidek, Aneta Szymkiewicz), ISBN 978-83-930731-0-8. mp3 with audio materials, free access to interactive Polish course e.polish.eu
The coursebook will be available at Bücherladen und Studentenladen Zentrum, Schönberggasse 2, 8001 Zürich, tel: 044 634 45 23, email: ladenz@zsuz.uzh.ch

Prerequisites / notice
Students are expected to attend regularly and participate actively in class. Completion of this course requires active and continuous participation. Students should be able to dedicate at least 3 hours a week to independent study activities.

The use of the open-source Learning Management System OLAT will be part of the course.

Assessment:
The assessment will embrace
- a portfolio including exercises done throughout the semester
- a final test assessing the different skills trained.

Requirements for the award of 2 ECTS credits and:
- learning achievement assessed and documented as successful
- no more than 3 absences

851-0851-00L

Russian I (A1.1) ■ W 2 credits 2U D. Henseler
Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.uzh.ch).

Abstract
This course is an introduction to Russian language (and culture) for beginners (Level A1.1). The course treats both the Cyrillic alphabet and phonetics and develops a basic vocabulary. In two terms the students acquire a basic knowledge of the most important aspects of Russian grammar.

Objective
The course focuses on speaking, reading comprehension and auding as well as on cultural competence.

Content
Everyday situations will be covered, for instance introducing yourself and others, living and working in an academic context, personal interests), to ask for information and services (in restaurants, coffeeshops, shops) etc.

The course focuses on speaking, reading, writing, comprehension and auding as well as on cultural competence. Special attention will be given to features of academic culture.

Working forms: Single, pair, and group work, and plenum. The course is supported by the learning platform OLAT.

Registration for the course at sprachenzentrum.uzh.ch is obligatory!

851-0853-00L

Russian III (A2.1) ■ W 2 credits 2U D. Henseler
Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.uzh.ch).

Abstract
This course is a sequel to the one-year basic course. Students level should come up to the level of the basic course (two terms, with two lessons per week). In case of doubt please contact the teacher prior to the beginning of the term.

Objective
The course focuses on speaking, reading comprehension and auding as well as on cultural competence.

Content
These are the contents of the course: talking about food and meals; indicating quantity; saying that one needs something or has to buy something; making sales talk; naming dishes and cutlery; making invitations; asking for an explanation of an unknown term; uttering congratulations and wishes; describing one's day; naming activities in the present, the past and the future; talking about one's way to the working place. The course is supported by the learning platform OLAT.

Lecture notes

851-0855-00L

Russian V (A2.2+) ■ W 2 credits 2U D. Henseler
Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.uzh.ch).

Abstract
The course Russian V requires a knowledge which should come up to the level of the four preceding courses (four terms, with two lessons per week). This corresponds to the level A2 of the "European Framework". In case of doubt please contact the teacher prior to the beginning of the term.

Objective
The course focuses on speaking, reading comprehension and auding as well as on cultural competence on a A2.2+ level according to the "European Framework".

Working forms: Single, pair, and group work, and plenum.
Content
These are the contents of the course: talking about the weather; naming seasons and months; understanding touristic offers; uttering approval, refusal and indifference; making appointments; talking about holiday plans and arrangements; uttering prohibitions; drawing comparisons; talking about learning; indicating year and date; talking about interests; saying what one is busy with; talking about one's biography; saying what one would like to do; making and asking for recommendations; passing on information; saying how to get to a place; making suggestions. The course is supported by the learning platform OLAT.

Lecture notes

851-0861-00L
Arabic I (A1.1)  W  3 credits  4U  E. Youssef-Grob
Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.uzh.ch).

Abstract
This course forms the first part (level A1) of a five semesters' Arabic course. Its aim is to acquire a basic competence on the level of speaking, hearing skills, and also reading and writing of the Arabic script.

Objective
The participants are able to adequately respond to selected situations of everyday life. Conversations in everyday life and typical situations while traveling will be taught and exercised. Another important focus is the learning of the Arabic script.

Content
Embedded in communicative situations we will work on the following contents: to greet, to present oneself, to talk about oneself (personal identity, occupation, place of living, etc.), simple telephone calls, to ask for information, to book a room. We will pay special attention to cultural aspects.

Literature
Arabisch Intensiv. Grundstufe. Landesspracheninstitut in der Ruhr-Universität Bochum; Buske Verlag (www.buske.de), 2011

Das Lehrmittel ist kurz vor Semesterbeginn erhältlich beim Bücherladen und Studentenladen Zentrum, Schönberggasse 2, 8001 Zürich, Tel: 044 634 45 23, Fax: 044 634 45 26, email: ladenz@zsuz.uzh.ch
geöffnet: Mo - Fr 09.00-17.00 Uhr

851-0861-01L
Arabic I (A1.1)  W  2 credits  3U  U. Göskén
Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.uzh.ch).

Abstract
This class aims at acquiring the elementary language competence on the level of speaking, listening and understanding as well as reading and writing of the Arabic script.

Objective
The participants are able to behave adequately in regard to language and culture in simple, but important everyday situations. Learning and practicing vocabulary and grammar are tailored to acquire sufficient confidence to meet everyday communication needs orally and in writing.

Content
The communicative needs which the practical contents and situations are designed to meet relate to: saying hello, asking about somebody's wellbeing, introducing each other, simple statements about objects and persons, asking for information and services. The participants are expected to do some of their homework on OLAT.

Lecture notes
All teaching material besides the reader will be distributed in the lessons and downloaded on OLAT.

Literature
Textbook:
Grundstufe
Landesspracheninstitut in der Ruhr-Universität Bochum
Jahr: 2011
Auflage: 3., völlig überarb. Aufl

Prerequisites / notice
The course is open for students, post-graduate students and staff of both Zurich university and ETH without any knowledge of the Arabic language.

851-0863-00L
Arabic III (A2.1)  W  2 credits  2U  U. Göskén
Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.uzh.ch).

Abstract
This course forms the third semester of a five semesters' Arabic curriculum. We will work on the following topics: Talking about one's life, daily routines, comparisons, wishes, orders, eventualities, preferences. Furthermore, we will pay special attention to acquiring a basic vocabulary and work on the Arabic verbal system.

Objective
The participants are able to show a culturally and linguistically appropriate behavior in common situations of everyday life. They acquire a basic vocabulary and know the important verbal constructions (present and past tense, imperative, conjunctive).

Content

Literature
Arabisch Intensiv. Grundstufe. Landesspracheninstitut in der Ruhr-Universität Bochum; Buske Verlag (www.buske.de), 2011

Das Lehrmittel ist kurz vor Semesterbeginn erhältlich beim Bücherladen und Studentenladen Zentrum, Schönberggasse 2, 8001 Zürich, Tel: 044 634 45 23, Fax: 044 634 45 26, email: ladenz@zsuz.uzh.ch
geöffnet: Mo - Fr 09.00-17.00 Uhr

Prerequisites / notice

851-0861-03L
Following Arabic Massmedia (B1)  W  2 credits  2U  E. Youssef-Grob
Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.uzh.ch).

Abstract
Arabic authentic texts or programs from audiovisual media. Introduction into the Arabic media landscape with its peculiarities.

Objective
Participants are able to understand easy authentic texts (reports, news, interviews) of Arabic mass media and discuss them in Arabic. Strategies of textual interpretation, vocabulary building or the use of a grammar will enable students further to develop their own, autonomous approach to Arabic media.

851-0877-00L
Chinese I (A1.1)  W  3 credits  4U  A.L. Achermann
Your course registration is only valid with a simultaneous online registration at the language center

Abstract

Objective

Notice

Prerequisites / notice

Literature

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**Objective**
The course aims at promoting various everyday communication skills without neglecting their cultural context.

**Content**
Building on the results of course Chinese V the students will learn a basic vocabulary of about 600 characters. Until the end of the course, the students will be trained to actively master a vocabulary of 300 words. In addition, the course will teach some of the basic grammatical patterns. Exercises in spoken Chinese covering a number of topics are also part of the course-work. The course aims to bring the participants up to level 2 of the new HSK (standardized international Chinese proficiency test).

**Literature**
Zhongguohua, shangce und Zhongguozi, shuxi (Beijing, 2007 mit Audio CD).

**Prerequisites / notice**

**Data: 06.03.2019 12:57**

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**Chinese III (A2.1)  851-0879-00L**

*W* 3 credits 4U  Q. Hu

**Abstract**
Building on course Chinese II the students will learn to actively master a vocabulary of 300 words. In addition, the course will teach some of the basic grammatical patterns. Exercises in spoken Chinese covering a number of topics are also part of the course-work. The course aims to bring the participants up to level 2 of the new HSK (standardized international Chinese proficiency test).

**Objective**
The course has the following aims: the participants shall acquire an advanced competence in the field of speaking, listening, reading and writing. They will build up a number of key characters, so that 300 words should be actively mastered by the end of the semester.

**Literature**
Wir arbeiten mit folgendem Lehrmittel:
Zhongguohua, shangce und Zhongguozi, shuxi (Beijing, 2007 mit Audio CD).

**Prerequisites / notice**

**Data: 06.03.2019 12:57**

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**Japanese I (A1.1)  851-0881-00L**

*W* 3 credits 4U  G. Gefter

**Abstract**
Elementary introduction to the Japanese language. Students acquire the basic language skills needed for everyday life communicative interactions.

**Literature**
Wir arbeiten mit folgendem Lehrmittel:
4U

**Prerequisites / notice**

**Data: 06.03.2019 12:57**
Objective Level A1.1 of the Common European Framework of Reference for Languages (CEFR).

Content For details see www.sprachenzentrum.uzh.ch

Lecture notes Heinrich Reinfried, “Kompaktlehrgang Japanisch” (available at the beginning of the course, later by mail to reinfried@asiaintensiv.ch; also available in English: “Concise course in Japanese”)

---

851-0881-01L Japanese I (A1.1) W 3 credits 4U I. Mosimann-Nakanishi

Objective Everyday conversation / Reading simple texts written with Hiragana and Katakana syllabaries / Writing simple texts about everyday topics using the Hiragana and Katakana syllabaries on the computer

Content For details see www.sprachenzentrum.unizh.ch

Lecture notes 1. Heinrich Reinfried "Kompaktlehrgang Japanisch" or "Concise Course in Japanese" (English Version)

This will be sold at the beginning of the course or can be ordered directly at www.asiaintensiv.ch .

---

851-0883-00L Japanese III (A2.1) W 2 credits 2U I. Mosimann-Nakanishi

Objective The participants consolidate and broaden the basic knowledge of the modern colloquial language in Japan. One of the focuses is on the acquisition of speech methods for important everyday standard situations. At the same time the grammar knowledge will be repeated and broadened. Higher reading skills will also be strived for by learning approx. 60 new Kanji.

Content For details see www.sprachenzentrum.uzh.ch

Lecture notes We will be using this textbook: "Japanisch Intensiv Grundkurs", LSI, Buske Verlag

---


Objective By reading selected original texts, students learn strategies for reading texts analytically. The aim is that they are able to handle Japanese sources independently, using appropriate tools.

Content For details see www.sprachenzentrum.uzh.ch

Lecture notes We will be using this textbook: "Concise Course in Japanese"

---

851-0890-00L Reading Course Latin: Augustus - The First Roman Princeps W 2 credits 2U C. Utzinger

Objective Students gain an understanding of various aspects of a new topic and are able to analyse and contrast these aspects within a wider context. Participants reactivate, review, and improve their language skills (vocabulary, morphology, morphosyntax) by applying these skills to texts and in exercises (translation competence, text analysis).

---

851-0900-01L Norwegian (Beginners) W 3 credits 2U E. Berg

Objective By the end of the course, you will have read some easy Norwegian texts, have written your own texts, and be able to conduct simple conversations.

Prerequisites / notice European Global Scale grading: A2 (basic user)

You are recommended to take part in the tutorial offered for this course.

---

851-0900-03L Norwegian III (University of Zürich) W 3 credits 2U E. Berg

Objective By reading selected original texts, students learn strategies for reading texts analytically. The aim is that they are able to handle Japanese sources independently, using appropriate tools.

Prerequisites / notice European Global Scale grading: A2 (basic user)

You are recommended to take part in the tutorial offered for this course.
Abstract
The third part of the Norwegian-course aims at a further development of your active and passive language competence. You will finish the textbook and round it off by an individual assignment on a Norwegian theme.
European Global Scale grading: B2 (independent user)

Objective
You will be reading Norwegian literature with ease and discussing various themes both in speech and in writing.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
<th>Type</th>
<th>Lecturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0900-02L</td>
<td>Norwegian II</td>
<td>3 credits</td>
<td>W</td>
<td>E. Berg</td>
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</tbody>
</table>

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.

Number of participants limited to 20.
No simultaneous online registration at the language center necessary.

Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

Abstract
This course is a continuation of the introductory course and is suited for students with elementary knowledge of Norwegian. By means of various media like articles, music and films, you will also get to know more about Norway.

European Global Scale grading: B1 (independent user)

Objective
The aim of this course is to expand your knowledge of the Norwegian grammar and vocabulary and train your oral and written skills.

<table>
<thead>
<tr>
<th>GESS Science in Perspective - Key for Type</th>
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<th>Key for Hours</th>
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</table>

ECTS
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
</table>
| 851-0242-06L| Cognitively Activating Instructions in MINT Subjects
Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).| W    | 2 credits | 2S   | R. Schumacher                      |
|             | This course unit can only be enrolled after successful participation in, or during enrollment in the course "Human Learning (EW 1)".|      |       |       |                                    |
|             | Abstract                                                              |      |       |       |                                    |
|             | This seminar focuses on teaching units in chemistry, physics and mathematics that have been developed at the MINT Learning Center of the ETH Zurich. In the first meeting, the mission of the MINT Learning Center will be communicated. Furthermore, in groups of two, the students will intensively work on, refine and optimize a teaching unit following a goal set in advance. |      |       |       |                                    |
|             | Objective                                                             |      |       |       |                                    |
|             | - Get to know cognitively activating instructions in MINT subjects     |      |       |       |                                    |
|             | - Get information about recent literature on learning and instruction  |      |       |       |                                    |
|             | Prerequisites / notice                                                 |      |       |       |                                    |
|             | Für eine reibungslose Semesterplanung wird um frühe Anmeldung und persönliches Erscheinen zum ersten Lehrveranstaltungstermin ersucht. |      |       |       |                                    |
| 851-0242-07L| Human Intelligence
Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).
Number of participants limited to 30.
This course unit can only be enrolled after successful participation in, or during enrollment in the course "Human Learning (EW 1)".| W    | 1 credit | 1S   | E. Stern, P. Edelsbrunner, B. Rütsche |
|             | This course unit can only be enrolled after successful participation in, or during enrollment in the course "Human Learning (EW 1)".|      |       |       |                                    |
|             | Abstract                                                              |      |       |       |                                    |
|             | The focus will be on the book "Intelligenz: Grosse Unterschiede und ihre Folgen" by Stern and Neubauer. Participation at the first meeting is obligatory. It is required that all participants read the complete book. Furthermore, in two meetings of 90 minutes, concept papers developed in small groups (5 - 10 students) will be discussed. |      |       |       |                                    |
|             | Objective                                                             |      |       |       |                                    |
|             | - Understanding research methods used in the empirical human sciences  |      |       |       |                                    |
|             | - Getting to know intelligence tests                                 |      |       |       |                                    |
|             | - Understanding findings relevant for education                       |      |       |       |                                    |
| 851-0242-08L| Research Methods in Educational Science
Number of participants limited to 30.
This course unit can only be enrolled after successful participation in, or during enrollment in the course "Human Learning (EW 1)".| W    | 1 credit | 1S   | P. Edelsbrunner, B. Rütsche, E. Stern, E. Ziegler |
|             | Literature from the learning sciences is critically discussed with a focus on research methods. |      |       |       |                                    |
|             | At the first meeting, working groups will be assembled and meetings with those will be set up. |      |       |       |                                    |
|             | In the small groups students will write critical essays about the read literature. At the third meeting, we will discuss the essays and develop research questions in group work. |      |       |       |                                    |
|             | Objective                                                             |      |       |       |                                    |
|             | - Understand research methods used in the empirical educational sciences|      |       |       |                                    |
|             | - Understand and critically examine information from scientific journals and media |      |       |       |                                    |
|             | - Understand pedagogically relevant findings from the empirical educational sciences |      |       |       |                                    |
| 851-0242-09L| Student Research Projects: Practical Research on Learning and Instruction
Number of participants limited to 20. The successful completion of both course no. 851-0240-00L "Menschliches Lernen (EW 1)" and course no. 851-0238-01L "Unterstützung und Diagnose von Wissenserwerbsprozessen (EW 3)" is a necessary prerequisite for this course.| W    | 2 credits | 2S   | A. Deiglmayr, P. Edelsbrunner, S. Holer, B. Rütsche, L. Schalk, E. Stern, E. Ziegler |
|             | In teams of two, participants in this seminar conduct their own research project. Each team is advised by one of the researchers serving as lecturers in this course. Basic conceptual and methodological issues are the topic of a series of plenary meetings; however, the major part of the work is done in small-group meetings with the advising researcher, and in self-directed research projects. |      |       |       |                                    |
|             | Objective                                                             |      |       |       |                                    |
|             | The course is targeted at advanced students who have taken an interest in gathering practical research experience in the field of Learning & Instruction. In teams of two, students conduct their own research projects (planning, conducting, analyzing, interpreting, and presenting research); thus, the course requires a high amount of self-directed working. Students are personally advised, and supported in their research project, by one of the researchers serving as lecturers in this course. During the first half the semester, relevant methodological knowledge and skills are practiced during plenary meetings and in students’ independent reading (e.g. generating and testing research questions, designing experiments, and analyzing data in the field of Learning and Instruction) |      |       |       |                                    |
|             | Learning goals include:                                               |      |       |       |                                    |
|             | - Participants can illustrate and explain basic methods and concepts for research in the fields of Learning and Instruction, e.g. with the help of practical examples. |      |       |       |                                    |
|             | - Participants can generate testable research questions for a topic relevant in the fields of Learning and Instruction. |      |       |       |                                    |
|             | - Participants can design and conduct a study that is relevant for answering their research question. |      |       |       |                                    |
|             | - Participants can summarize and evaluate the main results from a study in the field of learning and Instruction, with regard to the research question being asked. |      |       |       |                                    |

see Educational Science Teaching Diploma

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### Geographic Teaching Diploma


#### Educational Science

Course offerings in the category Educational Science are listed under "Programme: Educational Science for Teaching Diploma and TC".

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
</table>
| 651-4239-00L| Geography Didactics Geography I (University of Zurich)
No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. | O    | 3 credits | 2G   | B. Vettiger-Gallusser              |

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### Subject Didactics in Geography

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<thead>
<tr>
<th>Number</th>
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Data: 06.03.2019 12:57  Autumn Semester 2016  Page 690 of 1571
Abstract
Fundamentals (theory and practice) of specialist subject teaching for high-school geography lessons.

Objective
The course introduces students to the practical side of geography teaching. Participants look into the understanding of this school subject over the course of time and learn:
- how to plan their teaching in the context of the valid curricula, including on an interdisciplinary basis;
- how geographical contents can be implemented in didactic and methodological terms so as to ensure that fundamental competences can be imparted to pupils (knowledge, skills, attitudes), with a view to university studies as well;
- how to foster pupils in such a way that they can think independently in terms of spatial competence and can act in a responsible manner.

Content
Thematic Schwerpunkte
- Einführung in die Theorie der Geografiedidaktik.
- Bildungsauftrag der Geografie an Mittelschulen.
- Interesse der Lernenden am Geografieunterricht.
- Unterrichtsgestaltung und -vorbereitung: Sachanalyse, lernzielorientierte Unterrichtsplanung; Didaktische Analyse; Einführung in die Gestaltung von Lernarrangements.
- Mediendidaktik (Arbeiten mit Bildern und Karten).
- Planung einer Unterrichtseinheit (Struktur - Prozess - Verlauf).

Lernformen
Theoretische Konzepte werden präsentiert und an Beispielen diskutiert. Die Studierenden setzen sich mit Methoden aktiv auseinander (z.B. Lernpuzzle, Fallstudie sowie Sozial- und Aktionsformen) und reflektieren dabei ihre eigenen Schulerfahrungen im Fach.

Lecture notes
Unterlagen werden abgegeben.

Literature
Weitere Literaturangaben auf Liste.

Prerequisites / notice
Fachdidaktik I ist gleichzeitig mit dem Einführungspraktikum zu belegen. Sie gilt als Voraussetzung für Fachdidaktik II und III, sowie die FWV II und FWV III.
Fachdidaktik II findet nur im Sommersemester statt.
Fachdidaktik III kann parallel zur Fachdidaktik II im Sommersemester oder parallel zur FWV III (Ringvorlesung und FD-Seminar) im Herbstsemester belegt werden.

651-4124-00L Examination Didactics
■ Prerequisites: Successful completion of Geography Didactics of Geography Teaching I, II, III, IV as well as FV i, II, III, Introductory Internship and Internship.
Simultaneous enrolment in Examination Lessons Geography - course 651-2520-00L - is compulsory.

Content
Geprüft werden:
Fähigkeit, Geografie-Unterricht mit Bezug zur eigenen Praxis kritisch und unter verschiedenen Blickwinkeln (inhaltlich, methodisch-didaktisch) zu betrachten. Lernarrangements mit Bezug zum heutigen Bildungs- und Schulfachverständnis zu gestalten und kritisch zu hinterfragen sowie deren möglichen/erzielten Wirkungen zu diskutieren und zu begründen; Unterrichtssituationen zu reflektieren und zu evaluieren.

Unterlagen aus der Fachdidaktischen Ausbildung
Fachdidaktischer Text nach eigener Wahl

Lecture notes
Unterlagen aus der Fachdidaktik

Literature
Literaturlisten aus den Fachdidaktiken Geographie I-III

Prerequisites / notice
Die Fachdidaktik-Prüfung ist eine 15 minütige mündliche Prüfung. Sie findet am selben Tag wie die praktische Prüfung (2 Prüfungslektionen plus Kolloquium) statt.

651-4120-00L Geography Didactics IV: Mentored Project
■ Prerequisites: successful participation in Geography Didactics of Geography Teaching I+II+III (651-4239-00L, 651-2500-00L and 651-4118-00L).

Abstract
Mentorierte Arbeit mit Bezug zur Fachdidaktik

Objective
selbständige, theoretisch-gestützte Auseinandersetzung mit konkreter, praxisbezogener Fragestellung zum Geografieunterricht. Das Thema wird zu Beginn mit der Mentorin/ dem Mentor festgelegt.

Content
selbständige, mentorierte Arbeit zu einem Thema aus der Fachdidaktik mit direktem Bezug zur Lehrpraxis im Fach Geografie (z.B. zu eigenen Übungslektionen und Praktikum oder zur Unterrichtsforschung).

Prerequisites / notice
Frühstens parallel zum Fachdidaktik- Modul III zu belegen (Pflicht für ETH-Studierende)

651-4118-00L Geography Didactics of Geography Teaching III (University of Zurich)
No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.
UZH Module Code: 090GG3

Limited number of participants.
Prerequisites: successful participation in Geography Didactics of Geography Teaching I+II (651-4239-00L and 651-2500-00L).
Abstract

The Subject Didactics III course unit comprises two blocks: one "Specialisation" block with key subjects from courses I and II and a block on "Information technology in geography teaching" with specific applications.

Objective

- learn about the options for using ICT to design their geography teaching and also the integral furthearance of pupils’ IT competence. They plan an IT lesson, hold it and then evaluate it.
- identify the opportunities and limits of illustrating their geography teaching with films, models and experiments.
- look into the significance of the subjective theories for learning success and failure and discuss tuition options for a concept change (geographical case studies).

Content

- Fachdidaktik III Block "Vertiefung" (1/2 Semester)
  - Planung von Unterrichtseinheiten.
- Fachdidaktik III Block "ICT im Geografieunterricht" (1/2 Semester)
  - Fachspezifische Einsatzmöglichkeiten, Unterrichtshilfen, konkrete Anwendungen und Resultate an Beispielen kritisch reflektieren.

Lecture notes

Theoretical concepts are presented and illustrated with typical examples from practice. Examples from the IT sector are generated, presented and discussed by students themselves ("workshop").

Literature


Weitere Literaturangaben.

Professional Training in Geography

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>651-2519-01L</td>
<td>Introductory Internship (University of Zürich)</td>
<td>O</td>
<td>1</td>
<td>2P</td>
<td>B. Vettiger-Gallusser</td>
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<tr>
<td></td>
<td>No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: 090BPEP</td>
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<td>Mind the enrolment deadlines at UZH: <a href="http://www.uzh.ch/studies/application/mobilitaet_en.html">http://www.uzh.ch/studies/application/mobilitaet_en.html</a></td>
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<td></td>
<td>Simultaneous enrolment in Introductory Internship Geography (651-4219-01L), Practice Lessons for Didactics I an II (651-4219-02L) and Geography Didactics I (651-4239-00L) is compulsory.</td>
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<td>Abstract</td>
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<td>The Introductory Internship belongs to the practical expertise education of the teacher training for Upper Secondary Schools and must be completed at the beginning of studies.</td>
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<td>Prerequisites / notice</td>
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<td>The Introductory Internship can only be completed together with an accredited internship teacher of ETH Zurich (separate list).</td>
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</table>

| 651-2519-02L | Practice Lessons for Didactics (University of Zürich)               | O    | 2    | 4P    | B. Vettiger-Gallusser   |
|              | No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: 090BPUE |
|              | Mind the enrolment deadlines at UZH: http://www.uzh.ch/studies/application/mobilitaet_en.html |
|              | Simultaneous enrolment in Introductory Internship Geography (651-4219-01L), Practice Lessons for Didactics I an II (651-4219-02L) and Geography Didactics I (651-4239-00L) is compulsory. |
|              | Abstract                                                                 |
|              | The practice lessons help students to gain first experiences in teaching and to reflect the courses of the teacher training and didactics. Accurate planning (preliminary discussion, written proposal) is an integral part of this course as well as a wrap-up. |
|              | Prerequisites / notice                                                  |
|              | The Introductory Internship can only be completed together with an accredited internship teacher of ETH Zurich (separate list). |

| 651-2517-00L | Teaching Internship Geography (University of Zürich)                  | O    | 8    | 17P   | B. Vettiger-Gallusser   |
|              | No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: 090BPUP1 |
|              | Mind the enrolment deadlines at UZH: http://www.uzh.ch/studies/application/mobilitaet_en.html |
|              | Prerequisites: Successful completion of Educational Science and Subject Didactics in Geography (FD I, II, III) as well as Spec. Courses in Resp. Subj. w/ Educ. Focus & Further Subj. Didactics (FV I, II, III) plus completion of the introductory internship. |
|              | Abstract                                                                 |
|              | The Teaching Internship takes place after successful completion of the didactics courses (I, II incl. practice lessons). The teaching internship takes in 50 lessons: 30 are taught by the students, and the students sit in on 20 lessons. The teaching internship lasts a maximum of 10 weeks. |
|              | Prerequisites / notice                                                  |
|              | The Introductory Internship can only be completed together with an accredited internship teacher of ETH Zurich (separate list). |

| 651-2520-01L | Examination Lesson I Geography                                       | O    | 1    | 2P    | B. Vettiger-Gallusser   |
|              | Simultaneous enrolment in "Examination Lesson II"                   |      |      |       |                         |

Lecture notes
Dokument: Schriftliche Vorbereitung für Prüfungslektionen.

Prerequisites / notice
Bitte bei der Prüfungsanmeldung den schriftlichen Nachweis erbringen, dass die ganze Ausbildung abgeschlossen ist.

651-2520-02L Examination Lesson II Geography
Simultaneous enrollment in "Examination Lesson I Geography" (651-2520-01L) is compulsory.

Abstract
In the context of an examination lesson conducted and graded at a high school, the candidates provide evidence of the subject-matter-based and didactic skills they have acquired in the course of their training.

Objective
On the basis of a specified topic, the candidate shows that they are in a position - to develop and conduct teaching that is conducive to learning at high school level, substantiating it in terms of the subject-matter and from the didactic angle - to analyze the tuition they have given with regard to its strengths and weaknesses, and outline improvements.

Content

Lecture notes
Dokument: Schriftliche Vorbereitung für Prüfungslektionen.

Prerequisites / notice
Bitte bei der Prüfungsanmeldung den schriftlichen Nachweis erbringen, dass die ganze Ausbildung abgeschlossen ist.

651-4137-00L Semester Paper within the Teaching Internship Geography (University of Zurich)
No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.
UZH Module Code: 090BPPJ

Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

Only for Geography Teaching Diploma.
Simultaneous enrollment in "Teaching Internship Geography" (651-2517-00L) is compulsory.

Abstract
In the context of their teaching practice, students compile a portfolio in which they analyse and document selected aspects of their teaching experience.

Objective
The provision of insight into their personal, selected and also theoretically-founded:
- study of tuition elements and the compilation of a personal method profile based on subject-didactics assignments.
- processing of key events/happenings experienced during their teaching or teaching practice period (e.g. specialist content; didactic planning, conducting teaching, interaction with the class or individual pupils; communication with the teacher responsible for the teaching practice) in line with the instructions and the advice given in the guide for practical professional training (IGB UZH).

Content
- Erstellen eines Portfolios zum Praktikumsjournal (6-8 Seiten) und den dazu gehörenden Dokumenten (z.B. einem Beobachtungsprotokoll; einer Unterrichtsplanung; einer Lernaufgabe; einer Prüfung)
- Vorgängige Überlegungen (Problemstellung bzw. Vorbereitung einzelner Lektionen) werden schriftlich dokumentiert sowie die Erfahrungen reflektiert, die bei der Umsetzung und Durchführung des Unterrichts gemacht wurden.
- Im Praktikumsjournal sollen fachwissenschaftliche Aspekte, allgemein- und fachdidaktische Überlegungen, fachlich-pädagogische und didaktische Aspekte sowie konkrete Erfahrungen aus dem Praktikum einbezogen und angemessen miteinander in Verbindung gebracht werden.
- Die Art der Darstellung des Portfolios wird durch die Studierenden bestimmt.
- Der Hauptteil des Praktikumsjournals umfasst ca. sechs bis acht Seiten.
- Formal muss das Praktikumsjournal der Struktur einer wissenschaftlichen Arbeit entsprechen (Titelblatt, Inhaltsverzeichnis, Hauptteil, Schlusswort, Literatur- und Materialienangaben).

Lecture notes
Erarbeitung für das Unterrichtspraktikum und die unterrichtspraktischen Übungen:
- die berufspraktische Ausbildung am IFE LLBM; Wegleitung und Instrumente zur Vorbereitung, Durchführung und Reflexion sowie zur Beratung, Beobachtung und Beurteilung von Unterricht auf der Sekundarstufe II (Version 2012).
- Merkblatt Praktikumsjournal IFE LLBM
- Aufgabenstellungen für die berufspraktische Ausbildung aus der Fachdidaktik Geografie.

Literature

Prerequisites / notice


<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
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<tbody>
<tr>
<td>651-4237-01L</td>
<td>Specialised Courses in the Responsive Subject with an Educational Focus Geography</td>
<td>O</td>
<td>3 credits</td>
<td>2G</td>
<td>University lecturers</td>
</tr>
</tbody>
</table>

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: GEO891
Current approaches to research which are of relevance to society are presented on the basis of examples and critically examined in respect of their significance for a high-school education in the subject of geography.

Students
- look at the subject knowledge in its full breadth, on the basis of current approaches to research and with the consideration of specific examples, thereby creating a specialised basis on which to critically examine specialist contents for the school subject of geography, as part of a general education, over the course of time.
- see whether and where current topics from the specialist subject (research) can be incorporated in secondary-school tuition.
- familiarise themselves with questions and forms of cognition-oriented, moderately constructivist tuition.
- can reflect on geography teaching in an aware and theory-based manner.

Content
Veranstaltung:
In jeweils in sich geschlossenen Vorlesungen beleuchten Dozierende die gesellschaftliche Relevanz ihrer aktuellen Forschungsansätze an konkreten Beispielen aus der Physischen Geografie und den Erdwissenschaften, der Humangeografie sowie der Methodischen Geografie. Sie thematisieren dabei die Bedeutung der Ansätze für die Gesellschaft zur Auseinandersetzung mit räumlichen Fragestellungen und Problemlösungen und diskutieren die aus ihrem Forschungsansatz und den Ergebnissen resultierenden ethischen Fragen. Sie beleuchten damit die Breite des Fachverständnisses und legen das Fundament für die kritische Auseinandersetzung mit den allgemein bildenden Fachinhalten (Kompetenzen, Fachwissen, Einstellungen), die insbesondere in der gymnasialen Ausbildung im Fach Geographie vermittelt werden sollen.

Lecture notes
Zu jeder Vorlesung werden Folien/ Unterlagen abgegeben.

Literature
Wird von den jeweils verantwortlichen Dozierenden zusammengestellt.

Prerequisites / notice

It is recommended to attend the lecture series and seminar after Geography Didactics I - III.
### Abstract
Participants conduct a critical examination of regional geography in terms of the understanding of the subject and teaching in schools, and its potential for substantiated tuition is established.

### Objective
Regional geography observes delimited partial areas, mapped to different scales, considering thematic and exemplary aspects. Regional geography features in this form on a large number of geography syllabuses. Against this background, the module comprises two parts. A specialist lecture on the subject takes a specific regional example to highlight current, interdisciplinary topics and case studies. The aim here is to compile specialist contextual knowledge about a region. In an accompanying seminar, this contextual knowledge is then put in the correct practical form for teaching in a school, thus ensuring that the teachers are in a position to configure regional geography teaching that has been duly reflected on from the specialist-subject, didactic and pedagogical angle.

### Content
**Vorlesung**
- Übersicht über Themen, die für eine Region typisch sind oder sich in einer Region abspielen (z. B. Arabische Halbinsel, Afrika südlich der Sahara, Asien)
- Regionale Fallstudien mit interdisziplinärem Charakter
- Differenzierte Auseinandersetzung mit kulturellen und politischen Fragen und Entwicklungen in einer Region
- Erarbeiten von bedeutenden fachwissenschaftlichen Debatten zu einer Region

**Seminar**
- Regional-thematische Geografie versus traditionelle Länderkunde
- Geografisches Orientierungswissen: Stellenwert
- Werteerziehung und Interdisziplinarität im regionalgeogra-fischen Kontext
- Didaktische Analyse und Planung regionalgeografischen Unterrichts: Von der Sachanalyse über den Einstieg bis zur Bewertung
- Methoden und Recherche in der Regionalgeografie

**Lernformen**
- Fachwissenschaftliche Aspekte werden in der Form einer Vorlesung präsentiert. Die Studierenden vertiefen nach jeder Stunde die Inhalte und setzen diese im Hinblick auf die Schulpraxis um. Dabei wird ein elektronisches Lernumfeld geführt und über eine Lernplattform über die schulpraktische Umsetzung reflektiert. Es werden auch Materialien zusammengestellt.

### Lecture notes
Folien werden zur Verfügung gestellt.

Wird je nach regionalen Fokus zusammengestellt.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
<th>University lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>651-4247-10L</td>
<td>Regional Geography: Lecture and Didactic ConceptJapan (University of Zurich)</td>
<td>3</td>
<td>University lecturers</td>
</tr>
<tr>
<td>651-4247-30L</td>
<td>Regional Geography: Lecture and Didactic ConceptAustralia and Newzeeland (UZH)</td>
<td>2</td>
<td>University lecturers</td>
</tr>
</tbody>
</table>

Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html
Regional geography observes delimited partial areas, mapped to different scales, considering thematic and exemplary aspects. Regional geography features in this form on a large number of geography syllabuses. Against this background, the module comprises two parts. A specialist lecture on the subject takes a specific regional example to highlight current, interdisciplinary topics and case studies. The aim here is to compile specialist contextual knowledge about a region. In an accompanying seminar, this contextual knowledge is then put in the correct practical form for teaching in a school, thus ensuring that the teachers are in a position to configure regional geography teaching that has been duly reflected on from the specialist-subject, didactic and pedagogical angle.

### Content

- Vorlesung
  - Übersicht über Themen, die für eine Region typisch sind oder sich in einer Region abspielen (z. B. Arabische Halbinsel, Afrika südlich der Sahara, Asien)
  - Regionale Fallstudien mit interdisziplinärem Charakter
  - Differenzierte Auseinandersetzung mit kulturellen und politischen Fragen und Entwicklungen in einer Region
  - Erarbeiten von bedeutenden fachwissenschaftlichen Debatten zu einer Region
- Seminar
  - Regional-thematische Geografie versus traditionelle Länderkunde
  - Geografisches Orientierungs-Wissen: Stellenwert
  - Wertebewusstsein und Interdisziplinarität im regionalgeograﬁschen Kontext
  - Didaktische Analyse und Planung regionalgeograﬁscher Unterrichts: Von der Sachanalyse über den Einstieg bis zur Bewertung
  - Methoden und Recherche in der Regionalgeograﬁe

### Lecture notes

Lernformen
Fachwissenschaftliche Aspekte werden in der Form einer Vorlesung präsentiert. Die Studierenden vertiefen nach jeder Stunde die Inhalte und setzen diese im Hinblick auf die Schulpraxis um. Dabei wird ein elektronisches Lernumfeld geführt und über eine Lernplattform über die schulpädagogische Umsetzung reflektiert. Es werden auch Materialien zusammengestellt.

### Literature

Folienvon werden zur Verfügung gestellt.

### Additional Requirements (ETH-Masterstudents in ERDW and AC)

#### Part 1

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>651-2601-00L</td>
<td>Human Geography I: One Earth - Many Worlds (University of Zurich)</td>
<td>O</td>
<td>5 credits</td>
<td>2V+2U</td>
<td>University lecturers</td>
</tr>
</tbody>
</table>

Mind the enrolment deadlines at UZH: http://www.uzh.ch/studies/application/mobilitaet_en.html

- Imparting of research questions and basic principles in Human Geography
- To get an overview about basic research questions and principles of Human Geography
- (1) Society and space (2) Society and development (structure and dynamic of population, urbanisation, disparities (3) Society and natural environment (natural resources, food security, sustainability)
- PowerPoint-slides (German)

Humangeography III (Geographies of Difference) (Universität Zürich)

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: GEO232

Prerequisite: Human Geography II (UZH Module Code: GEO122)

Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

Abstract
Teil GEO232.1:
Das Seminar verfolgt das Ziel, ein tieferes Verständnis für sozialwissenschaftliche Grundlagen der Humangeographie zu gewinnen.

Teil GEO232.2:
In der Vorlesung und den Tutorien werden aktuelle wirtschaftsgeographische Themen behandelt. Demonstriert und erklärt wird insbesondere, wie die Wirtschaft mit Grenzen und Grenzziehungen umgeht.

Objective
- Sie vertiefen ihre theoretischen, empirischen und methodischen Fähigkeiten in folgenden Themenbereichen:
  - Gesellschaft und Raum
  - Gesellschaft und Entwicklung
  - Gesellschaft und natürliche Umwelt/Ressourcen
  - Offenheit und Geschlossenheit in Wirtschaft und Gesellschaft
  - Chancen und Herausforderungen einer globalisierten Weltwirtschaft
  - Sie sind in der Lage, Verknüpfungen zwischen grundlegenden sozial- und wirtschaftswissenschaftlichen Theorien und deren Konkretisierung in der Geographie herzustellen.
  - Sie können die erwähnten Themen mit ausgewähltem Faktenwissen verknüpfen und diskutieren
  - Sie schulen Ihre analytischen und theoretischen Fähigkeiten und können diese in Diskussionen einbringen
  - Sie können die Relevanz von weiterführenden wissenschaftlichen Texten diskutieren
  - Sie sind in der Lage, eine Diskussion über wissenschaftliche Themen zu strukturieren und - mit einfachen Moderationstechniken - zu moderieren

Prerequisites / notice
Besuch von GEO122.

Part 2

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>651-4088-03L</td>
<td>Physical Geography III (Geomorphology and Glaciology)</td>
<td>W</td>
<td>5</td>
<td>1V+1U</td>
<td>University lecturers</td>
</tr>
<tr>
<td></td>
<td>(University of Zürich)</td>
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</tr>
<tr>
<td></td>
<td>No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: GEO231</td>
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<td></td>
<td>Mind the enrolment deadlines at UZH:</td>
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</tr>
<tr>
<td></td>
<td><a href="http://www.uzh.ch/studies/application/mobilitaet_en.html">http://www.uzh.ch/studies/application/mobilitaet_en.html</a></td>
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</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Das Modul bietet eine kurze Einführung in einige Komponenten und Prozesse des hydrologischen Kreislaufs. Dabei werden einzelne Wasserspeicher (Schnee-, Boden und Grundwasser) und Flüsse zwischen den Speichern (Verdunstung, Niederschlag und Abfluss) betrachtet. Übungen ergänzen die Vorlesung.</td>
<td></td>
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</tr>
</tbody>
</table>

| 651-2603-00L| Geography. Matters. (University of Zurich)                  | W    | 4    | 2V          | University lecturers |
|             | (University of Zurich)                                     |      |      |             |                  |
|             | No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: GEO410 |
|             | Mind the enrolment deadlines at UZH:                      |      |      |             |                  |
|             | http://www.uzh.ch/studies/application/mobilitaet_en.html  |      |      |             |                  |
|             | Abstract                                                  |      |      |             |                  |
|             | The course demonstrates geography’s interdisciplinary approach to contribute solving urgent challenges ahead of society. Students are encouraged to reflect on the value of interdisciplinary research at discipline level and on their individual interdisciplinary curricula. The course creates awareness of ways that concepts structure our thinking, and how they figure in research and practice. |

| 651-2338-00L| Remote Sensing and Geographic Information Science III (University of Zürich) | W+   | 5    | 2V+3U       | University lecturers |
|             | No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: GEO233 |
|             | Mind the enrolment deadlines at UZH:                      |      |      |             |                  |
|             | http://www.uzh.ch/studies/application/mobilitaet_en.html  |      |      |             |                  |
|             | Abstract                                                  |      |      |             |                  |
|             | Exercices to the course Introduction Remote Sensing.      |      |      |             |                  |

Geography Teaching Diploma - Key for Type

<table>
<thead>
<tr>
<th>Type</th>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
<td></td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td></td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td></td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
<td></td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
<td></td>
</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
<td></td>
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</tbody>
</table>

Data: 06.03.2019 12:57   Autumn Semester 2016   Page 697 of 1571
### Key for Hours

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

**ECTS**

- European Credit Transfer and Accumulation System

**Note:** Special students and auditors need special permission from the lecturers.
**First Year Examinations**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-0241-00L</td>
<td>Analysis I</td>
<td>O</td>
<td>7</td>
<td>5V+2U</td>
<td>M.h. Akka Ginosar</td>
</tr>
<tr>
<td></td>
<td>Abstract: Mathematical tools for the engineer</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Objective: Mathematics as a tool to solve engineering problems.</td>
<td></td>
<td></td>
<td></td>
<td>Mathematical formulation of technical and scientific problems.</td>
</tr>
<tr>
<td></td>
<td>Content: Complex numbers.</td>
<td></td>
<td></td>
<td></td>
<td>Calculus for functions of one variable with applications.</td>
</tr>
<tr>
<td></td>
<td>Simple Mathematical models in engineering.</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Lecture notes: Die Vorlesung folgt weitgehend</td>
<td></td>
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<tr>
<td></td>
<td>Urs Stammbach, &quot;Analysis III&quot; (erhältlich im ETH Store);</td>
<td></td>
<td></td>
<td></td>
<td><a href="https://people.math.ethz.ch/~stammb/analysisskript.html">https://people.math.ethz.ch/~stammb/analysisskript.html</a></td>
</tr>
<tr>
<td>401-0141-00L</td>
<td>Linear Algebra and Numerical Analysis</td>
<td>O</td>
<td>5</td>
<td>3V+1U</td>
<td>V. C. Gradinaru, R. Käppeli</td>
</tr>
<tr>
<td></td>
<td>Abstract: Introduction to Linear Algebra and Numerical Analysis with emphasis on both abstract concepts and algorithms.</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Objective: To acquire basic knowledge of Linear Algebra and Numerical Methods. Enhanced capability for abstract and algorithmic thinking based on mathematical concepts and models. Ability to select appropriate numerical linear algebra methods, to apply them properly and to implement them efficiently in MATLAB.</td>
<td></td>
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<tr>
<td></td>
<td>Content: 1. Linear systems of equations</td>
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<tr>
<td></td>
<td>2. Vector and matrix calculus</td>
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<td></td>
<td>3. Subspaces and bases</td>
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<td></td>
<td>4. The Euclidean space Rn</td>
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<tr>
<td></td>
<td>5. Numerical linear algebra with MATLAB</td>
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<tr>
<td></td>
<td>6. Linear mappings [optional]</td>
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<tr>
<td></td>
<td>7. Diagonalization (eigenproblems)</td>
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<tr>
<td>252-0845-00L</td>
<td>Computer Science I</td>
<td>O</td>
<td>5</td>
<td>2V+2U</td>
<td>M. Hirt</td>
</tr>
<tr>
<td></td>
<td>Abstract: The course covers the basic concepts of computer programming.</td>
<td></td>
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<tr>
<td></td>
<td>Objective: Basic understanding of programming concepts. Students will be able to write and read simple programs and to modify existing programs.</td>
<td></td>
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</tr>
<tr>
<td>101-0031-01L</td>
<td>Systems Engineering</td>
<td>O</td>
<td>4</td>
<td>3G</td>
<td>B. T. Adey, C. Richmond</td>
</tr>
<tr>
<td></td>
<td>Abstract: An introduction to system development, analysis and optimization, and decision making, with focus on linear programming, networks, formal decision methods and economic analysis.</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Objective: - to gain competency in methods used to plan and analyse systems</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>- to gain the ability to formulate, analyse and solve complex problems</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>- to gain competency in the methods used for the evaluation of multiple solutions</td>
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<tr>
<td></td>
<td>Content: - Introduction</td>
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</tr>
<tr>
<td></td>
<td>- System development</td>
<td></td>
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<tr>
<td></td>
<td>- System analysis</td>
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<tr>
<td></td>
<td>- Networks</td>
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<td></td>
<td>- Decision theory</td>
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<tr>
<td></td>
<td>- Economic analysis</td>
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<tr>
<td></td>
<td>- Cost-benefit analysis</td>
<td></td>
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<tr>
<td></td>
<td>Lecture notes: Script and transparencies as well as additional material via Moodle. The transparencies will be provided via Moodle two days before the respective class.</td>
<td></td>
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<tr>
<td>101-0031-02L</td>
<td>Business Administration</td>
<td>O</td>
<td>2</td>
<td>2V</td>
<td>M. Passardi</td>
</tr>
<tr>
<td></td>
<td>Abstract: Remark: Students BSc Civil Engineering (StR2014) are not allowed to assign to 101-0031-02, but have to assign 101-0031-04 in spring semester (2. Sem).</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Objective: Prepare and analyze the financial statements of organizations</td>
<td></td>
<td></td>
<td></td>
<td>Establish budget and determine profitability of investment</td>
</tr>
<tr>
<td></td>
<td>Understand the major costing systems</td>
<td></td>
<td></td>
<td></td>
<td>Perform some product calculations</td>
</tr>
</tbody>
</table>

Data: 06.03.2019 12:57
Autumn Semester 2016
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Overview in business administration

This course gives an overview of the basic concepts of geology and petrography and shows some links to the application of these concepts. The course consists of lectures and exercises in groups. The lectures cover all aspects of the dynamic earth, from the history of the earth, to the formation of rocks, mountains, and oceans, and the degradation processes shaping the uppermost earth’s crust.

Abstract

This course gives an overview of the basic concepts of geology and petrography and shows some links to the application of these concepts.

Objective

This course gives an overview of the basic concepts of geology and petrography and shows some links to the application of these concepts.

Content

- Landslides and Rutschungen, Groundwater, Rivers, Wind and Glaciers, Processes in the Earth’s crust, the Schatzkammer Earth and its Geology
- Übungen zum Gesteinsbestimmen and Lesen von geologischen, tektonischen und geotechnischen Karten, einfache Konstruktionen

Lecture notes

The course is based on the book Dynamic Earth from Press & Siever

Literature

Press, F.; Siever, R.: Allgemeine Geologie, Spektrum Akademischer Verlag, Heidelberg

---

Geology and Petrography

651-0032-00L

Abstract

This course gives an overview of the basic concepts of geology and petrography and shows some links to the application of these concepts. The course consists of lectures and exercises in groups. The lectures cover all aspects of the dynamic earth, from the history of the earth, to the formation of rocks, mountains, and oceans, and the degradation processes shaping the uppermost earth’s crust.

Objective

This course gives an overview of the basic concepts of geology and petrography and shows some links to the application of these concepts.

Content

- Landslides and Rutschungen, Groundwater, Rivers, Wind and Glaciers, Processes in the Earth’s crust, the Schatzkammer Earth and its Geology
- Übungen zum Gesteinsbestimmen and Lesen von geologischen, tektonischen und geotechnischen Karten, einfache Konstruktionen

Lecture notes

The course is based on the book Dynamic Earth from Press & Siever

Literature

Press, F.; Siever, R.: Allgemeine Geologie, Spektrum Akademischer Verlag, Heidelberg

---

Biology III: Essentials of Ecology

701-0243-01L

Abstract

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

Objective

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

Content

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

Lecture notes

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

Literature

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

3. Semester

Compulsory Courses

Examination Block 1

- Physics

Abstract

This course will cover the basic topics in Physics and will show/display/explain with a variety of experiments the most important physical effects. The course will address classical as well as modern physics, and the interplay between basic research and applications.

Objective


Content

- Elektromagnetismus: Elektrostatik and Magnetostatik, Strom, Spannung and Widerstand, Maxwell-Gleichungen, elektromagnetische Wellen, elektromagnetische Eigenschaften of the Materie.
- Thermodynamik: Temperatur and Wärme, Zustandsgleichungen, erster and zweiter Hauptsatz der Wärmelehre, Entropie, Transportvorgänge.
- Quantenphysik and Atomphysik.
- Schwingungen and Wellen.
- Grundlagen of the speziellen Relativitätstheorie.

Lecture notes

Manuskript and Übungsbilder
### Examination Block 2

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
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<tbody>
<tr>
<td>103-0115-00L</td>
<td>Geodetic Metrology II</td>
<td>O</td>
<td>5</td>
<td>4G</td>
<td>A. Wieser, G. Boffi</td>
</tr>
<tr>
<td>103-0253-00L</td>
<td>Geoprocessing and Parameter Estimation</td>
<td>O</td>
<td>5</td>
<td>4G</td>
<td>A. Geiger, M. Meindl</td>
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<tr>
<td>103-0214-00L</td>
<td>Cartography I</td>
<td>O</td>
<td>5</td>
<td>4G</td>
<td>L. Hurni</td>
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<tr>
<td>103-0313-00L</td>
<td>Planning I</td>
<td>O</td>
<td>5</td>
<td>4G</td>
<td>G. Nussbaumer, P. Rütsche</td>
</tr>
<tr>
<td>103-0233-01L</td>
<td>GIS I</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>M. Raubal</td>
</tr>
</tbody>
</table>

---

**Literature**

- Hans J. Paus, Physik in Experimenten und Beispielen, Carl Hanser Verlag München Wien (als unterrichtsbegleitendes und ergänzendes Lehrbuch)
- Philippe Limpach, General Adjustment and Collocation, Alain Geiger

**Content**

- Mathematical modeling of engineering problems, general adjustment, minimization principles, propagation of variances, uncertainty of measurements, dealing with heterogeneous measurement types, linear/non linear regression, autocorrelation and colocation

**Lecture notes**

- Parameter estimation and Adjustment
- Philippe Limpach, General Adjustment and Collocation
- Alain Geiger

**Prerequisites / notice**

- Linear Algebra, Statistics

---

**Objective**

- The students are capable of analysing measurements with with appropriate methods. They can optimally extract model parameters from real measurements and are able to analyse and to retrieve additional information from time series. They understand the underlying algorithms of different geometric analysis tools and processing methods for map graphics.

**Abstract**

- This course provides basic knowledge on parameter estimation and data processing. The necessary mathematical and statistical methods are developed and applied to actual examples in geomatics.

**Number**

- 5 credits

**Hours**

- 4G

---

**Objective**

- The students acquire enhanced knowledge regarding the operating mode, the application and the limitations of modern geodetic standard instruments. They will be able to properly select, test and apply these instruments for geodetic tasks with higher accuracy requirements. They will get acquainted with the typical workflow from the preparation of the field works to the digital or plotted plan. Finally, the students will be introduced to specific geodetic tasks related to construction and civil engineering.

**Content**

- The geometry workflow
- Propagation of light in the atmosphere
- The modern total station
- Terrestrial Laserscanning
- Digital levels
- Field tests
- Transformations and Centering
- Trigonometric leveling
- Precision leveling
- Route planning and transition curves
- Earthworks: Area and cubature

**Lecture notes**

- The slides and documents for enhanced study and further reading will be provided online.

**Literature**

Abstract
Fundamentals of geoinformation technologies: spatial data modeling, metrics & topology, vector and raster data, thematic data, spatial queries and analysis, spatial databases; labs with GIS software

Objective
Knowing the fundamentals of geoinformation technologies for the realization, application and operation of geographic information systems in engineering projects.

Content
Einführung GIS & GIScience
Konzeptionelles Modell & Datenschema
Vektorgeometrie & Topologie
Rastergeometrie und -algebra
Thematische Daten
Räumliche Abfragen & Analysen
Geodatenbanken

Lecture notes
Vorlesungspräsentationen werden digital zur Verfügung gestellt.

Literature

Examination Block 3
In place of the German course 851-0703-03L Introduction to Law for Civil Engineering students can take the French course 851-0709-00L Droit civil.

Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
851-0703-03L | Introduction to Law for Civil Engineering | W | 2 credits | 2V | G. Hertig

Abstract
This class introduces students to basic features of the legal system. Questions of constitutional and administrative law, contract law, tort law, corporate law, as well as litigation are covered.

Objective
Introduction to fundamental questions of public and private law which serves as a foundation for more advanced law classes.

Content
1. Public Law
   Constitutional law: sources of law, organization of the state, fundamental rights. Administrative law: administrative decisions, organization of the administration, enforcement of administrative decisions, procedural law, basics of police, environmental and zoning law.

2. Private law

Lecture notes
There are ‘Lecture Notes’ (in German) for this course.

Literature
Further information is available at http://www.hertig.ethz.ch/education/grundzuege-des-rechts-fuer-baug-und-arch.html

851-0709-00L | Introduction to Civil Law | W | 2 credits | 2V | H. Peter

Abstract
The course Private Law focuses on the Swiss Code of Obligations (contracts, torts) and on Property Law (ownership, mortgage and easements). In addition, the course will provide a short overview of Civil Procedure and Enforcement.

Objective

Content
Le cours de droit civil porte notamment sur le droit des obligations (droit des contrats et responsabilité civile) et sur les droits réels (propriété, gages et servitudes). De plus, il est donné un bref aperçu du droit de la procédure et de l'exécution forcée.

Literature
Editions officielles récentes des lois fédérales, en langue française (Code civil et Code des obligations) ou italienne (Codice civile e Codice delle obbligazioni), disponibles auprès de la plupart des librairies.

Sont indispensables:
- le Code civil et le Code des obligations;
- Sont conseillés:
  - Nef, Urs Ch.: Le droit des obligations à l'usage des ingénieurs et des architectes, trad. Bovay, J., éd. Payot, Lausanne
  - Boillod, J.-P.: Manuel de droit, éd Slatkine, Genève

Remarques
- Le cours de droit civil et le cours de droit public (2e sem.) sont l'équivalent des cours "Recht I" et "Recht II" en langue allemande et des exercices y relatifs.
- Les examens peuvent se faire en français ou en italien.
- Examen au 1er propédeutique; convient pour travail de semestre.
- Les examens peuvent se faire en français ou en italien.
- Examen au 1er propédeutique; convient pour travail de semestre.

5. Semester
Compulsory Courses 5. Semester

Examination Block 4

Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
103-0126-00L | Geodetic Reference Systems | O | 3 credits | 2G | M. Meindl

Abstract
Fundamentals and theory of geodetic reference systems and frames. Introduction to current international systems as well as to systems for the Swiss national geodetic survey.

Objective
Introduction to fundamental knowledge and theory to get familiar with the applications of geodetic reference systems. Special emphasis will be placed on international global systems as well as on the systems of the Swiss national geodetic survey.

Content
Various coordinate systems and transformations; reference systems and frames (inertial, Earth-fixed, topocentric) and associated transformations between the systems; introduction to Earth rotation theory; time systems; Swiss national geodetic survey

Lecture notes
Script will be provided electronically as pdf file.

Prerequisites / notice
If possible, a field trip to the geodetic fundamental station Zimmerwald (Bern) will be offered.

103-0184-00L | Higher Geodesy | O | 5 credits | 4G | M. Rothacher

Prerequisites / notice
If possible, a field trip to the geodetic fundamental station Zimmerwald (Bern) will be offered.
Abstract

Objective
Overview over the entire spectrum of Higher Geodesy

Content
Actual methods of Higher Geodesy. Basics of Shape of the Earth: Geodetic determination and deflection of the vertical. Introduction into the most important topics: Satellite Geodesy (GPS) and Navigation; Physical Geodesy and gravity field of the Earth; Astronomical Geodesy and Positioning; Mathematical Geodesy and basics of Geodynamics. Reference systems and applications in National and Global Geomatics.

Lecture notes

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>103-0435-01L</td>
<td>Land Management</td>
<td>O</td>
<td>5 credits</td>
<td>4G</td>
<td>G. Nussbaumer, F. Frei, M. Huhmann, R. Michelon</td>
</tr>
<tr>
<td>101-0515-00L</td>
<td>Project Management</td>
<td>O</td>
<td>2 credits</td>
<td>2G</td>
<td>M. Kersting</td>
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<tr>
<td>101-0415-01L</td>
<td>Railway Infrastructures (Transportation II)</td>
<td>O</td>
<td>3 credits</td>
<td>2G</td>
<td>U. A. Weidmann</td>
</tr>
<tr>
<td>103-0245-01L</td>
<td>Thematic Cartography</td>
<td>W</td>
<td>2 credits</td>
<td>2G</td>
<td>L. Hurni</td>
</tr>
</tbody>
</table>

Objective
Typical map types (focus on quantitative information), analysis of themes and application, base maps, generalisation

Content
First part: Spatial planning on the Commune level with focus on the special land use management
Second part: land re-allocation as an instrument of spatial planning; specific explanations for land re-allocations in rural areas and in construction zones.
Third part: land marketing; the view of investors.

Objective
Getting knowledge in spatial planning and land re-allocation as an interactive process.

Content
PART 1: Spatial Planning and Special Land Use Management
- Overview about Spatial Planning on the commune level
- workflows and planning methods on the commune level
- comprehension of the public
- getting knowledge of the special land use management

PART 2: Methods of Land Re-Allocation
- Intensions and principles of land re-allocation
- implementation of the land re-allocation
- land re-allocation in construction zones
- amelioration

PART 3: Agricultural Planning

Lecture notes
Lecture notes and slides (in German) can be downloaded from the PLUS homepage.

Download: http://www.irl.ethz.ch/plus/education

Literature
References in the lecture notes

Prerequisites / notice
Knowledge of most important thematic map types.
Ability to design adequate thematic maps from statistical data.
Content
Thematic map types (focus on quantitative information)
Analysis of themes and application using adequate structural types
Use of adequate base maps
Generalisation of thematic maps
Dynamic thematic maps

Lecture notes
Will be distributed.

Literature
- Terry A. Slocum, Terry et al. (2004): "Thematic Cartography and Geographic Visualization. 2nd ed. Prentice Hall, ISBN 0130351237"

Prerequisites / notice
Prerequisite: Cartography Introduction
Further information at http://www.karto.ethz.ch/studium/lehrangebot.html

Elective Block: Geodesy and Geodetic Metrology

Number 103-0125-00L
Title Geodetic Networks and Parameter Estimation
Type W
ECTS 3
Hours 3G
Lecturers S. Guillaume

Abstract
This course provides knowledge for parameter estimation and data analysis in geodetic networks. The necessary mathematical and statistical methods are explained and applied by means of concrete examples.

Objective
The students are able to plan, pre-analyse and perform analysis of geodetic networks for practical problems. They are able to understand and develop geodetic software.

Content
- Refreshment of statistical and probabilistic basics (simulations with random number generators, correlated random noise, empirical density and distribution functions, hypothesis tests), 2D +1 and 3D terrestrial and satellite based observation equations, coordinate transformation (Helmert, affine), geodetic datum problem (free networks, stochastic datum, constrained datum), quality indicators of geodetic networks (global and local accuracy resp. reliability), robust estimators (M-estimators, L-estimators, LMS-estimator), network optimization (manual, semi-automatic), deformation measurements (congruence test, S-transformations)

Prerequisites / notice
Linear algebra, statistic and probability, geoprocessing and parameter estimation, geodetic metrology

Elective Block: Spatial Development and Environmental Planning

Number 103-0315-00L
Title Global Navigation Satellite Systems
Type W
ECTS 3
Hours 3G
Lecturers M. Rothacher

Abstract
GPS, GLONASS, Galileo, COMPASS, QZSS as GNSS. System components, signal structure, reference and time systems and observation equations. Forming of differences and linear combinations, Satellite orbits and clocks, tropospheric and ionospheric refraction, antenna phase centers, multipath and measurement noise. Observation techniques and ambiguity resolution. Reference station networks and services.

Objective
Acquisition of the theoretical and practical basics of the different GNSS. Understanding of the most important error sources and observation techniques for applications in surveying, positioning, navigation, GIS, in geomonitoring and in the Earth and Environmental Sciences.

Content
Overview of the different GNSS (GPS, GLONASS, Galileo, Compass and QZSS) with the corresponding system components, signal structures, reference and time systems and observation equations for pseudorange and phase measurements. Forming of differences and linear combinations of the original observations. Error sources: satellite orbits and clocks, tropospheric and ionospheric refraction, antenna phase centers, relativistic effects, multipath and measurement noise. Processing strategies and observation techniques as well as methods for ambiguity resolution. Reference station networks and services. Many examples of applications. Practical and computational exercises for the recording and analysis of GNSS measurements.

Lecture notes

Elective Block: Transport
401-0647-00L

Introduction to Mathematical Optimization

W 5 credits 2V+1U D. Adjiashvili

Abstract
Introduction to basic techniques and problems in mathematical optimization, and their applications to problems in engineering.

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

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

Literature
Information about relevant literature will be given in the lecture.

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

363-0503-00L

Principles of Microeconomics

W 3 credits 2G M. Filippini

Abstract
The course introduces basic principles, problems and approaches of microeconomics.

Objective
The learning objectives of the course are:
(1) Students must be able to discuss basic principles, problems and approaches in microeconomics. (2) Students can analyse and explain simple economic principles in a market using supply and demand graphs. (3) Students can contrast different market structures and describe firm and consumer behaviour. (4) Students can identify market failures such as externalities related to market activities and illustrate how these affect the economy as a whole. (5) Students can apply simple mathematical treatment of some basic concepts and can solve utility maximization and cost minimization problems.

Lecture notes
Lecture notes, exercises and references can be downloaded from Moodle.

Literature
The book can also be used for the course "Principles of Macroeconomics" (Sturm)

Complementary:

GESS Science in Perspective

Recommended GESS Science in Perspective (Type B) for D-BAUG:
see GESS Science in Perspective: Type A: Enhancement of Reflection Capability

see GESS Science in Perspective: Language Courses

Electives

The entire course programs of ETH Zurich and the University of Zurich are open to the students to individual selection.

Recommended Electives of Bachelor Degree Programme

Number Title Type ECTS Hours Lecturers

252-1425-00L Geometry: Combinatorics and Algorithms W* 6 credits 2V+2U+1A B. Gärtner, E. Welzl, M. Hoffmann, A. Pilz

Abstract
Geometric structures are useful in many areas, and there is a need to understand their structural properties, and to work with them algorithmically. The lecture addresses theoretical foundations concerning geometric structures. Central objects of interest are triangulations. We study combinatorial (Does a certain object exist?) and algorithmic questions (Can we find a certain object efficiently?)

Objective
The goal is to make students familiar with fundamental concepts, techniques and results in combinatorial and computational geometry, so as to enable them to model, analyze, and solve theoretical and practical problems in the area and in various application domains. In particular, we want to prepare students for conducting independent research, for instance, within the scope of a thesis project.

Content
Planar and geometric graphs, embeddings and their representation (Whitney's Theorem, canonical orderings, DCEL), polygon triangulations and the art gallery theorem, convexity in R^d, planar convex hull algorithms (Jarvis Wrap, Graham Scan, Chan's Algorithm), point set triangulations, Delaunay triangulations (Lawson flips, lifting map, randomized incremental construction), Voronoi diagrams, the Crossing Lemma and incidence bounds, line arrangements (duality, Zone Theorem, ham-sandwich cuts), 3-SUM hardness, counting triangulations.

Lecture notes
Yes

Literature

Prerequisites / notice
Prerequisites: The course assumes basic knowledge of discrete mathematics and algorithms, as supplied in the first semesters of Bachelor Studies at ETH.

Outlook: In the following spring semester there is a seminar "Geometry: Combinatorics and Algorithms" that builds on this course. There are ample possibilities for Semester-, Bachelor- and Master Thesis projects in the area.

103-0240-00L Cartography Seminar W 4 credits 9S L. Hurni

Abstract
Independent scholarly piece based on up-to-date papers, text books, and internet sources. The thematic topic will be defined together with the supervision in the beginning.

Objective
Analysis and evaluation of text and other sources; structuring and writing a concise and reader-friendly seminar Report.

Content
German

Lecture notes
An information sheet will be distributed in the beginning by the supervisor.

Literature
Text references and internet sources will be distributed in the beginning by the supervisor.

Prerequisites / notice
Cartography I

103-0241-00L Cartography Lab 1 W 6 credits 13S L. Hurni

Data: 06.03.2019 12:57 Autumn Semester 2016 Page 705 of 1571
Abstract
Independent practical work in cartography

Objective
Independent practical work in cartography

Content
Choice of theme upon individual agreement

Prerequisites / notice
German or English

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**103-0242-00L Cartography Lab 2**

<table>
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<td>103-0242-00L</td>
<td>Cartography Lab 2</td>
<td>W</td>
<td>8 credits</td>
<td>17S</td>
<td>L. Hurni</td>
</tr>
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</table>

Abstract
Independent practical work in cartography

Objective
Independent practical work in cartography

Content
Choice of theme upon individual agreement

Prerequisites / notice
German or English

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**Bachelor’s Thesis**

Course Catalogue of ETH Zurich

### Bachelor’s Thesis

**Number**
103-0006-00L

**Title**
Bachelor’s Thesis

<table>
<thead>
<tr>
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<tr>
<td>O</td>
<td>10 credits</td>
<td>20D</td>
<td>Lecturers</td>
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</tbody>
</table>

**Abstract**
The Bachelor Programme concludes with the Bachelor Thesis. This project is supervised by a professor. Writing up the Bachelor Thesis encourages students to show independence and to produce structured work.

**Objective**
Encourages students to show independence, to produce scientifically structured work and to apply engineering working methods.

**Content**
The contents base upon the fundamentals of the Bachelor Programme. Students can choose from different subjects and tasks. The thesis consists of both a written report and an oral presentation.

### Geomatic Engineering and Planning Bachelor - Key for Type

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
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<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
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<td>W+</td>
<td>Eligible for credits and recommended</td>
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<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
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<td>Z</td>
<td>Courses outside the curriculum</td>
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<td>Suitable for doctorate</td>
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### Key for Hours

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<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
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<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
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</table>

ECTS
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
### Geomatic Engineering Master

#### Major Courses

##### Major in Engineering Geodesy and Photogrammetry

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>103-0287-00L</td>
<td>Image Interpretation</td>
<td>O</td>
<td>4</td>
<td>3G</td>
<td>J. D. Wegner, S. Galliani, M. Rothermel</td>
</tr>
</tbody>
</table>

**Abstract**
Introduction to interactive, semi-automatic and automatic methods for image interpretation; methodological aspects of computer-assisted remote sensing, including semantic image classification and segmentation; detection and extraction of individual objects; estimation of physical parameters.

**Objective**
Understanding the tasks, problems, and applications of image interpretation; basic introduction of computational methods for image-based classification and parameter estimation (clustering, classification, regression), with focus on remote sensing.

**Content**
- Image (and point-cloud) interpretation tasks: semantic classification (e.g. land-cover mapping), physical parameter estimation (e.g. forest biomass), object extraction (e.g. roads, buildings), visual driver assistance;
- Image coding and features; probabilistic inference, generative and discriminative models; clustering and segmentation; continuous parameter estimation, regression; classification and labeling; atmospheric influences in satellite remote sensing;

**Literature**
C. Bishop: Pattern Recognition and Machine Learning

**Prerequisites / notice**
basics of probability theory and statistics; basics of image processing; elementary programming skills (Matlab);

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Lecturers</th>
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<tr>
<td>103-0137-00L</td>
<td>Engineering Geodesy</td>
<td>O</td>
<td>4</td>
<td>3G</td>
<td>A. Wieser, E. Serantoni</td>
</tr>
</tbody>
</table>

**Abstract**
Introduction to Engineering Geodesy: methods, instruments, and applications.

**Objective**
The students will be introduced to the methods, instruments and applications in Engineering Geodesy with a focus on end-to-end quality assessment, sensor and multi-sensor-systems, setting out, and monitoring of engineering objects. They will be able to acquire enhanced knowledge and fundamental competences in high-precision angle, distance and height measurements. They will be introduced to aspects of interdisciplinary work in particular related to construction processes and civil engineering.

**Content**
- Introduction: Definition, methods, and tasks
- Planning and realizing geodetic networks
- High precision distance, angle and height measurements
- Sensors and multi-sensor-systems
- Calibration and testing
- Engineering Geodesy in construction above and below ground
- Tunnel surveying
- Building Information Modeling (BIM)
- Deformation monitoring: Models, methods, and applications

**Literature**

**Prerequisites / notice**
Fundamental knowledge in geodetic metrology (applied geodesy), physical geodesy, reference systems, GNSS and parameter estimation is required for this course. This knowledge can for instance been acquired within the appropriate courses of the bachelor studies in Geomatics and Planning.

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<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<tr>
<td>103-0267-01L</td>
<td>Photogrammetry and 3D Vision Lab</td>
<td>O</td>
<td>3</td>
<td>2P</td>
<td>J. D. Wegner</td>
</tr>
</tbody>
</table>

**Abstract**
The course deals with selected topics of close-range photogrammetry and geometric computer vision, including wide-baseline image matching and reconstruction, dense surface reconstruction, image search and indexing; emphasis is put on reading and self-study and on practical project work, typically in groups.

**Objective**
The aim of the course is to get to know the methods and practice of close-range photogrammetric reconstruction, and an in-depth understanding of selected topics in modern close-range photogrammetry and computer vision.

**Content**
This course builds in part on the courses "Photogrammetrie", "Bildverarbeitung" and "Photogrammetrie II" from the Bachelor program. It focuses on the particular challenges of automated close-range photogrammetry.

**Literature**
Recommended textbooks:
- T. Luhmann, Nahbereichsphotogrammetrie (also available in English)
- R. Hartley and A. Zisserman. Multi-view geometry in computer vision
- R. Szeliski. Computer Vision

**Prerequisites / notice**
A recommended prerequisite for taking this course are the Bachelor courses "Photogrammetrie", "Bildverarbeitung" and "Photogrammetrie II". If you have not passed them, please contact the main lecturer of the course before enrolling. The course will include both practical work with commercial software, and programming in Matlab.

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>103-0767-00L</td>
<td>Engineering Geodesy Lab</td>
<td>O</td>
<td>4</td>
<td>3P</td>
<td>A. Wieser, R. Mautz</td>
</tr>
</tbody>
</table>

**Abstract**
Development of concepts and solutions for challenging tasks in Engineering Geodesy using real-world examples

**Objective**
The students learn to develop, assess and realize concepts and solutions for real-world problems in Engineering Geodesy. They advance the knowledge and skills which they have acquired in relation with geodetic metrology, engineering geodesy. They establish links between these subjects. Particular attention is paid to the selection of appropriate sensors and measurement systems, selection of appropriate measurement and data processing methods, end-to-end quality control, fulfillment of non-technical criteria, and to the documentation of the work.

**Content**
Actual real-world problems are chosen for this lab depending on the number, background and experience of the students.

In Fall 2016 one of the problems will be a study of the layout of railway tracks associated with changes of a train station, carried out under various technical and legal restrictions.

An additional problem will be chosen in connection with current research projects within the Geosensors and Engineering Geodesy Group. Examples of such problems are:
- high-precision transfer of coordinates and orientation through a long vertical shaft
- monitoring of the deformation of an ice-pancake
- development of a 2D-machine-control-and guidance system
- bridge vibration monitoring
The course is giving an introduction into SAR techniques, the interpretation of SAR imaging responses and the use of SAR for different applications. The students will get an understanding of the nature, role and importance of cadastral systems and related concepts such as land administration, land registration and spatial data infrastructures (SDIs). The Swiss cadastral system as well as a range of international systems are covered. The course is divided into 8 sessions (2 hours): the first hour of each is given in the form of a lecture, the second in the form of a case-study. If the timetable of the participants allows it, the 3-hourly lab units will partially be combined to individual full-time units.

103-0787-00L Project Parameter Estimation

Abstract
Solving engineering problems with modern methods of parameter estimation for network adjustment in a real-world scenario; choosing adequate mathematical models, suitable data-flow and performing software analysis.

Objective
Learn to solve engineering problems with modern methods of parameter estimation in a real-world scenario.

Content
Analysis of the given problem, selection of effective mathematical models, use of appropriate software.

Prerequisites / notice
Prerequisite: Statistics and Probability Theory, Geoprocessing and Parameterestimation, Geodetic Reference Systems and Networks

102-0617-00L Basics and Principles of Radar Remote Sensing for Environmental Applications

Abstract
The course will provide the basics and principles of Radar Remote Sensing (specifically Synthetic Aperture Radar (SAR)) and its imaging techniques for the use of environmental parameter estimation.

Objective
The course should provide an understanding of SAR techniques and the use of the imaging tools for bio/geophysical parameter estimation. At the end of the course the student has the understanding of:
1. SAR basics and principles,
2. SAR polarimetry,
3. SAR interferometry and
4. environmental parameter estimation from multi-parametric SAR data

Content
The course is giving an introduction into SAR techniques, the interpretation of SAR imaging responses and the use of SAR for different environmental applications. The outline of the course is the following:
1. Introduction into SAR basics and principles
2. Introduction into electromagnetic wave theory
3. Introduction into scattering theory and decomposition techniques
4. Introduction into SAR interferometry
5. Introduction into polarimetric SAR interferometry
6. Introduction into bio/geophysical parameter estimation (classification/segmentation, soil moisture estimation, earth quake and volcano monitoring, forest height inversion, wood biomass estimation etc.)

Prerequisites / notice
Prerequisite: Statistics and Probability Theory, Geoprocessing and Parameterestimation, Geodetic Reference Systems and Networks

851-0724-00L Property Law for Geometers: Land Registry and Geoinformation Law

Abstract
Fundamental concepts of Land Register Law and Land Surveying Law (substantive and procedural rules of Land Register Law, the parts and the relevance of the Land Register, process of registration with the Land Register, legal problems of land surveying, reform of the official land surveying).

Objective
Overview of the legal norms of land registry and surveying law.

Content
Basic principles of material and formal land registry law, components of the land register, consequences of the land register, the registration process, legal problems of surveying, the reform of official surveying, liability of the geometer. The lecture unit is carried out within a frame of 8 sessions (2 hours); the first hour of each is given in the form of a lecture, the second in the form of a case-study.

Prerequisites / notice
Requirements: Property Law (12-722)
## Major in Space Geodesy and Navigation

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>103-0187-01L</td>
<td>Space Geodesy</td>
<td>0</td>
<td>4</td>
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<td>M. Rothacher</td>
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<tr>
<td>103-0567-01L</td>
<td>Signal Processing, Modeling, Inversion</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>A. Geiger</td>
</tr>
<tr>
<td>103-0627-00L</td>
<td>Astro and Gravity Lab</td>
<td>W</td>
<td>5</td>
<td>4P</td>
<td>S. Guillaume</td>
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</tbody>
</table>

### Computer Vision
- **Abstract**: The goal of this course is to provide students with a good understanding of computer vision and image analysis techniques. The main concepts and techniques will be studied in depth and practical algorithms and approaches will be discussed and explored through the exercises.
- **Objective**: The objectives of this course are:
  1. To introduce the fundamental problems of computer vision.
  2. To introduce the main concepts and techniques used to solve these.
  3. To enable participants to implement solutions for reasonably complex problems.
  4. To enable participants to make sense of the computer vision literature.
- **Content**: Camera models and calibration, invariant features, Multiple-view geometry, Model fitting, Stereo Matching, Segmentation, 2D Shape matching, Shape from Silhouettes, Optical flow, Structure from motion, Tracking, Object recognition, Object category recognition.
- **Prerequisites / notice**: It is recommended that students have taken the Visual Computing lecture or a similar course introducing basic image processing concepts before taking this course.

### Lecture Notes
- **Computer Vision**: see: http://www.geo21.ch/ethz/
- **Computer Vision**: see: http://www.geo21.ch/ethz/
- **Computer Vision**: see: http://www.geo21.ch/ethz/

### Literature

### Additional Literature
- Additional literature will be distributed during lectures.
851-0724-00L Property Law for Geometers: Land Registry and Geoinformation Law

- Meinrad Huser, Schweizerisches Vermessungsrecht, unter besonderer Berücksichtigung des Geoinformationsrechts und des Grundbuchrechts, Begriffe aus dem Institut für schweizerisches und internationales Baurecht der Universität Freiburg/Schweiz, Zürich 2014

- Meinrad Huser, Darstellung von Grenzen zur Sicherung dinglicher Rechte, in ZBGR 2013, 238 ff.

810-0724-00L Property Law for Geometers: Land Registry and Geoinformation Law

- Meinrad Huser, Schweizerisches Vermessungsrecht, unter besonderer Berücksichtigung des Geoinformationsrechts und des Grundbuchrechts, Begriffe aus dem Institut für schweizerisches und internationales Baurecht der Universität Freiburg/Schweiz, Zürich 2014

- Meinrad Huser, Darstellung von Grenzen zur Sicherung dinglicher Rechte, in ZBGR 2013, 238 ff.
- Meinrad Huser, Datenschutz bei Geodaten
The course deals with advanced topics in GIS: GIS project lifecycle, Managing GIS, Legal issues, GIS assets & constraints; Geospatial

Objectives:

1. Plate Tectonics before Space Geodesy.
3. The seismic cycle monitoring (Moment release, seismology, Stress transfer)
4. Presentation of GPS and Applications 1 (positioning, rigid plate motions)
5. GPS networks in the world. Development of tectonic geodesy and Applications 2 (Practical on inter-seismic deformation)
6. InSAR applied to subsidence and small deformation.
7. Troposphere sounding. Accuracies of GPS and InSAR.
8. GPS and deformation related to volcanoes (Practical on Mogi source)
9. GPS, Strain, Stress and Plate motion.
10. InSAR applied to subsidence and small deformation.
11. GPS and normal modes?

Lecture notes:
Slides. Script in English is planned. PDF of articles cited.

Literature:
See webpage

Prerequisites:
Pre-Requisite:
Of advantage:
Higher Geodesy Basics; Physical Geodesy and Geodynamics I; Seismotectonics

The grading is based on participation, homework sets, and a final oral presentation. There is no final exam.

### Major in GIS and Cartography

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>103-0227-00L</td>
<td>Cartography III</td>
<td>O</td>
<td>5</td>
<td>4G</td>
<td>L. Hurni</td>
</tr>
<tr>
<td>Abstract</td>
<td>Basic methods, technologies, scripting, and systems for interactive web mapping projects and in the internet cartography.</td>
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<tr>
<td>Objective</td>
<td>Gain knowledge about basic methods, technologies, scripting, and systems for interactive web mapping projects. Assessment of existing methods regarding production methods. Definition of useful methods for Web-based map projects.</td>
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<tr>
<td>Content</td>
<td>- Web mapping</td>
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<td></td>
<td>- Web Map Services (WMS)</td>
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<td></td>
<td>- User Interface design</td>
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<td>- Symbolisation</td>
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<td>- Programming</td>
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<td>- JavaScript</td>
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<td></td>
<td>- Debugging</td>
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<td></td>
<td>- Map production using GIS data</td>
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<tr>
<td></td>
<td>- 3D applications in cartography</td>
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<tr>
<td>Lecture notes</td>
<td>Own script and instructions will be distributed.</td>
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<tr>
<td>Prerequisites</td>
<td>Kartografie I; Kartografie II; Thematische Kartografie</td>
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</tbody>
</table>

| 103-0237-00L   | GIS III          | O    | 5    | 3G    | M. Rauval       |
| Abstract       | The course deals with advanced topics in GIS; GIS project lifecycle, Managing GIS, Legal issues, GIS assets & constraints; Geospatial Web Services; technical basics, architecture, functions, interoperability, standards, mashups, portals, applications; Geostatistics; Sensor Web Enablement; Human-Computer Interaction; Cognitive Issues in GIS. |
| Objective      | Students will get a detailed overview of advanced GIS topics. They will go through all steps of setting up a Web-GIS application in the labs and perform other practical tasks relating to Sensor Web Enablement, Human-Computer Interaction, Geostatistics, and Web Processing Services. |
| Content        | Lecture slides will be made available in digital form. |

| 103-0747-00L   | Cartography Lab  | W    | 6    | 13A   | L. Hurni        |
| Abstract       | Independent practical work in cartography |
| Objective      | Independent practical work in cartography |
| Content        | Choice of theme upon individual agreement |
| Prerequisites  | German or English |

| 103-0687-00L   | Cadastral Systems | W    | 2    | 2G    | D. M. Steudler   |
| Abstract       | Nature, role and importance of cadastral systems and related concepts such as land administration, land registration and spatial data infrastructures (SDIs). |
| Objective      | The students will get an understanding of the nature, role and importance of cadastral systems and related concepts such as land administration, land registration and spatial data infrastructures (SDIs). The Swiss cadastral system as well as a range of international approaches both in developed and developing countries will be reviewed. |
Semantic interoperability of GIS is in the main part of this lecture and means to transform back and forth (geo-)data with same content but different structure. The reduction of the necessary programming amount to a modest minimum is provided by the system-independent model-driven approach. Its elements reality selection, conceptual modelling, flexible standard formats, 1:1 processors and semantic transformation are presented and used. As generally useful tools are introduced and applied the conceptual schema languages UML and INTERLIS, the formats ITF, XML, the tools ILI-Checker and awk, and for the semantic transformation UMLT and FME.


- Explain and apply the model-driven approach based on standards
- Know and use interoperability types
- Know transfer formats and reformat with 1:1 processors
- Explain object-oriented modelling (with graphic and text)
- Know and use communication technologies and OGC Web services
- UML, EBNF, INTERLIS, ITF, XML, awk, FME
- Know and apply appropriate software tools

Semantic interoperability of GIS is in the main part of this lecture and means to transform back and forth (geo-)data with same content but different structure. The reduction of the necessary programming amount to a modest minimum is provided by the system-independent model-driven approach. Its elements reality selection, conceptual modelling, flexible standard formats, 1:1 processors and semantic transformation are presented and used. As generally useful tools are introduced and applied the conceptual schema languages UML and INTERLIS, the flexible transfer formats ITF, XML the ILI-Checker, the efficient reformatting tool awk and for the semantic transformation UMLT and FME.


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- Know transfer formats and reformat with 1:1 processors
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- UML, EBNF, INTERLIS, ITF, XML, awk, FME
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Semantic interoperability of GIS is in the main part of this lecture and means to transform back and forth (geo-)data with same content but different structure. The reduction of the necessary programming amount to a modest minimum is provided by the system-independent model-driven approach. Its elements reality selection, conceptual modelling, flexible standard formats, 1:1 processors and semantic transformation are presented and used. As generally useful tools are introduced and applied the conceptual schema languages UML and INTERLIS, the flexible transfer formats ITF, XML the ILI-Checker, the efficient reformatting tool awk and for the semantic transformation UMLT and FME.

Objective

The aims of this course are:
1) To illustrate the concept of landscape planning, the economic relevance of landscape and nature in the context of the environmental systems (soil, water, air, climate, flora and fauna).
2) To show landscape planning as an integral information system for the coordination of different instruments by illustrating the aims, methods, instruments and their functions in landscape planning.
3) To show the importance of ecosystem services.
4) To point out basic information about nature and landscape: Analysis and assessment of the complex interactions between landscape elements, effects of existing and foreseeable utilization of space (nature goods and services and landscape functions).
5) To identify and measure the characteristics of landscape.
6) Learn how to use the instrument of GIS appropriately in landscape planning.

Content

In this course, the following topics are discussed:
- Definition of the concept of landscape
- Landscape change
- Landscape planning
- Methods, instruments and aims of landscape planning (politics)
- Socio-political questions of the future
- Environmental systems, IUCN Red List, ecological connectivity
- Urban landscape services
- Practice of landscape planning
- Use of GIS in landscape planning

Lecture notes

No script. The documentation, consisting of presentation slides are partly handed out and are provided for download on the PLUS website.

Prerequisites / notice

The contents of the course will be illustrated in the associated lecture 103-0347-01 U (Landscape Planning and Environmental Systems (GIS Exercises)). An combination of courses is recommended.

103-0337-00L Site and Project Development

Abstract

The main focus of the lecture is on site and project development questions in relation to recycling of industrial wasteland. A semester exercise covers a specific major project and serves as the semester grade (project report and presentation).

Objective

Objectives of the lecture are:
1) Get knowledge of comprehensive and multifunctional large-scale projects and their problem areas
2) Get deepened knowledge in selected fields (site analysis, market analysis, project development, cooperative planning, participation processes)
3) Practical orientation, insight into occupational fields
4) Independent acquisition and acquisition of theoretical knowledge

Content

The lecture consists of several modules. The main focus is on site and project development questions in relation to recycling of industrial wasteland. Technical presentations, lectured by scientific staff of the division of Planning of Landscape and Urban Systems PLUS as well as guest referees treat different subjects.

The subjects are:
- Site and market analysis
- Real estate development
- Project development from the perspective of project developers and investors
- Parking and transportation models
- Cooperative planning, participation processes, mediation

The theory is discussed and illustrated at case studies and exercises. Specific large-scale projects that are currently in development phase will be discussed, for example the area Sihl-Manegg in Zurich (GreenCity) or the area Alter Pilatusmarkt (Niedfeld) Luzern. For one specific industrial wasteland area the students will develop a vision for a possible redevelopment and a new land-use concept, which will be discussed with experts.

Lecture notes

- Handouts of the lectures
- Extracts from relevant scientific articles and theory literature
- Exercise material

Download: http://www.irl.ethz.ch/plus/education

103-0377-00L Introduction to the Data Analysis Software R

Abstract

R is one of the most popular statistical open-source software for data analysis and data modeling. It has proved very useful for a variety of tasks commonly faced by planners, such as data preparation, exploratory analysis, model estimation or graphical display. R is also a programming language providing users with a more flexible and powerful tool for solving more complex problems.

Objective

Objectives of the course are:
1) Number of participants limited to 36.
2) To show landscape planning as an integral information system for the coordination of different instruments by illustrating the aims, methods, instruments and their functions in landscape planning.
3) To show the importance of ecosystem services.
4) To point out basic information about nature and landscape: Analysis and assessment of the complex interactions between landscape elements, effects of existing and foreseeable utilization of space (nature goods and services and landscape functions).
5) To identify and measure the characteristics of landscape.
6) Learn how to use the instrument of GIS appropriately in landscape planning.

Content

The subjects are:
- Reading data from files
- Creating and handling R objects such as matrices, vectors and arrays
- Plotting data: histograms, boxplots, scattered plots
- Writing data to files
- Reading raster and vector data
- Writing for- and while-loops
- Writing your own functions

Lecture notes

- Handouts of the lectures and exercises will be distributed

Literature

"Introduction to R" by W. N. Venables and D. M. Smith
available online at http://cran.r-project.org/doc/manuals/R-intro.pdf

Prerequisites / notice

The course is held in English and no prior knowledge on R is required.

103-0317-00L Sustainable Spatial Development I

Abstract

The lectures impart important knowledge for solving spatial relevant conflicts and problems. Case studies will be used to demonstrate the implementation in practice.
The course provides the necessary knowledge to develop models supporting the solution of given planning problems. Examples of such models include:

- Knowledge of methods and algorithms commonly used in transport planning
- Understanding of algorithms and their implementations commonly used in transport planning
- Ability to independently develop a transport model able to solve / answer the given problem / questions
- Constructing transport models.

References to technical literature will be included in the course script. An additional list of literature will be given during the course.

To solve problems in spatial planning it is necessary to explore actions and to judge them; finally, one has to argue why a certain option should be preferred to others. Assessments of the situation are the basis for the problems to treat. Specific knowledge, represented in an adequate manner, is required.

The participants know the interdependencies between the assessment of a situation, decision making, knowledge and language. They know the nature of a decision dilemma and maximes, how to deal with it. Especially they learn that the requirement of information for a decision depends upon the preferences of the deciding actor. They are also familiar with difficulties and pitfalls within these contexts and know what can be done against it.

Assessment of the situation, deciding, language and knowledge are the main parts.

### Contents

- **Tasks of Spatial Planning and development**
- **Issues of local and supra-local interest**
- **Recurring spatial changes, impacts and key figures**
- **Formal and informal instruments and procedures in spatial planning**
- **Spatial Design - Ideas about the future**
- **Reasoning and assessing the situation in spatial planning**
- **Spatial planning as a sequence of decisions and interventions**
- **Process and procedures management**
- **Focus issues - Inner development before external development**
- **Focus issues - Cross-border tasks**
- **Focus Issues - Integrated spatial and infrastructure development**

### Lecture notes

Further information and the documents for the lecture can be found on the homepage of the Chair of Spatial Development.

### Literature

- **K. W. Axhausen**
- **S.E. Rabe, A. Stritih**

### Objective

- **Learn how to use the instrument of GIS appropriately in landscape planning.**
- **To identify and measure the characteristics of landscape.**

### Content

The course content of the lecture Landscape Planning and Environmental Systems (103-0347-00 V) will be illustrated. To show the importance of ecosystem services.

**3 credits**

**Autumn Semester 2016**

**Data: 06.03.2019 12:57**
# Content

- Environmental systems, IUCN Red List, ecological connectivity
- Calculating urban landscape services
- Practice of landscape planning
- Use of GIS in landscape planning
- Modelling
- Landscape analysis
- Landscape metrics

## Lecture notes

No script. The documentation, consisting of presentation slides are partly handed out and are provided for download on the PLUS website.

## Literature

Will be named in the lecture.

## Prerequisites / notice

Basic GIS skills are recommended. A brief introduction to GIS will be given in the first exercise.

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<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
<th>Type</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
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<td>103-0569-00L</td>
<td>European Aspects of Spatial Development</td>
<td>3 credits</td>
<td>W</td>
<td>G</td>
<td>A. Peric Momcilovic</td>
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</tbody>
</table>

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## Abstract

Following the insight into historical perspective and contemporary models of governance and planning, the course focuses on the international dimension of spatial planning in Europe. This includes a discussion of how European spatial policy is made and by whom, how planners can participate in such process and how they can address transnational challenges of spatial development cooperatively.

## Objective

Keeping the general aim of exploring the European dimension of spatial planning in mind, the specific course learning objectives are as follows:

- to interpret the history of spatial planning at the transnational scale
- to understand and explain the content of the European spatial policy agenda
- to describe and analyse the role of territorial cooperation in making European spatial development patterns and planning procedures
- to discuss the changing role of planners and evaluate the ways of their engagement in European spatial policy-making

## Content

- European spatial policy agenda: introduction and basic directives
- Governance models
- Planning models: collaborative planning model (main concepts & critics)
- Post-positivist approach to spatial planning
- Transnational spatial planning in Europe; questioning the European spatial planning; spatial development trends in Europe
- EU as a political system; EU institutions & non-EU actors
- Planning families in Europe; the European spatial planning agenda
- Spatial planning strategies and programmes on territorial cooperation
- The notion of planning culture and planning system; planning cultures in Europe
- Basic characteristics of planning systems in Europe: remarkable and exceptional peculiarities
- The relevance of transnational spatial cooperation for spatial planning
- European transnational initiatives: CODE 24 (Rotterdam-Genoa), Orient/east-Med corridor (Hamburg-Athens), Danube region

## Lecture notes

The documents for the lecture will be provided at the moodle, https://moodle-app2.let.ethz.ch/course/view.php?id=2298.

---

### Obligatory literature:


### Recommended literature:

**Governance models:**


**Planning models:**


**EU as a political context:**


**Territorial cooperation in Europe:**


**Planning families and cultures:**


**Planning systems in Europe:**


---

### Prerequisites / notice

Only for master students, otherwise a special permission by the lecturer is required.
Approach with Cost Benefit Analysis in Transport

Abstract
The course presents cost benefit analysis and related evaluation methods in transport and introduces the survey methods used to derive the monetary values of non-market goods.

Objective
Familiarity with the essential methods of project appraisal

Content
Cost-Benefit-Analysis; multi-criteria analysis; European guidelines; stated response methods; travel cost approach and others; Valuation of travel time savings; valuation of traffic safety

Lecture notes
Handouts

Literature


101-0449-00L Management, Marketing, Quality W 6 credits 4G U. A. Weidmann

Abstract
Does not take place this semester.

Objective
Comprehension of the transport and administrative policy as well as of the regulation of public transport companies. To develop a full understanding of the three important public transport system operations management processes: (1) Business management; (2) Marketing; (3) Quality control. The course will teach essential working techniques in each of these processes.

Content
(1) Transport and administrative policy: Goals of the state related to public transports, governmental activities in public transport, regulation. (2) Business management in public transport enterprises: goals of public transport companies, goals of the business management; management of public transport on the different management levels, business organization. (3) Marketing, advertising and pricing: Fundamentals and goals; marketing strategies and concepts in public transports; marketing tools; putting marketing into action. (4) Quality control: Quality in transport systems; goals of quality management; structuring quality control measures; collecting quality data in an operating service; use of quality control systems for service optimization.

Lecture notes
Course notes will be provided in German. Slides will be made available.

Literature
References to technical literature will be included in the course script. An additional list of literature will be given during the course.

Prerequisites / notice
Lectures System and Network Planning as well as Systems Dimensioning and Capacity recommended.

363-1065-00L Design Thinking: Human-Centred Solutions to Real World Challenges

Abstract
Due to didactic reasons, the number of participants is limited to 30.

All interested students are invited to apply for this course by sending a one-page motivation letter until 14.9.16 to Florian Rittiner (frittiner@ethz.ch).

Additionally please enroll via mystudies. Places will be assigned after the first lecture on the basis of your motivation letter and commitment for the class.

Objective
The goal of this course is to engage students in a multidisciplinary collaboration to tackle real world problems. Following a design thinking approach, students will work in teams to solve a set of design challenges that are organized as a one-week, a three-week, and a final six-week project in collaboration with an external project partner.

During the course, students will learn about different design thinking methods and tools. This will enable them to:
- Generate deep insights through the systematic observation and interaction of key stakeholders.
- Engage in collaborative ideation with multidisciplinary (student) teams.
- Rapidly prototype and iteratively test ideas and concepts by using various materials and techniques.

Content
The purpose of this course is to equip the students with methods and tools to tackle a broad range of problems. Following a Design Thinking approach, the students will learn how to observe and interact with key stakeholders in order to develop an in-depth understanding of what is truly important and emotionally meaningful to the people at the center of a problem. Based on these insights, the students will ideate on possible solutions and immediately validated them through quick iterations of prototyping and testing using different tools and materials. The students will work in multidisciplinary teams on a set of challenges that are organized as a one-week, a three-week, and a final six-week project with an external project partner. In this course, the students will learn about the different Design Thinking methods and tools that are needed to generate deep insights, to engage in collaborative ideation, rapid prototyping and iterative testing.

Design Thinking is a deeply human process that taps into the creative abilities we all have, but that get often overlooked by more conventional problem solving practices. It relies on our ability to be intuitive, to recognize patterns, to construct ideas that are emotionally meaningful as well as functional, and to express ourselves through means beyond words or symbols. Design Thinking provides an integrated way by incorporating tools, processes and techniques from design, engineering, the humanities and social sciences to identify, define and address diverse challenges. This integration leads to a highly productive collaboration between different disciplines.

For more information and the application visit: http://sparklabs.ch/ethz

Prerequisites / notice
Class attendance and active participation is crucial as much of the learning occurs through the work in teams during class. Therefore, attendance is obligatory for every session. Please also note that the group work outside class is an essential element of this course, so that students must expect an above-average workload.

Electives ETH Zurich
Course Catalogue of ETH Zurich

Seminar Work

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
</table>

Abstract
Introduction to general scientific working methods and skills in the core fields of geomatics. It includes a literature study, a review of one of the articles, a presentation and a report about the literature study.
Objective
Learn how to search for literature, how to write a scientific report, how to present scientific results, and how to critically read and review a scientific article

Content
A list of themes for the literature study are made available at the beginning of the semester. A theme can be selected based on a moodle.

Prerequisites / notice
Agreement with one of the responsible Professors is necessary

► Interdisciplinary Project Work

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>103-0298-02L</td>
<td>Interdisciplinary Project</td>
<td>O</td>
<td>12 credits</td>
<td>24A</td>
<td>Professors</td>
</tr>
</tbody>
</table>

Abstract
Promote independent, structured and scientific work in an interdisciplinary context; learn to apply engineering methods; deepen the knowledge in the field of the treated task.

Content
The project work is supervised by a professor. Students can choose from different subjects and tasks.

► Master's Thesis

Before starting the Master's thesis, students must have

- obtained the Bachelor's degree;
- fulfilled all specified admission conditions, if any;
- acquired at least 90 credits in the Master's programme, including 12 credits in the area of the interdisciplinary project.

Abstract
The Master Programme concludes with the Master Thesis, which has to be done in one of the chosen Majors and has to be completed within 16 weeks. The Master Thesis is supervised by a professor and shall attest the students ability to work independently and to produce scientifically structured work.

Objective
To work independently and to produce a scientifically structured work.

Content
The topics of the Master Thesis are published by the professors. The Topic can be set also in consultation between the student and the professor.

► Course Units for Additional Admission Requirements

The courses below are only available for MSc students with additional admission requirements.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>103-0115-AAL</td>
<td>Geodetic Metrology II</td>
<td>E-</td>
<td>5 credits</td>
<td>4R</td>
<td>A. Wieser</td>
</tr>
</tbody>
</table>

Abstract
Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Objective
Advanced topics in geodetic metrology with focus on instrumental and methodic aspects for applications with higher accuracy demands.

Content
- The geomatics workflow
- Propagation of light in the atmosphere
- The modern total station
- Terrestrial Laserscanning
- Digital levels
- Field tests
- Traverses
- Trigonometric leveling
- Precision leveling
- Route planning and transition curves
- Earthworks: Area and cubature

Lecture notes
Slides and documents for enhanced study and further reading will be provided online.

Literature

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>103-0126-AAL</td>
<td>Geodetic Reference Systems</td>
<td>E-</td>
<td>3 credits</td>
<td>3R</td>
<td>M. Meindl</td>
</tr>
</tbody>
</table>

Abstract
Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Objective
Fundamentals and theory of geodetic reference systems and frames. Introduction to current international systems as well as to systems for the Swiss national geodetic survey.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>103-0132-AAL</td>
<td>Geodetic Metrology Fundamentals</td>
<td>E-</td>
<td>6 credits</td>
<td>4R</td>
<td>A. Wieser</td>
</tr>
<tr>
<td>Course Code</td>
<td>Course Title</td>
<td>Credits</td>
<td>ECTS</td>
<td>Prerequisities / notice</td>
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</tr>
<tr>
<td>101-0414-AAL</td>
<td>Transport Planning (Transportation I)</td>
<td>3</td>
<td>103</td>
<td>none</td>
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<td></td>
<td>Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.</td>
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<tr>
<td></td>
<td>Abstract</td>
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<tr>
<td></td>
<td>The lecture course discusses the basic concepts, approaches and methods of transport planning in both their theoretical and practical contexts.</td>
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<td></td>
<td>Objective</td>
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<tr>
<td></td>
<td>The course introduces the basic theories and methods of transport planning.</td>
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<td></td>
<td>Content</td>
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<td></td>
<td>Basic theoretical links between transport, space and economic development; basic terminology; measurement and observation of travel behaviour; methods of the four stage approach; cost-benefit analysis.</td>
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<tr>
<td></td>
<td>Literature</td>
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<tr>
<td>103-0153-AAL</td>
<td>Cartography II</td>
<td>5</td>
<td>153</td>
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<td></td>
<td>Abstract</td>
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<tr>
<td></td>
<td>Basic knowhow about communication with spatial information by using plans and maps, about the most important design rules and production methods for map graphics.</td>
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<td></td>
<td>Acquire basic knowhow about communication with spatial information by using plans and maps, about the most important design rules and production methods for map graphics. Ability to assess existing products with respect to their content-related and design quality. Ability to design proper plans and well designed legends for basic maps.</td>
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<td></td>
<td>Content</td>
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<tr>
<td></td>
<td>Definitions &quot;map&quot; and &quot;cartography&quot;, map types, current tasks and situation of cartography, map history, spatial reference systems, map projections, map conception and workflow planning, map design, analog and digital map production technology, prepress technology, printing technology, topographic maps, map critics.</td>
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<tr>
<td></td>
<td>Literature</td>
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<tr>
<td>103-0184-AAL</td>
<td>Higher Geodesy</td>
<td>5</td>
<td>153</td>
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<td>Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.</td>
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<td>Abstract</td>
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<td>Objective</td>
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<tr>
<td></td>
<td>Overview over the entire spectrum of Higher Geodesy</td>
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<tr>
<td>103-0214-AAL</td>
<td>Cartography I</td>
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<td>153</td>
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<td></td>
<td>Abstract</td>
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<tr>
<td></td>
<td>Introduction and basics in mathematics of geometric geo-objects in the three-dimensional space (with exercises).</td>
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<td>Objective</td>
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<td></td>
<td>Basics, structures and processes in modern geovisualisation and computer graphics. Exercises in 2D and 3D computer graphics with software from desktop publishing, GIS, and computer visualisation.</td>
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<tr>
<td></td>
<td>Lecture notes</td>
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<tr>
<td></td>
<td>References and other materials will be distributed by the supervisors.</td>
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<tr>
<td>103-0233-AAL</td>
<td>GIS I</td>
<td>3</td>
<td>103</td>
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<tr>
<td></td>
<td>Abstract</td>
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<tr>
<td></td>
<td>Fundamentals in geoinformation technologies: database principles, including modeling of spatial information, geometric and semantic models, topology and metrics; practical training with GIS software.</td>
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<td>Objective</td>
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<td></td>
<td>Know the fundamentals in geoinformation technologies for the realization, application and operation of geographic information systems in engineering projects.</td>
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</tbody>
</table>
## Content
- Modelling of spatial information
- Geometric and semantic models
- Topology & metrics
- Raster and vector models
- Databases
- Applications
- Labs with GIS software

## Literature

### 103-0234-AAL
#### GIS II
**Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.**

**Abstract**
Advanced course in geoinformation technologies: conceptual and logical modelling of networks, 3D- and 4D-data and spatial processes in GIS; raster data structures and operations; mobile GIS; Internet and GIS; interoperability and data transfer; legal and technical foundations of spatial data infrastructures (SDI).

**Objective**
Students will be able to carry out the following phases of a GIS project: data modelling, mobile data acquisition and analysis, Web publication of data and integration of interoperable geospatial web services into a Spatial Data Infrastructure (SDI).

Students will deepen their knowledge of conceptual and logical modeling by means of the particular requirements of networks as well as 3D- and 4D-data.

**Literature**

### 103-0253-AAL
#### Geoprocessing and Parameter Estimation
**Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.**

**Abstract**
This course provides basic knowledge on parameter estimation and data processing. The necessary mathematical and statistical methods are developed and are applied to actual examples in geomatics.

**Objective**
The students are capable of analysing measurements with with appropriate methods. They can optimally extract model parameters from real measurements and are able to analyse and to retrieve additional information from time series. They understand the underlying algorithms of different geodetic analysis tools and processing methods.

**Literature**

**Prerequisites / notice**
Requirements: knowledge of physics, linear algebra and analytical geometry, calculus, least-squares adjustment and statistics, basic programming skills.

### 103-0254-AAL
#### Photogrammetry
**Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.**

**Abstract**
The class conveys the basics of photogrammetry. Its aim is to equip students with an understanding of the principles, methods and applications of image-based measurement.

**Objective**
The aim is an understanding of the principles, methods and possible applications of photogrammetry. The course also forms the basis for more in-depth studies and self-reliant photogrammetric project work in further photogrammetry courses.

**Content**
The basics of photogrammetry, its products and applications: the principle of image-based measurement; digital aerial cameras and related sensors; projective geometry; mathematical modeling, calibration and orientation of cameras; photogrammetric reconstruction of points and lines, and stereoscopy; orthophoto generation; digital photogrammetric workstations; recording geometry and flight planning

**Lecture notes**
Photogrammetry (slides on the web)

**Literature**

**Enrolment**
Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

**Prerequisites / notice**
Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

### 103-0255-AAL
#### Geodata Analysis
**Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.**

**Abstract**
The course deals with advanced methods in spatial data analysis.

**Objective**
- Understanding the theoretical principles in spatial data analysis.
- Understanding and using methods for spatial data analysis.
- Detecting common sources of errors in spatial data analysis.
- Advanced practical knowledge in using appropriate GIS-tools.

**Content**
The course deals with advanced methods in spatial data analysis in theory as well as in practical exercises.

**Literature**

### 103-0274-AAL
#### Image Processing
**Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.**

**Abstract**
The objective of this lecture is to introduce the basic concepts of image formation and explain the basic methods of signal and image processing.

**Objective**
Understanding core methods and algorithms in image processing and computer vision and the underlying signal processing foundations. Applying image processing algorithms to relevant problems in photogrammetry and remote sensing.
Content
- Image segmentation
  The following topics will be covered in the course:
- Properties of digital images
- Signal processing/Sampling
- Image enhancement
- Image restoration: Spatial domain
- Image restoration: Fourier domain
- Color/Demosaicing
- Image compression
- Feature extraction
- Texture analysis

Lecture notes
A script will be provided as PDF files on the lecture website.

Literature
We suggest the following textbooks for further reading:

Rafael C. Gonzalez, Richard E. Woods
Digital Image Processing
ISBN: 013168728X

Rafael C. Gonzalez, Steven L. Eddins, Richard E. Woods:
Digital Image Processing Using MATLAB
Prentice Hall, 2003
ISBN: 0130085197

Prerequisites / notice
The course is accompanied by programming assignments, that need to be completed in order to pass the semester performance.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
<th>Semester</th>
<th>Instructor</th>
</tr>
</thead>
<tbody>
<tr>
<td>103-0313-AAL</td>
<td>Planning I</td>
<td>5</td>
<td>4R</td>
<td>G. Nussbaumer</td>
</tr>
<tr>
<td>103-0325-AAL</td>
<td>Planning II</td>
<td>5</td>
<td>4R</td>
<td>B. Scholl</td>
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<tr>
<td>103-0435-AAL</td>
<td>Landmanagement</td>
<td>5</td>
<td>4R</td>
<td>G. Nussbaumer</td>
</tr>
<tr>
<td>252-0846-AAL</td>
<td>Computer Science II</td>
<td>4</td>
<td>9R</td>
<td>F. O. Friedrich</td>
</tr>
</tbody>
</table>

Abstract
The lecture introduce into the main-features of spatial planning. Attended will be the themes planning as a national responsibility, instruments of spatial planning, techniques for problem-solutions in spatial planning and the swiss concept for regional planning.

Objective
- To get to know the interaction between the community and our living space and their resulting conflicts.
- Link theory and practice in spatial planning.
- To get to know instruments and facilities to process problems in spatial planning.

Abstract
The lecture imparts methodological and instrumental fundamentals for spatial planning and will be exemplified by exploring two Zurich city quarters.

Objective
Spatial planning is concerned with the foresighted design of the built and un-built environment. Starting points are spatially relevant problems that need to be explored, clarified and solved. The cornerstone of the course is formed by an independent exploration by the student of two Zurich city quarters that involves investigating specific spatially relevant conditions, recognizing regularities and relevant problems.

Content
The self-study course compromises the following readings:
- Lynch, Kevin: «The Image of the City»,
- Alexander, Christopher et al.: «A Pattern Language»,
- Mikoleit, Anne and Pürckhauer, Moritz: «Urban Code», and
- «SIDAIA - Spatial and Infrastructure Development: An Integrated Approach».

The graded semester performance comprises a condensed paper to be written by the student reflecting both the literature read as well as exemplarily applying the knowledge gained from the literature by independently exploring the two city quarters.

Abstract
Spatial planning on the Commune level with focus on the special land use management. Land re-allocation as an instrument of spatial planning; specific explanations for land re-allocations in rural regions and in construction zones. Land marketing: the view of investors.

Objective
Getting knowledge in spatial planning and land re-allocation as an interactive process.

Abstract
Introduction to programming in Java. Procedural foundations of programming and outlook to object oriented programming. Variables, types, assignments, control structures (branch, loop), data structures, algorithms, line graphics, graphical user interface. Writing small programs. Working with a professional programming environment (Eclipse).

Objective
The students will be able to write simple programs and to modify existing programs.

Content
This course offers an introduction to variables, control structures (branch, loop), algorithms and data structures, as well as an outlook to modularisation and object oriented techniques.

In the exercises students train programming skills (in the programming language JAVA). Students can solve the exercises on their own laptop or in the computer labs at ETH. The software used in this course runs on MS Windows, MacOS X and Linux.
### Prerequisites / notice

**Prerequisites:**
252-0845-00 Computer Science I (D-BAUG)

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<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Semester</th>
<th>Lecturer(s)</th>
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<tbody>
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<td>406-0023-AAL</td>
<td>Physics Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.</td>
<td>7</td>
<td>15R</td>
<td>L. Degiorgi</td>
</tr>
</tbody>
</table>

**Abstract**
Basic topics in classical as well as modern physics, interplay between basic research and applications.

**Content**
Electrodynamics, Thermodynamics, Quantum physics, Waves and Oscillations, special relativity

**Literature**


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<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Semester</th>
<th>Lecturer(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>406-0141-AAL</td>
<td>Linear Algebra and Numerical Analysis Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.</td>
<td>5</td>
<td>11R</td>
<td>R. Käppeli, V. C. Gradinaru</td>
</tr>
</tbody>
</table>

**Abstract**
Introduction to Linear Algebra and Numerical Analysis for Engineers. This reading course is based on chapters from the book "Introduction to Linear Algebra" by Gilbert Strang (SIAM 2009), and "A First Course in Numerical Methods" by U. Ascher and C. Greif (SIAM, 2011).

**Objective**
To acquire basic knowledge of Linear Algebra and some aspects of related numerical methods and the ability to apply basic algorithms to simple problems.

**Content**

- Linear systems of equations: Gaussian elimination, row echelon form, theory about existence and uniqueness of solutions (Strang Ch. 2 and 3.4)
- Mathematical modelling by linear systems (e.g. networks, trusses) (Strang, parts of Ch. 8)
- Column space, null space and rank of matrices (Strang 3.2, 3.3)
- Linear combinations, linear (in)dependence, bases, dimension theorem for matrices (Strang 3.5, 3.6)
- Inner product, orthogonality, length in Euclidean space (Strang 4.1, 4.2)
- Least squares solutions and orthogonalization (Gram-Schmidt and QR) (Strang 4.3, 4.4)
- Linear mappings, matrix representation and change of basis (Strang Ch. 7)
- Determinants and diagonalization of matrices (eigenvalues and eigenvectors) (Strang 6.1, 6.2, 6.5, 6.6)
- Diagonalization applied to linear differential and difference equations. (Strang 6.3)
- Numerical methods for solving linear systems of equations (Ascher/Greif 5.1, MATLAB Documentation)
- Interpolation with polynomials and splines (Ascher/Greif Ch. 10 and 11)

**Literature**


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<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Semester</th>
<th>Lecturer(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>406-0242-AAL</td>
<td>Analysis II Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.</td>
<td>7</td>
<td>15R</td>
<td>M. Akveld, C. Busch</td>
</tr>
</tbody>
</table>

**Abstract**
Mathematics as a tool to solve engineering problems, mathematical formulation of problems in science and engineering. Basic mathematical knowledge of an engineers.

**Content**

- Complex numbers.
- Calculus for functions of one variable with applications.
- Simple Mathematical models in engineering.

**Literature**

- J. Stewart: Multivariable Calculus, Thomson Brooks/Cole
- V. I. Smirnov: A course of higher mathematics. Vol. II. Advanced calculus
- M. Akveld, R. Sperl, Analysis II, vdf
- L. Papula: Mathematik für Ingenieure 2, Vieweg Verlag

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<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Semester</th>
<th>Lecturer(s)</th>
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<tr>
<td>406-0243-AAL</td>
<td>Analysis I and II Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.</td>
<td>14</td>
<td>30R</td>
<td>M. Akveld, C. Busch</td>
</tr>
</tbody>
</table>

**Abstract**
Mathematical tools of an engineer

**Objective**
Mathematics as a tool to solve engineering problems. Mathematical formulation of technical and scientific problems. Basic mathematical knowledge of an engineers.

**Content**


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**Data:** 06.03.2019 12:57  
**Autumn Semester 2016**  
**Page 721 of 1571**
Literature

Textbooks in English:

Textbooks in German:
- M. Akveld, R. Sperb: Analysis I, vdf
- M. Akveld, R. Sperb: Analysis II, vdf
- L. Papula: Mathematik für Ingenieure und Naturwissenschaftler, Vieweg Verlag
- L. Papula: Mathematik für Ingenieure 2, Vieweg Verlag

406-0603-AAL Stochastics (Probability and Statistics) E- 4 credits 9R M. Kalisch
Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract
Introduction to basic methods and fundamental concepts of statistics and probability theory for non-mathematicians. The concepts are presented on the basis of some descriptive examples. Learning the statistical program R for applying the acquired concepts will be a central theme.

Objective
The objective of this course is to build a solid fundament in probability and statistics. The student should understand some fundamental concepts and be able to apply these concepts to applications in the real world. Furthermore, the student should have a basic knowledge of the statistical programming language "R".

Content
From "Statistics for research" (online)
Ch 1: The Role of Statistics
Ch 2: Populations, Samples, and Probability Distributions
Ch 3: Binomial Distributions
Ch 6: Sampling Distribution of Averages
Ch 7: Normal Distributions
Ch 8: Student’s t Distribution
Ch 9: Distributions of Two Variables

From "Introductory Statistics with R (online)"
Ch 1: Basics
Ch 2: The R Environment
Ch 4: Descriptive statistics and tables
Ch 5: One- and two-sample tests
Ch 6: Regression and correlation

Literature
- "Statistics for research" by S. Dowdy et. al. (3rd edition); Print ISBN: 9780471267355; Online ISBN: 9780471477433; DOI: 10.1002/0471477435
From within the ETH, this book is freely available online under: http://onlinelibrary.wiley.com/book/10.1002/0471477435

From within the ETH, this book is freely available online under: http://www.springerlink.com/content/m17578/

Geomatic Engineering Master - Key for Type

| O | Compulsory | E-  | Recommended, not eligible for credits |
| W+ | Eligible for credits and recommended | Z | Courses outside the curriculum |
| W | Eligible for credits | Dr | Suitable for doctorate |

Key for Hours

| V | lecture |
| G | lecture with exercise |
| U | exercise |
| S | seminar |
| K | colloquium |
| P | practical/laboratory course |
| A | independent project |
| D | diploma thesis |
| R | revision course / private study |

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
The interdisciplinary lecture series are exclusively addressed to the students of the HPK-M.A. programme. They provide an insight into all the disciplines which participate in the M.A. programme and their specific demands, approaches, problems and techniques. Subsequent to the lectures, there will be an opportunity to discuss difficulties occurring within the procedures of thesis-writing. The series should provide and secure a substantial, methodological and formal orientation within the disciplines taught in the M.A.-program.

**851-0125-18L**  
**Self-Ownership - Philosophical and Juridical Perspectives**  
Type: W  
ECTS: 3 credits  
Hours: 2G  

*Notice*

The lecture series are held by all scientific disciplines involved in the HPK-Master programme and are meant to acquaint the students with the different ambitions, methods and techniques of each discipline. Furthermore, the lectures should serve as a "helpdesk" and "workshop" for all theses written within the M.A. programme.

**Prerequisites / notice**

Dates: Thursday, 10-12

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The last 2500 years, the mind-brain relationship has been articulated in various ways. In these lectures, I will explore the scientific and philosophical aspects of this relationship in the context of relevant cultural, historical and technological processes, with a focus on the modern neurosciences, but I will also discuss works of art and literature.

**Abstract**

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**Objective**

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**Prerequisites / notice**

Dates: Thursday, 10-12

---

According to a myth, the ancient Greek philosopher Democrit dissected animals, because he was in search of the seat of the soul. Current neuroscientists use neuroimaging techniques like functional magnetic-resonance-tomography in order to localize cognitive and emotional qualities in the brain. Between these two dates lies a history of 2500 years, in which the relationship between the mind and the brain has been defined in various ways. Starting with ancient and medieval theories, the lecture will have its focus on modern theories from the nineteenth century onward. I will discuss essential issues in the history of the neurosciences such as localization theories, the neuron doctrine, reflex theory, theories of emotions, neurocybernetics and the importance of visualizing the brain and its parts, but I will also include works of art and literature.

**851-0125-41L**  
**Introduction Into Philosophy of Technology**  
Type: W  
ECTS: 3 credits  
Hours: 2V  
Lecturers: O. Müller
Abstract
Since antiquity philosophy reflects about and evaluates technology. The technical developments in the 19th and 20th century have led to an autonomous philosophy of technology, which had become important also for other philosophical disciplines (e.g. in Heidegger's philosophy).

Objective
The course gives an overview on the main schools in the philosophy of technology. Students should learn to analyse and evaluate different philosophies of technology (compensation, objectification, externalisation). For credit point a critical protocol is to be written.

851-0609-06L
Governing the Energy Transition
W  2 credits  2V  T. Schmidt

Number of participants limited to 30.

Abstract
This course addresses the role of policy and its underlying politics in the transformation of the energy sector. It covers historical, socio-economic, and political perspectives and applies various theoretical concepts to specific aspects of governing the energy transition.

Objective
- To gain an overview of the history of the transition of large technical systems
- To recognize current challenges in the energy system to understand the theoretical frameworks and concepts for studying transitions
- To demonstrate knowledge on the role of policy and politics in energy transitions

Content
Climate change, access to energy and other societal challenges are directly linked to the way we use and create energy. Both the recent United Nations Paris climate change agreement and the UN Sustainable Development Goals make a fast and extensive transition of the energy system necessary.

This course introduces the social and environmental challenges involved in the energy sector and discusses the implications of these challenges for the rate and direction of technical change in the energy sector. It compares the current situation with historical socio-technical transitions and derives the consequences for policy-making. It then introduces theoretical frameworks and concepts for studying innovation and transitions. It then focuses on the role of policy and policy change in governing the energy transition, considering the role of political actors, institutions and policy feedback.

The course has a highly interactive (seminar-like) character. Students are expected to actively engage in the weekly discussions and to give a presentation (15-20 minutes) on one of the weekly topics during that particular session. The presentation (30%) and participation in the discussions (20%) will form one part of the final grade, the remaining 50% of the final grade will be formed by a final exam.

Lecture notes
Slides and reading material will be made available via moodle.ethz.ch (only for registered students).

Literature
A reading list will be provided via moodle.ethz.ch at the beginning of the semester.

Prerequisites / notice
This course is particularly suited for students of the following programmes: MA Comparative International Studies; MSc Energy Science & Technology; MSc Environmental Sciences; MSc Management, Technology & Economics; MSc Science, Technology & Policy; ETH & UZH PhD programmes.

851-0144-19L
Philosophy of Time
W  3 credits  2V  N. Sieroka

Does not take place this semester.

Particularly suitable for students of D-BIOL, D-INFK, D-MATH, D-PHYS

Abstract
This course provides an introduction to philosophical issues surrounding the concept of time. We will treat topics such as: the existence of past, present, and future; the constitution of time consciousness and its possible neurophysiological counterparts; temporal biases in the conduct of our lives; responsibility to future and past generations.

Objective
By the end of the course students are able to describe and compare different theories and concepts of time (physical time, perceptual time, historical time …). They are able to identify and examine issues concerning time as they occur in various philosophical subdisciplines - especially in philosophy of science, philosophy of mind, metaphysics, and ethics. Students are in a position to critically discuss and evaluate the repercussions of these issues in broader scientific and social contexts.

Part of the course reflects on methods and contents from physics, neuroscience/cognitive science, and logic.

851-0125-61L
What is the Value of Truth?
W  3 credits  2G  L. Wingert

It is useful to know which fellowships are available or to know the causes of frequent occurrence of extreme weather. These truths are of instrumental value. Is it also intrinsically good to know the truth, e.g. to know that there are gravitational waves? And which is the role of truth in our lives? The course will deal with such philosophical questions.

Objective
3. Ebenso soll ein besseres Urteil gebildet werden darüber, welche existenzielle Rolle die Suche nach Wahrheiten in unserem persönlichen Leben hat.

851-0125-62L
On the Relation Between Nature and Social Culture in Human Cognition and Action
W  3 credits  2G  L. Wingert

How should we human beings understand ourselves according to our best knowledge about us, the social world, human history and nature? What are the relationships between biological and socio-cultural determinants of our thinking and doing? Michael Tomasello, psychologist, and social philosopher, has answered these questions in a thought provoking way. His answers will be studied and examined.

Literature


851-0101-18L
"Bollywood and Beyond" - A Cultural History of Indian Cinema in the 20th Century
W  3 credits  2V  H. Fischer-Tiné

Abstract
The Indian film industry has been around for 100 years and is one of the richest and most variegated of the world. The lecture reconstructs the historical development of Indian cinema and uses it as a lens through which cultural, social and political change in the subcontinent can be explored.

Objective
The objectives of this course are three-fold. For one, the participants shall learn to question aesthetic certainties and received modes of perception of cinematic art. Secondly they will be acquainted with the huge potential of films as a historical source to grasp processes of social and cultural change. Besides, the reconstruction of the international career of a specific variety of art and entertainment will also raise important questions of cultural globalisation and consumerism. As a side-effect, a sit were, the students will also be provided with important insights into the chequered history of the Indian subcontinent in during the course of the 20th century.

Literature
Zur Einführung:


851-0512-05L Development Cooperation from a Biographical Point of View  
**W**  3 credits  2U  G. Spuhler  
**Abstract**  
The Archives of Contempory History provide 75 video interviews with contemporary witnesses who report on their missions abroad for Swiss humanitarian aid and development cooperation. Based on selected interviews the motives of their commitment and the experience in a foreign country is examined.  
**Objective**  
The course provides basic knowledge about the beginnings of modern development aid and its increasing professionalism. It aims for a critical and historically informed reflection on the transfer of knowledge and technology between the first and the third world. Furthermore it sharpens the critical awareness of the possibilities and limitations of retrospective accounts of eyewitnesses.  
**Literature**  

851-0125-63L Images of Mathematics  
**W**  3 credits  2G  M. Hampe, A. Schubbach  
**Abstract**  
The lecture series “Images of Mathematics” deals with the formalization of the objects and the logical language of mathematics from Hilbert to Gödel and considers its consequences in view of our conception of mathematical practice and knowledge, the limits of calculability and computability in mathematics, and the logical proof procedures and the involved intuitive aspects.  
**Objective**  
The lecture series will present philosophical problems of theoretical mathematics in the 20th century and will discuss the consequences of formalization and axiomatization. It aims at a critical reflection on the modern images of mathematics.  
**Content**  
How we understand Mathematics is probably strongly influenced by the Mathematics lessons we participated in during our school days. The common image of mathematics is therefore often characterized by the impression of a very stable form of knowledge with clear-cut problems and suitable recipes for finding the solution. It is a very static image which is very much in conflict with the rapid series of innovations that the discipline has experienced especially since the 19th century: Mathematics as a field of research has been highly innovative and even revolutionary as few other scientific disciplines in the last 200 hundred years.  
These mathematical innovations did not only contribute to a progress amassing more and more knowledge. They very often changed how mathematicians conceived of their discipline. Even a contribution to a specific research question that appears at first sight to be of minor importance can sometimes establish new connections to other fields, found a whole research field of its own or introduce new methods thereby changing the whole image of mathematics in the same way that a small addition to a picture can alter radically what we take to be represented.  

The lecture series “Images of Mathematics” deals with a few moments in the history of the scientific discipline since the middle of the 19th century when the image of mathematics changed. In particular, it focuses on the consequences of the fact that in the 19th century mathematics started to not only reflect on their own conceptual and methodological foundations in a general manner (which had been done since the dawn of mathematics and was especially a philosophical task), but to formalize them in a strict, mathematical way: the objects of mathematics, its logical language and its proof procedures. Through Cantor's set theory, the mathematical treatment of logic since Boole and especially through Frege and the formalization of its axioms in a wide ranging discussion involving Zermelo, Fraenkel and others, this self-reflexive stance came to the fore.  
Yet, the deeper mathematics dug its foundations into, the more radical the problems became. Finally, the optimistic Hilbert program of laying the foundation of mathematics within mathematics and of proving its own consistency as well as its completeness contributed to clarifying of the foundation of mathematics primarily inssofar as it was doomed to failure. Gödel proved his famous incompleteness theorems and thereby dismissed the same time the formalist attempt to reduce mathematical truth to logical provability. His work resulted in deepened insights in the precariousness of the foundation of mathematics and further numerous of productive consequences within mathematics.  
Moreover, Gödel’s theorems open many far-reaching and intriguing questions in view of our image of mathematics, questions concerning the conception of mathematical practice and knowledge, the limits of calculability of mathematics and the possible role of computability and machines in mathematics, the relation between the logical proof procedures and the involved intuitive aspects. In short, the image of mathematics is not as static as we sometimes expect it to be, it was radically redrawn by the mathematicians of the 20th century and has since then again been open to diverging interpretations.

851-0125-51L Man and Machine  
**W**  3 credits  2G  M. Hampe  
**Abstract**  
The lecture gives an overview about the different Man-Machine-Relations since the 16th century. Different models of machines will be presented and thereby dismissed at the same time the formalist attempt to reduce mathematical truth to logical provability. His work resulted in detailed insights in the precariousness of the foundation of mathematics and further numerous of productive consequences within mathematics.  

851-0125-05L The Knowledge of Literature. An Introduction  
**W**  3 credits  2V  A. Kilcher  
**Abstract**  
This lecture provides a general introduction to literary theory and presents the important theories dealing with knowledge and its role in and as literature.  
**Objective**  
Students are introduced to the various approaches and methods of literature studies and gain an overview of literary theory.  
**Content**  
This lecture has two aims: Firstly, it serves as a general introduction into the field of literary theory (thereby looking into "knowledge about literature"). Secondly, there will be a special emphasis on recent theoretical approaches that take seriously literature and knowledge as one of its components (thus investigating the "knowledge of literature"). Even though traditional criticism disagrees, a number of recent approaches, based on literature and culture studies, hold that literature is not to be understood as standing in opposition to the world and the classificatory system of the academic disciplines, particularly the sciences (e.g. Foucauldian discourse analysis and New Historicism). Instead, these approaches understand literature in terms of its epistemological forms and functions. Thus, the main thesis is that literary activities participate in the constitution and formation of knowledge. Literature itself generates models of knowledge, sometimes with critical or even utopian intentions. Moreover, it draws attention to the fundamental role of order and representation (systematization, narrative rendering, linguistic and pictorial representation) in both humanities and sciences.

851-0125-60L Introduction to Epistemology  
**W**  3 credits  2G  N. El Kassar  
**Abstract**  
This lecture series will present philosophical problems of theoretical mathematics in the 20th century and will discuss the consequences of formalization and axiomatization. It aims at a critical reflection on the modern images of mathematics.  
**Content**  
How we understand Mathematics is probably strongly influenced by the Mathematics lessons we participated in during our school days. The common image of mathematics is therefore often characterized by the impression of a very stable form of knowledge with clear-cut problems and suitable recipes for finding the solution. It is a very static image which is very much in conflict with the rapid series of innovations that the discipline has experienced especially since the 19th century: Mathematics as a field of research has been highly innovative and even revolutionary as few other scientific disciplines in the last 200 hundred years.  
These mathematical innovations did not only contribute to a progress amassing more and more knowledge. They very often changed how mathematicians conceived of their discipline. Even a contribution to a specific research question that appears at first sight to be of minor importance can sometimes establish new connections to other fields, found a whole research field of its own or introduce new methods thereby changing the whole image of mathematics in the same way that a small addition to a picture can alter radically what we take to be represented.  

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Practical exercises in writing articles for the feature pages of newspapers will be combined with the theoretical work on topics relevant for learning to write texts, that can present topics from the sciences to an interested public (in newspapers, non-specialist journals but also in non-academic publications).

### Seminars

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<td>851-0129-00L</td>
<td>Writing for Others - Science and Public</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>U. J. Wenzel</td>
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<tr>
<td>Abstract</td>
<td>Learning to write texts, that can present topics from the sciences to an interested public (in newspapers, non-specialist journals but also in non-academic publications)</td>
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<td>Objective</td>
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<tr>
<td>Content</td>
<td>Practical exercises in writing articles for the feature pages of newspapers will be combined with the theoretical work on topics relevant for learning to write texts, that can present topics from the sciences to an interested public (in newspapers, non-specialist journals but also in non-academic publications)</td>
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<tr>
<td>Prerequisites/notice</td>
<td>Voraussetzungen: Die Bereitschaft, sich auf ein Projekt mit experimentellem Charakter einzulassen. GUTE BEHERRSCHUNG DER DEUTSCHEN SPRACHE.</td>
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</table>

Die Teilnehmerzahl ist begrenzt. SCHRIFTLICHE ANMELDUNG erforderlich (bis 31. August): uwe.justus.wenzel@zzz.ch

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<tr>
<th>Number</th>
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<th>Hours</th>
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<tr>
<td>701-0019-00L</td>
<td>Readings in Environmental Thinking</td>
<td>W</td>
<td>3</td>
<td>2S</td>
<td>J. Ghazoul, G. Hirsch Hadorn, A. Patt</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course introduces students to foundational texts that led to the emergence of the environment as a subject of scientific importance, and shaped its relevance to society. Above all, the course seeks to give confidence and raise enthusiasm among students to read more widely around the broad subject of environmental sciences and management both during the course and beyond.</td>
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<tr>
<td>Objective</td>
<td>The course will provide students with opportunities to read, discuss, evaluate and interpret key texts that have shaped the environmental movement and, more specifically, the environmental sciences. Students will gain familiarity with the foundational texts, but also understand the historical context within which their academic and future professional work is based. More directly, the course will encourage debate and discussion of each text that is studied, from both the original context as well as the modern context. In so doing students will be forced to consider and justify the current societal relevance of their work.</td>
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<tr>
<td>Content</td>
<td>The course will be run as a book reading club. The first session will provide a short introduction as to how to explore a particular text (that is, not a scientific paper) to identify the key points for discussion.</td>
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<tr>
<td>Literature</td>
<td>Thereafter, in each week a text (typically a chapter from a book or a paper) considered to be seminal or foundational will be assigned by a course lecturer. The lecturer will introduce the selected text with a brief background of the historical and cultural context in which it was written, with some additional biographical information about the author. He/she will also briefly explain the justification for selecting the particular text.</td>
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<td>The students will read the text, with two to four students (depending on class size) being assigned to present it at the next session.</td>
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<td>Presentation of the text requires the students to prepare by, for example:</td>
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<td>- identifying the key points made within the text</td>
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<td>- identifying issues of particular personal interest and resonance</td>
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<td>- considering the impact of the text at the time of publication, and its importance now</td>
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<td></td>
<td>- evaluating the text from the perspective of our current societal and environmental position</td>
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<td>Such preparation would be supported by a mid-week tutorial discussion (about 1 hour) with the assigning lecturer.</td>
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<td>These students will then present the text (for about 15 minutes) to the rest of the class during the scheduled class session, with the lecturer facilitating the subsequent class discussion (about 45 minutes). Towards the end of the session the presenting students will summarise the emerging points (5 minutes) and the lecturer will finish with a brief discussion of how valuable and interesting the text was (10 minutes). In the remaining 15 minutes the next text will be presented by the assigning lecturer for the following week.</td>
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<td>The specific texts selected for discussion will vary, but examples include:</td>
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<td></td>
<td>- Leopold (1949) A Sand County Almanach</td>
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<td></td>
<td>- Carson (1962) Silent Spring</td>
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<tr>
<td>Literature</td>
<td>Discussions might also encompass films or other forms of media and communication about nature.</td>
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<tr>
<td>851-0145-05L</td>
<td>Narratives of Health and Illness</td>
<td>W</td>
<td>3</td>
<td>2S</td>
<td>S. Baier</td>
</tr>
<tr>
<td>Abstract</td>
<td>Particularly suitable for students of D-HEST</td>
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<td>Objective</td>
<td>Das Seminar gibt einen Einblick in den Forschungsbereich der Narrativen Medizin als Teilbereich der Medizinischen Geisteswissenschaften. Erzählungen spielen eine vielfältige Rolle, wenn es um Gesundheit und Krankheit geht.</td>
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<td>Literature</td>
<td>Ziel der Veranstaltung ist es, eine eigenständige kritische Perspektive auf Erzählungen von Gesundheit und Krankheit zu ermöglichen. Im Seminar werden daher unterschiedliche Arten von aktuell Texten und Materialien zur Rolle von medizinischen Narrativen kritisch miteinander diskutiert.</td>
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<td>Cyclical time</td>
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<td>T. Böhm</td>
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<tr>
<td>Abstract</td>
<td>The idea of cyclical time is found in ancient pieces of wisdom (Pythagoreans, Plato, Buddhism) as reincarnation or memory, but also in Nietzsche as eternal return, in Deleuze as repetition, in Freud as repetition compulsion. We investigate the concept of repetition in combination with difference as a positive mode of thinking change.</td>
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<td>Objective</td>
<td>Understanding of the various forms and functions of repetition on the basis of texts by Plato (anamnesis), Freud (repetition compulsion), Kierkegaard (narration), Nietzsche (eternal return as cosmological and ethical principle), Deleuze (time synthesis and repetition of the future), Poincaré's theorem of recurrence.</td>
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By the end of the course students are able to describe and compare different interpretations of quantum mechanics. They are able to identify and examine issues concerning these different interpretations and issues concerning the transition between quantum and classical descriptions in physics. Students are in a position to critically discuss and evaluate the repercussions of these issues in broader scientific contexts.

**851-0301-05L**

**Beginnings**

Number of participants limited to 25

- All beginnings are difficult,” goes the saying, “but without them there wouldn’t be an end.” However, what makes beginnings so difficult?
- What kind of action is that? Which knowledge does it presuppose? And what would a beginning say about the end? We will pursue these questions by reading sacred, philosophical, literary, and scientific texts that, each in its own way, make a beginning.

**Objective**

- thorough reading and critical analysis of the texts
- reflection upon the conditions and practice of beginnings in terms of their epistemology and rhetorical strategy (i.e. as an intellectual and literary operation)
- consider the cultural and historical function of fictions that tell of origins, such as cosmological myths, foundationalist philosophy, or poetic incantations

**Literature**

Myths of Creation and First Origins (Genesis und Gospel of St. John, Theogony, Upanishads), philosophy (Fichte, Hegel), literature and poetry (Wieland, Hölderlin, Novalis, Wordsworth, Melville, Richard Wagner, Beckett). For an introduction, see Wolfgang Iser, Emergenz: Nachgelassene und verstreut publizierte Essays (Konstanz 2013).

**Prerequisites / notice**

readings partly in English

**851-0306-05L**

**Literature and Technology - Simulations, Prototypes, Machines**

Particularly suitable for students of D-ITET, D-MAVT, D-MATL

- Literature about technology transposes models, products and procedures of scientific progress into the logic of poetry. This literature converts not only technology into fiction, but it also creates new cultural and social contextualisations, which reveal alternative readings of configurations of knowledge.

**Objective**

Students are familiar with different relations between literature and technology. They can verbalise and analyse central contentions.

**Content**

Im Seminar lesen wir unter anderem Texte von E.T.A. Hoffmann, Franz Kafka, Georg Kaiser und Max Frisch.

**851-0551-03L**

**Postal Knowledge and the History of Digital Societies**

Particularly suitable for students of D-ARCH, D-BAUG, D-HEST, D-INFK, D-MAVT

- In the second half of the 20th century, postal services have dramatically changed. Communication today is computer-based. The lecture offers problem oriented insights into this sociotechnical process of translation.

**Objective**

Students become familiar with the mutual interdependence of social and technological change that characterises the history of computing and communication.

**Content**


**851-0157-66L**

**Who was Sigmund Freud?**

- In 30 years it would have been bizarre to ask the question: Who was Sigmund Freud? The influence of psychoanalysis on twentieth century thinking was taken for granted even by those ones who rejected Freud's ideas. In contrast, the question today would be: What are Freud's central theories? We will tackle this question in the seminar and reconstruct Freud's thinking from his early medical writings to those writings, in which he developed a critical view of his time. The aim of the seminar is not only to understand Freud's thinking in historical context, but also to reflect, what it could mean to us in early twenty-first century.

**Objective**

30 years ago it would have been bizarre to ask the question: Who was Sigmund Freud? The influence of psychoanalysis on twentieth century thinking was taken for granted even by those ones who rejected Freud's ideas. In contrast, the question today would be: What are Freud's central theories? We will tackle this question in the seminar and reconstruct Freud's thinking from his early medical writings to those writings, in which he developed a critical view of his time. The aim of the seminar is not only to understand Freud's thinking in historical context, but also to reflect, what it could mean to us in early twenty-first century.

**851-0127-28L**

**Death - The Secret Problem of Life**

- No detective novel without a corpse, no religion without knowledge about death and life, no large transplantation of an organ without certificate for the donor's death. Is a dead person always a corpse? - Death is part of life and yet stands simultaneously in opposition to it. We cling to life and nonetheless wish to have the option to commit suicide. Do we know what we really want in that case?

**Objective**

Discussion of 1) several conceptions of death in history, 2) determination of death in a medical sense (brain-death, etc.), 3) The search for a personal view about life and death. 4) The practice of a precise manner of speaking based on reflection.

**Literature**

- Leistungsnachweise der Studenten: 
  - Es besteht Anwesenheitspflicht. Einmaliges Fehlen ist möglich mit Entschuldigung. Als Ersatz die Sitzung wird eine 4-seitige Darstellung des diskiutierten Textes geliefert.
  - Ab dem 2. Seminartermin erfolgt im Voraus pro Sitzung (d.h. insgesamt 6mal) eine 2-seitige Darstellung bzw. Stellungnahme zu einem vorgegebenen Text.
  - Die 2-seitigen Darstellungen müssen bis Dienstag Abend in der Woche vor der nächsten Sitzung vorliegen, damit wir Zeit haben, sie zu lesen.

- Statt einer der 6 Kurzdarstellungen kann ein einführendes Referat (15 min, max. 2 Personen) gehalten werden.

- MA-Studenten Philosophie und Geschichte des Wissens schreiben zusätzlich einen 5-seitigen Essay zu Michael Theunissen: "Die Gegenwart des Todes im Leben".

- Ihre Texte schicken Sie bitte an die eigens eingerichtete Email-Adresse: grundpapier.tod@ethz.ch

Formulare (Minimalanforderungen):
- Schriftbild: Zeilenabstand 1,5, Schriftgröße 12, Seitenabstand 2,5cm, Schriftart: Arial, Times New Roman.
- Vor- und Nachname, Matrikelnummer, Veranstaltungsname, Dozent, E-Mail-Adr., Studiengang.

- organisatorische Rückfragen bitte an den Assistenten Raphael Salvi: raphael.salvi@phil.gess.ethz.ch

Data: 06.03.2019 12:57
Autumn Semester 2016
Page 727 of 1571
This seminar deals with the past, present, and imaginary futures of scientific publishing. We shall discuss the origins and trajectories of www.blogs.ethz.ch/valuesinscience/

N. Guettler

In the past decades, philosophers of science have begun to challenge the value-free ideal in science. With the help of recent literature from W3 credits

Being creative may appear to be the most important requirement of the present age: creative thinking, start-ups, project development all seem to promise an ongoing innovation of work and life. Instead of repeating that promise once again, this course asks for the historical conditions of discourses of creativity.

We will deal with historical and contemporary theories of inventive imagination, fantasy, and creativity. Looking at artistic, psychological, pedagogical, economic, and entrepreneurial discourses of creativity from the 18th to the 21st century we will discuss their specific contexts in order to uncover historical differences and changes. Is it indeed possible to identify conjunctures between the economization, scientification and normalization of creativity? Are there any alternatives to the reigning paradigm of creativity? And if so, what are those?

Creativity

Number of participants limited to 40.

Abstract

Being creative may appear to be the most important requirement of the present age: creative thinking, start-ups, project development all seem to promise an ongoing innovation of work and life. Instead of repeating that promise once again, this course asks for the historical conditions of discourses of creativity.

Objective

We will deal with historical and contemporary theories of inventive imagination, fantasy, and creativity. Looking at artistic, psychological, pedagogical, economic, and entrepreneurial discourses of creativity from the 18th to the 21st century we will discuss their specific contexts in order to uncover historical differences and changes. Is it indeed possible to identify conjunctures between the economization, scientification and normalization of creativity? Are there any alternatives to the reigning paradigm of creativity? And if so, what are those?

Witz

How did racial scientists determine racial affiliation? In the seminar we will examine the practical challenges and eventual works of physical anthropologists from 1850 to the present. By scrutinizing the scientific toolbox of racial scientists, we will reveal how national affiliation, anti-Semitic perceptions and Gender identity shaped scholars’ choices of graphical and computational methods.

Objective

The aim of the course is to analyze the mutual relations between scientific theories and social perceptions, and to follow the formation of the "scientific mind". The course focuses on racial scientists and on the way their practices of computation and statistical analysis influenced their world-views - and vice versa. The students will be instructed on the way historians of science analyze scientific sources.

Prerequisites / notice

Please note that the seminar will be held in English and most texts will be in English. However, a small portion of the reading material will be in German.

History of Astronomy

Die Veranstaltung ist ausgebucht

Abstract

The course is designed to provide an overview of the astronomical developments from the ancient Greek world to the 16th century. We are going to use primary sources tackling historical, technical and philosophical questions. Special attention will be paid to the dramatic change in the way people understood the structure of the heavens and the nature of the physical world.

Objective

The course aims at providing a working knowledge of astronomy and cosmology from the ancient world to the 16th century. Upon its completion the students will be able to describe how our knowledge of the heavens changes from Aristotle’s system to the Copernican Revolution. In addition, they will also have acquired an appreciation of the debates about man's place in the cosmos and the philosophical principles underpinning cosmology.

Theories of Joke

Abstract

From Plato, Aristotle and Cicero, philosophers have tried to find the core principle of wit (or the joke, as both meanings are contained in the German term "Witz"). Even during the 20th century, the philosophy of life and psychoanalysis struggle with it. The seminar provides an overview of this history.

Objective

This seminar deals with the meaning and history of "Witz" (wit, joke) as a form of knowledge. It places "Witz" as a switch or transitional figure within the development of modern theories of knowledge in particular.

Collections in Context: What Do Historians and Scientists Learn from Butterflies, Stones, and Bones?

Abstract

Zurich holds huge scientific collections. They contain objects from around the world, some of them dating back to the 18th century. This interdisciplinary seminar combines perspectives from the history of science and from current scientific disciplines. What do these objects tell us about Zurich's place in the global history of science? What potentials do old collections hold for scientists today?

Objective

The aim of this seminar is threefold: Firstly, students will become familiarised with historiographical approaches to scientific collections. Among them are constructivist approaches that seek to understand scientific knowledge not primarily as a system of objective truths, but rather as an outcome of human 'constructions'. Other approaches deal with the problem of how scientific objects are related to systems of power and oppression, namely in the case of objects collected during the time of European colonialism overseas. Secondly, students will become familiarised with how old collections can yield new insights for current scientists working, e.g., on questions of ecology. Thirdly, the seminar shall serve as a platform to discuss ways of dialogue and possible collaboration between these different approaches.

Students will be expected to read theoretical texts and case studies during semester, participate in discussions with external experts (historians, curators, and scientists), and to write a summarizing essay at the end of the term.

Semester Report
### Semester Paper

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### Major Courses

**Essays**

*In each subject of the master reading lists are handed out. The books on these lists are the subject of the tutorials one has to attend with the teachers that are named in the Leitaden. In three subjects essays are to be written about works on these lists.*

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Data: 06.03.2019 12:57  Autumn Semester 2016  Page 729 of 1571
This essay is the outcome of an individual teaching and learning process during several terms and draws upon representative books and articles in history of technology. It has to consider the state of the art in the field.

Writing essays intends to become acquainted with methods, tools and concepts relevant for the students master thesis.

### Seminars

In the seminars topics from the introductory courses are taught in more detail. Topics for essays are to be arranged with the teachers of the courses.

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<tr>
<td>862-0041-14L</td>
<td>Advanced Seminar in Science Research (HS 2016)</td>
<td>W</td>
<td>3 credits</td>
<td>6S</td>
<td>Lecturers</td>
</tr>
<tr>
<td>862-0042-14L</td>
<td>Advanced Seminar in Theoretical Philosophy (HS 2016)</td>
<td>W</td>
<td>3 credits</td>
<td>6S</td>
<td>Lecturers</td>
</tr>
<tr>
<td>862-0043-14L</td>
<td>Advanced Seminar in Practical Philosophy (HS 2016)</td>
<td>W</td>
<td>3 credits</td>
<td>6S</td>
<td>Lecturers</td>
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<tr>
<td>862-0044-14L</td>
<td>Advanced Seminar in Literature and Culture (HS 2016)</td>
<td>W</td>
<td>3 credits</td>
<td>6S</td>
<td>Lecturers</td>
</tr>
<tr>
<td>862-0045-14L</td>
<td>Advanced Seminar in the Modern World (HS W 2016)</td>
<td>W</td>
<td>3 credits</td>
<td>6S</td>
<td>Lecturers</td>
</tr>
</tbody>
</table>

### Research Colloquium

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>862-0075-00L</td>
<td>Master-Colloquium: Research Colloquium for Ph.D. Students and Members of Staff</td>
<td>W</td>
<td>2 credits</td>
<td>1K+4A</td>
<td>L. Wingert</td>
</tr>
<tr>
<td>862-0088-00L</td>
<td>Research Colloquium Science Studies</td>
<td>W</td>
<td>2 credits</td>
<td>1K</td>
<td>M. Hagner</td>
</tr>
<tr>
<td>862-0089-00L</td>
<td>Advanced Colloquium in Literary Studies</td>
<td>W</td>
<td>2 credits</td>
<td>1K</td>
<td>A. Kilcher</td>
</tr>
<tr>
<td>851-0551-00L</td>
<td>Colloquium for Master and Ph.D. Students</td>
<td>W</td>
<td>2 credits</td>
<td>1K</td>
<td>G. Hürlimann</td>
</tr>
<tr>
<td>862-0002-16L</td>
<td>Research Colloquium History of Knowledge (HS 2016) Only for MAGPW students, D-GESS PHD and D-ARCH</td>
<td>W</td>
<td>2 credits</td>
<td>1K+1A</td>
<td>A. Kilcher, K. M. Espahangizi, D. Gugerli, M. Hagner, P. Sarasin,</td>
</tr>
</tbody>
</table>
This colloquium is highly recommended for first and second semester MAGPW students.

Abstract
The colloquium of the ZGW focuses on present developments, debates and perspectives in the field of history of knowledge. On the second and fourth date there will be public events in the Cabaret Voltaire.

Objective
The colloquium deals with the general problems, questions and methods of the interdisciplinary research field “The History of Knowledge”. Knowledge has become one of the existential conditions of modern societies and it increasingly determines their dynamics. Therefore, it is getting more and more relevant to develop a differentiated analysis of the epistemic, social and cultural constraints of the production, circulation and the decay of knowledge. In addition, the colloquium asks after the cultural and ethical resonances of knowledge not only within science but also in relation to art, literature, technology, everyday life, and so on.

Prerequisites / notice
Short notice about program changes are possible and will be communicated through the ZGW newsletter. Please register with www.zgw.ethz.ch/de/newsletter.html

Credit points can be gained by regular attending and by writing an essay. In addition to the five colloquia there will be a deepening seminar on offer (lecturer K. Esphahangizi).

Free childcare available.


Abstract
The fortnightly colloquium provides a forum for PhD students and postdoctoral researchers to present and discuss their current work. Half of the slots are reserved for presentations by invited external scholars.

Objective
PhD students will have an opportunity to improve their presentation skills and obtain an important chance to receive feedback both from peers and more advanced scholars.

862-0004-03L Philosophical Colloquium (HS 2016) W 2 credits 1K L. Wingert

Abstract
Ph.D. students, post docs, members of staff, and senior colleagues from other philosophy departments will report on their work in progress. Furthermore, promising new philosophical articles and parts of new philosophical books will be studied.

Objective
Ideas and arguments dealing with systematic problems especially in epistemology, ethics, political philosophy, and the philosophy of mind will be scrutinized and elaborated.

Master’s Thesis
The work on the master-thesis is supervised by one of the teachers that are allowed to offer tutorials for it, named in the Leitfaden.

Number Title Type ECTS Hours Lecturers
862-0500-00L Master’s Thesis O 30 credits 64D Supervisors

History and Philosophy of Knowledge Master - Key for Type

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

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<thead>
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<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Mathematics I

- Students understand mathematics as a language for modeling and as a tool for solving practical problems in natural sciences.
- Students can analyze models, describe solutions qualitatively or calculate them explicitly if need be. They can solve examples as well as their practical applications manually and using computer algebra systems.

**Objective**

- Einführung in die Differential- und Integralrechnung von Funktionen einer Variablen und Anwendungen:
- Funktionen, Stetigkeit, Differentialrechnung, Anwendungen der Differentialrechnung, Integralrechnung, Potenzreihen, komplexe Zahlen, Matrizen.

**Literature**

- L. Papula, Mathematik für Ingenieure und Naturwissenschaftler, 11. Auflage, Vieweg und Teubner
- Th. Wihler, Mathematik für Naturwissenschaften, 2 Bände: Einführung in die Analysis, Einführung in die Lineare Algebra; Haupt-Verlag Bern, UTB
- Ch. Blatter, Lineare Algebra; VDF
- H. H. Storner: Einführung in die mathematische Behandlung der Naturwissenschaften; Birkhäuser.

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**Prerequisites / notice**

The course consists of plenary lectures (2 h per week) and problem-solving lessons (2 h per week, groups of ca. 25 people). In addition, online exercises are available in the e-learning environment Moodle (Course OC I).
Students learn to apply selected concepts and tools from computer science for working on interdisciplinary projects.

The following topics are covered: modeling and simulations, introduction to programming, visualizing multi-dimensional data, introduction matrices, managing data with lists and tables and with relational databases, universal methods for algorithm design.

- understand the role of computer science in science,
- to control computer and automate processes of problem solving by programming,
- choose and apply appropriate tools from computer science,
- process and analyze real-world data from their subject of study,
- handle the complexity of real-world data,
- know universal methods for algorithm design.

Students should know the terms, models and classification systems used in health and disease; in addition, they should understand the methods of scientific working.

The goal of this course is to provide students with a wide general understanding in cell biology. With this material as a foundation, students have enough of a cell biological basis to begin their specialization not only in cell biology but also in related fields such as biochemistry, microbiology, pharmacological sciences, molecular biology, and others.

The focus is animal cells and the development of multicellular organisms with a clear emphasis on the molecular basis of cellular structures and phenomena. The topics include biological membranes, the cytoskeleton, protein sorting, energy metabolism, cell cycle and division, viruses, extracellular matrix, cell signaling, embryonic development and cancer research.

The lectures are presented in the Powerpoint format. These are available on the WEB for ETH students over the nethz (Moodle). Some lectures are available on the ETH WEB site in a live format (Livestream) at the above WEB site.


Some of the lectures are given in the English language. Certain sections of the text-book must be studied by self-instruction.
This course will provide insight into various aspects of medical device design such as patient needs assessment, product specification, research and technical design, validation, regulatory affairs and clinical evaluation.

The goal of this lecture series is to enable the students to (i) identify the principal functional requirements for a medical device, (ii) to understand the mechanical properties of natural tissues and synthetic biomaterials, (iii) to apply this information and a basic knowledge of mechanics in the calculation of implant performance, (iv) to develop a plan for the pre-clinical evaluation and regulation of a new device.

1. Introduction to Medical Technology
2. Design Process
3. Mechanics
4. Mechanics of Materials
5. Tissue Mechanics
6. Prostheses: Biomechanics and Design
7. Prostheses: Biomaterials, Surfaces and Wear
8. Arthroplastics: Heart Valves
9. Preclinical Evaluation
10. Regulatory Affairs (MepV, FDA, CE)
11. Intellectual Property
12. Group Work and Presentation

Lecture notes: https://moodle-app2.let.ethz.ch/course/view.php?id=180
### Examination Block 3

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<tbody>
<tr>
<td>376-0151-00L</td>
<td>Anatomy and Physiology I</td>
<td>O</td>
<td>5 credits</td>
<td>4V</td>
<td>M. Ristow, K. De Bock, L. Slomianska, C. Spengler, N. Wenderoth, D. P. Wolfer</td>
</tr>
</tbody>
</table>

**Abstract**  
Basic knowledge of the anatomy and physiology of tissues, of the embryonal and postnatal development, of the basic terminology of pathology, of the neuro-muscular system, of the cardiovascular system and of the respiratory system.

**Objective**  
Basic knowledge of human anatomy and physiology and basics of clinical pathophysiology.

**Content**  
Short overview of human anatomy, physiology and general pathology.

**Anatomy and Physiology I** (fall term):  
Basic knowledge of cytology, histology, embryology, general pathology; nervous system, muscles, cardiovascular system, respiratory system.

**Anatomy and Physiology II** (spring term):  
Digestive system, kidney and urinary tract, endocrine system, skin, thermoregulation, sensory organs, male and female reproductive system, pregnancy and child birth.

**Lecture notes**  

**Literature**  
Anatomie:  
Schiebler TH, Korf H-W: Anatomie (10. vollständig überarbeitete Auflage)  
Steinkopf / Springer, Heidelberg 2007

Martini FH, Timmons MJ, Tallitsch RB: Human Anatomy  

**Physiologie:**  

**Prerequisites / notice**  
Voraussetzungen: 1. Jahr, naturwissenschaftlicher Teil

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>402-0043-00L</td>
<td>Physics I</td>
<td>O</td>
<td>4 credits</td>
<td>3V+1U</td>
<td>T. Esslinger</td>
</tr>
</tbody>
</table>

**Abstract**  
Introduction to the concepts and tools in physics with the help of demonstration experiments: mechanics of point-like and ridged bodies, periodic motion and mechanical waves.

**Objective**  
The concepts and tools in physics, as well as the methods of an experimental science are taught. The student should learn to identify, communicate and solve physical problems in his/her own field of science.

**Content**  
Mechanics (motion, Newton's laws, work and energy, conservation of momentum, rotation, gravitation, fluids)  
Periodic Motion and Waves (periodic motion, mechanical waves, acoustics).

**Lecture notes**  
The lecture follows the book "Physics" by Paul A. Tipler.

**Literature**  
Physik:  
Paul A. Tipler and Gene P. Mosca, Physics (for Scientists and Engineers), W. H. Freeman and Company

**Prerequisites / notice**  
Prerequisites: Mathematics I & II

### Examination Block 4

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-0007-00L</td>
<td>Advanced Anatomy and Physiology I</td>
<td>O</td>
<td>2 credits</td>
<td>2V</td>
<td>K. De Bock, N. Wenderoth, D. P. Wolfer</td>
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</tbody>
</table>

**Abstract**  
Advanced knowledge of anatomy and physiology, and of molecular and pathophysiological aspects of different organ systems.

**Objective**  
Advanced knowledge of human anatomy and physiology and of molecular and pathophysiological aspects.

**Content**  
Advanced Anatomy and Physiology I (fall term):  
Closer look to the nervous system,  
Advanced Anatomy and Physiology II (spring term):  
Introduction to Molecular Biology; Closer look to muscles, cardiovascular system, and respiratory system as well as immunology.

### Third Year Focus Courses

#### Focus Courses: Human Movement Science and Sport

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-0203-00L</td>
<td>Movement and Sport Biomechanics</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>B. Taylor, R. List, S. Lorenzetti</td>
</tr>
</tbody>
</table>

**Abstract**  
Learning to view the human body as a (bio-) mechanical system. Making the connections between everyday movements and sports activity with injury, discomfort, prevention and rehabilitation.

**Objective**  
Students are able to describe the human body as a mechanical system. They analyse and describe human movement according to the laws of mechanics.

**Content**  
Movement- and sports biomechanics deals with the attributes of the human body and their link to mechanics. The course includes topics such as functional anatomy, biomechanics of daily activities (gait, running, etc.) and looks at movement in sport from a mechanical point of view. Furthermore, simple reflections on the loading analysis of joints in various situations are discussed. Additionally, questions covering the statics and dynamics of rigid bodies, and inverse dynamics, relevant to biomechanics are investigated.

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-0207-00L</td>
<td>Exercise Physiology</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>C. Spengler</td>
</tr>
</tbody>
</table>

**Abstract**  
This course provides an overview over molecular and systemic aspects of neuromuscular, cardiovascular and respiratory adaptations to acute and chronic exercise as well as the interaction of the different systems influencing factors, e.g. genetics, gender, age, altitude/depth, heat/cold, with respect to performance and health.

**Objective**  
The aim of this course is to understand molecular and systemic aspects of neuromuscular, cardiovascular and respiratory adaptations to acute and chronic exercise as well as as the interaction of the different systems regarding health-relevant aspects and performance in healthy people and persons with selected diseases. Furthermore, students will understand the influence of genetics, gender, age, altitude/depth, heat and cold on the named factors.
Introduction to Biomedical Engineering I

**Recommended textbooks:**

- History of Exercise Physiology, research methods, fibertype heterogeneity and its functional significance, neural control of muscle force, molecular nad cellular mechanisms of muscle adaptation to resistance, endurance and stretching exercise, interindividual variability in the response to training, cardiorespiratory and metabolic responses to acute and chronic exercise, sexi differences relevant to exercise performance, exercise in hot and cold environment, children and adolescents in sport and exercise, exercise at altitude and depth, aging and exercise performance, exercise for health, exercise in the context of disease.

**Lecture notes:**

Online material is provided during the course.

**Literature:** Recommended textbooks:

- William D. Mc Ardle, Frank I. Katch, Victor L. Katch
  ISBN/ISSN: 9781451191554

- W.L. Kenney, J.H. Wilmore, D.L. Costill
  Physiology of Sport and Exercise

**Prerequisites / notice:**

Anatomy and Physiology I + II

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### Focus Courses: Molecular Health Sciences

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-0309-00L</td>
<td>Concepts in Modern Genetics</td>
<td>W</td>
<td>6 credits</td>
<td>4V</td>
<td>Y. Barral, D. Bopp, A. Hajnal, M. Stoffel, O. Voinnet</td>
</tr>
</tbody>
</table>

**Abstract:** Concepts of modern genetics and genomics, including principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

**Objective:**

This course focuses on the concepts of classical and modern genetics and genomics.

**Content:**

- The topics include principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

**Lecture notes:** Scripts and additional material will be provided during the semester.

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### Focus Courses: Medical Technology

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<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>376-0021-00L</td>
<td>Introduction to Biomedical Engineering I</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>P. Christen, R. Müller, J. G. Snedeker, M. Zenobi-Wong</td>
</tr>
</tbody>
</table>

**Abstract:** Introduction to biomechanics, biomaterials, tissue engineering, medical imaging as well as the history of biomedical engineering.

**Objective:** Understanding of physical and technical principles in biomechanics, biomaterials, tissue engineering, medical imaging as well as the history of biomedical engineering. Mathematical description and problem solving. Knowledge of biomedical engineering applications in research and clinical practice.

**Content:**

- Tissue and Cellular Biomechanics,
- Molecular Biomechanics and Biopolymers,
- Computational Biomechanics,
- Biomaterials,
- Tissue Engineering,
- Radiation and Radiographic Imaging,
- Diagnostic Ultrasound Imaging,
- Magnetic Resonance Imaging,
- Biomedical Optics and Lasers.

**Lecture notes:**

Stored on ILIAS.

**Literature:**

Introduction to Biomedical Engineering, 3rd Edition 2011,
Autor: John Enderle, Joseph Bronzino, ISBN 9780123749796
Academic Press

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### Focus Courses: Neurosciences

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
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<tr>
<td>376-1714-00L</td>
<td>Biocompatible Materials</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>K. Manirua, J. Möller, M. Zenobi-Wong</td>
</tr>
</tbody>
</table>

**Abstract:**

Introduction to molecules used for biomaterials, molecular interactions between different materials and biological systems (molecules, cells, tissues). The concept of biocompatibility is discussed and important techniques from biomaterials research and development are introduced.

**Objective:**

The class consists of three parts:

1. Introduction into molecular characteristics of molecules involved in the materials-to-biology interface. Molecular design of biomaterials.
2. The concept of biocompatibility.
3. Introduction into methodology used in biomaterials research and application.

**Content:**

Introduction into native and polymeric biomaterials used for medical applications. The concepts of biocompatibility, biodegradation and the consequences of degradation products are discussed on the molecular level. Different classes of materials with respect to potential applications in tissue engineering and drug delivery are introduced. Strong focus lies on the molecular interactions between materials having very different bulk and/or surface chemistry with living cells, tissues and organs. In particular the interface between the materials surfaces and the eukaryotic cell surface and possible reactions of the cells with an implant material are elucidated. Techniques to design, produce and characterize materials in vitro as well as in vivo analysis of implanted and explanted materials are discussed. In addition, a link between academic research and industrial entrepreneurship is established by external guest speakers.

**Lecture notes:**

Handouts can be accessed online.

**Literature**

(available online via ETH library)

Handouts provided during the classes and references therein.
The lecture requires reading of book chapters, handouts and original scientific papers. Further information will be given in the individual lectures and are mentioned on OLAT.

Prerequisites / notice

376-1305-01L  
Structure, Plasticity and Repair of the Nervous System  
W  3 credits  2V  M. E. Schwab, L. Filli, K. A. Martin, further lecturers

Abstract  
The course covers the structure, plasticity and regeneration of the adult nervous system (NS) with focus on: sensory systems, cognitive functions, learning and memory, molecular and cellular mechanisms, animal models, and diseases of the NS.

Objective  
The aim is to give a deepened insight into the structure, plasticity and regeneration of the nervous system based on molecular, cellular and biochemical approaches.

Content  
The main focus is on the structure, plasticity and regeneration of the NS: biology of the adult nervous system; structural plasticity of the adult nervous system, regeneration and repair: networks and nerve fibers, regeneration, pathological loss of cells.

Lecture notes  
ETH students: Lecture notes will be provided on Moodle https://moodle-app2.let.ethz.ch/course/view.php?id=694  
Password will be provided at the beginning of the lecture.

Literature  
The lecture requires reading of book chapters, handouts and original scientific papers. Further information will be given in the individual lectures and are mentioned on Moodle / OLAT.

551-0309-00L  
Concepts in Modern Genetics  
W  6 credits  4V  Y. Barral, D. Bopp, A. Hajnal, M. Stoffel, C. Voinnet

Abstract  
Concepts of modern genetics and genomics, including principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

Objective  
This course focuses on the concepts of classical and modern genetics and genomics.

Content  
The topics include principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

Lecture notes  
Scripts and additional material will be provided during the semester.

Prerequisites / notice  
This course is a co-production of the University of Zurich and ETH Zurich, and will be taught in English. The course takes place on Monday afternoon at ETH Hönggerberg, and on Tuesday morning at UZH Irchel.

Electives

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>151-0255-00L</td>
<td>Energy Conversion and Transport in Biosystems</td>
<td>W</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>D. Poulikakos, A. Ferrari</td>
</tr>
<tr>
<td>151-0575-01L</td>
<td>Signals and Systems</td>
<td>W</td>
<td>4 credits</td>
<td>2V+2U</td>
<td>R. D’Andrea</td>
</tr>
<tr>
<td>151-0604-00L</td>
<td>Microrobotics</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>B. Nelson</td>
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</tbody>
</table>

Data: 06.03.2019 12:57  Autumn Semester 2016  Page 737 of 1571
This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore the application of these principles to important engineering problems is demonstrated.

The course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore the application of these principles to important engineering problems is demonstrated.

Fick's laws; application and significance of mass transfer; comparison of Fick's laws with Newton's and Fourier's laws; derivation of Fick's 2nd law; diffusion in dilute and concentrated solutions; rotating disk; dispersion; diffusion coefficients, viscosity and heat conduction (Pr and Sc numbers); Brownian motion; Stokes-Einstein equation; mass transfer coefficients (Nu and Sh numbers); mass transfer across interfaces; Reynolds- and Chilton-Colburn analogies for mass-, heat-, and momentum transfer in turbulent flows; film-, penetration-, and surface renewal theories; simultaneous mass, heat and momentum transfer (boundary layers); homogeneous and heterogenous reversible and irreversible reactions; diffusion-controlled reactions; mass transfer and first order heterogenous reaction. Applications.


Lecture notes

Two tests are offered for practicing the course material. Participation is mandatory.

Abstract

Signal theory and systems theory (continuous-time and discrete-time); Signal analysis in the time and frequency domains, signal spaces, Hilbert spaces, generalized functions, linear time-invariant systems, sampling theorems, discrete-time signals and systems, digital filter structures, Discrete Fourier Transform (DFT), finite-dimensional signals and systems, Fast Fourier Transform (FFT).

Objective

Introduction to mathematical signal processing and system theory.

Content

Signal theory and systems theory (continuous-time and discrete-time); Signal analysis in the time and frequency domains, signal spaces, Hilbert spaces, generalized functions, linear time-invariant systems, sampling theorems, discrete-time signals and systems, digital filter structures, Discrete Fourier Transform (DFT), finite-dimensional signals and systems, Fast Fourier Transform (FFT).

Lecture notes

http://www.multimat.mat.ethz.ch/education/lectures/intro.html

Literature

James F. Shackelford
Introduction to Materials Science for Engineers

Abstract

Fundamental knowledge and understanding of the atomistic and macroscopic concepts of material science.

Objective

Basic concepts in materials science.

Content

Atomic structure
Atomic bonds
Crystalline structure, perfection - imperfection
Diffusion
Mechanical and thermal properties
Phase diagrams
Kinetics
Structural materials
Electric, magnetic and optical properties of materials
Materials selection criteria

Lecture notes

http://www.multimat.mat.ethz.ch/education/lectures/intro.html

Literature

James F. Shackelford
Introduction to Materials Science for Engineers

Abstract

Conduct physical performance tests and measurements that are typically used to assess performance of athletes and/or patients and that deepen the understanding of physiological processes in response to physical exertion.

Objective

Gain hands-on experience in exercise physiology and consolidate knowledge on physiological adaptations to different types and degrees of physical activity and climatic influences. Learn fundamental assessment techniques of the muscular system, the cardio-respiratory system and of whole-body performance, learn scientifically correct data analysis and interpretation of results. Insight into today's Sports Medicine.

Content

Laboratory course:
- Various exercise tests assessing human performance and assessments of physiological responses to activity (examples are VO2max-test, Conconi-Tests, Determination of anaerobic threshold, Cooper-Test, 1-repetition maximum test, lactate minimum test), dynamometry, mechanography, body composition etc.). Insight into measurements in Sports Medicine.
- Various exercise tests assessing human performance and assessments of physiological responses to activity (examples are VO2max-test, Conconi-Tests, Determination of anaerobic threshold, Cooper-Test, 1-repetition maximum test, lactate minimum test), dynamometry, mechanography, body composition etc.). Insight into measurements in Sports Medicine.

Lecture notes

Tutorial on Laboratory Experiments in Exercise Physiology
(Editor: Exercise Physiology Lab)

Literature

Schmidt/Lang/Heckmann: Physiologie des Menschen, Springer-Verlag, Heidelberg

Prerequisites / notice

Desirable:
- Exercise Physiology Lecture (concomitantly or passed; is selection criterion in case of more applications than lab spaces)

Abstract

Comprehension for development and changes of sports from the ancient world to the present. Description of sports in services of national idea, from education and health promotion from the middle of the 18th century till this day.

Objective

Understanding for the development and adaptation of sports from the ancient world to present times.

Content


Lecture notes

Ein Skript für die aktuelle Veranstaltung wird abgegeben.

Literature


Abstract

This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore the application of these principles to important engineering problems is demonstrated.
Sport Psychology

Central aspects of Sport related pedagogy will be handled in these lectures. These aspects cover, amongst others, the subject and tasks of Sport related pedagogy. Furthermore, the general and sports relevant foundations of Sport related pedagogy will be covered.

Inhaltliche Schwerpunkte der Vorlesung sind:
- Einführung in die Sportpädagogik und die pädagogische Psychologie des Sportunterrichts
- Bedeutung des Sports im Jugendalter
- Zeitgemäßer Sportunterricht
- Sport und Leistung
- Heterogenität im Sportunterricht
- Sport und Gesundheit
- Geschlechterfragen im Sport
- Soziale und moralische Entwicklung im Sportunterricht

Unterrichtsmaterialien zu den einzelnen Veranstaltungen werden den Studierenden zur Verfügung gestellt.

This lecture is intended as an introduction to sport psychology and imparts knowledge on selected areas of the subject.

Insights of human movement sciences concerning wear, overstraining and regeneration of the musculoskeletal system form an important

Main Topics
- Introduction to sport psychology
- Cognitions in sports: mental rehearsal and mental training
- Emotions and stress
- Motivation: goal-setting in sports
- Career and career transition in elite sport
- Coach-Athlete-Interaction
- Psychological aspects of sport-injury rehabilitation
- Group dynamics in sport

Students are given insight into different work areas of sport psychology. In order to understand what «sport psychology» is, it is necessary to explain the essence and tasks of sport psychology and what it relates to, and to work out an underlying basis for key topics, such as cognition and emotions. Students' expertise is furthered by presenting and providing more in-depth treatment of additional topics of sport psychology. Selected intervention forms are intended to provide insight into applied sport psychology and ensure that mental processes and their impact in sport can be recognised. Case studies and practical exercises (e.g. objective training) are intended to prompt students to reflect to a greater extent on the forms in which sport psychology can be applied in their practice of sports and to integrate these in their teaching.

Consolidated findings of movement sciences concerning deterioration, overload and regeneration of the musculoskeletal system are an


Conflicts and politics: sports organizations, doping, violence
Social inequalities and distinctions: gender differences and group behavior

Students are able to describe selected chemicals, biological and molecular processes that occur in cells spontaneously or after physical or chemical exposure and resulting in a tumor. They are able to list important cancer-inducing agents and explain the respective mechanism of action. They have knowledge of significant risk factors for cancer diseases. They are confronted with the basics of toxicology and they can explain the principle of the most common therapeutic strategies.

- Cognitions in sports: mental rehearsal and mental training
- Emotions and stress
- Motivation: goal-setting in sports
- Career and career transition in elite sport
- Coach-Athlete-Interaction
- Psychological aspects of sport-injury rehabilitation
- Group dynamics in sport

A detailed program with additional references will be delivered at the beginning of the lecture.

The Musculoskeletal System and Work

Consolidated findings of movement sciences concerning deterioration, overload and regeneration of the musculoskeletal system are an important basis for an ergonomic working environment. The following topics are covered: Muscle fatigue during the 8-hour day, use of the computer mouse, backaches, Tendinitis, nerve compression, epidemiology, prevention, rehabilitation, laws, measuring procedures.

Goal of the course is the activation of physiological and patho-physiological insights for the understanding of loads of the musculoskeletal system during work. Prevention and rehabilitation of work related musculoskeletal disease will be discussed with the help of a bio-psycho-social model. Furthermore, evidence based methods for a healthy work design will be presented.

Insights of human movement sciences concerning wear, overstraining and regeneration of the musculoskeletal system form an important base for an ergonomic work design. The following topics will be covered: Muscle fatigue in an 8-hours-day, mouse appliance, back pain, insertion tendinitis, nerve compression, epidemiology, prevention, rehabilitation, laws, and measurement methods.

Skript und Folien auf NETZ als PDF-Datei zur Verfügung


Cancer: Fundamentals, Origin and Therapy


Students are able to describe selected chemicals, biological and molecular processes that occur in cells spontaneously or after physical or chemical exposure and resulting in a tumor. They are able to list important cancer-inducing agents and explain the respective mechanism of action. They have knowledge of significant risk factors for cancer diseases. They are confronted with the basics of toxicology and they can explain the principle of the most common therapeutic strategies.
The combining of training and coaching as in the example of sport analysis, which has an effect on youth training and athlete development.

Students learn the assessments to plan an exercise-therapy-treatment.

**Basics of Exercise Therapy**

- Schüle / Huber: Grundlagen der Sporttherapie, Deutscher Ärzteverlag, Köln 2012


Handouts with reproductions of all presented transparencies will be distributed.

The lecture requires an active participation of the students. All students will participate in individual or group work focussing on specific subject of the lecture. Students will have ample time for preparation during lecture time.
Intensive discussion concerning complications of a spinal cord injury and their consequences on trainability and exercise performance of C. Perret

Structure, function and chemistry of nucleic acids and carbohydrates. DNA/RNA structure and synthesis; recombinant DNA technology and B. Spörri Kälin

Nucleic Acids and Carbohydrates skript will be on lern-platform

Impart knowledge of practical basics of Sports and Exersice Therapy

General literature:
Medicinal Chemistry I

The lectures give an overview of selected drugs and the molecular mechanisms underlying their therapeutic effects in disease. The historical and modern-day methods by which these drugs were discovered and developed are described. Structure-function relationships and the biophysical rules underlying ligand-target interactions will be discussed and illustrated with examples.

Prerequisite: Anatomy and Physiology

Knowledge of the pathophysiology and the concomitant complications of a spinal cord injury and the consequences for physical exercise and trainability during rehabilitation as well as in recreational and elite sport.

The following issues will be discussed: Epidemiology and etiology of spinal cord injury; complications and consequences of spinal cord injury; trainability/exercise physiology and spinal cord injury; history and organisation of wheelchair sports; elite sport and spinal cord injury

Special literature:
G.A. Zäch, H. G. Koch
Paraplegie - ganzheitliche Rehabilitation
Karger-Verlag, 2006
ISBN 3-8055-7980-2

V. Goosney-Tolrefy
Wheelchair sport: A complete guide for athletes, coaches and teachers
Human Kinetics, 2010

Y.C. Vanlandewijck, W.R. Thompson
The Paralympic Athlete
Wiley-Blackwell, 2011
ISBN 978-1-4443-3404-3

Liz Broad
Sports Nutrition for Paralympic Athletes
CRC Press 2014

Voraussetzung: Vorlesung Anatomie/Physiologie besucht!

Mainly based on recent original literature, a detailed list will be distributed during the first lecture

Physical Chemistry I (for Biology and Pharmacy)

Understanding the fundamental thermodynamical properties of chemical and biological systems.

In process, will be distributed at the beginning of the first lecture

Prerequisite: mathematics I+II, functions of multiple variables, partial derivatives.

The lectures give an overview of selected drugs and the molecular mechanisms underlying their therapeutic effects in disease. The historical and modern-day methods by which these drugs were discovered and developed are described. Structure-function relationships and the biophysical rules underlying ligand-target interactions will be discussed and illustrated with examples.

Prerequisite: mathematics I+II, functions of multiple variables, partial derivatives.

Basic understanding of therapeutic agents with respect to molecular, pharmacological and pharmaceutical properties.

Molecular mechanisms of action of drugs. Structure function and biophysical basis of ligand-target interactions

Will be provided in parts before each individual lecture.
The lectures will provide a comprehensive survey of pharmacology and toxicology. Special emphasis is placed on the interrelationship between pharmacological, pathophysiological and clinical aspects. The lectures integrate disease pathology with mechanisms of drug action, usage, metabolism, pharmacokinetics, side effects, toxicology, contraindications and dosage of relevant drug classes. Basic principles of clinical pharmacology and pharmacotherapy will be covered.

Language: German and English

Prerequisites / notice

535-0521-00L Pharmacology and Toxicology I W 2 credits 2V U. Quitterer

Objective
The lectures will provide a comprehensive survey of pharmacology and toxicology. Special emphasis is placed on the interrelationship between pharmacological, pathophysiological and clinical aspects.

Content
Topics include disease-relevant macroscopic, microscopic, pathobiochemical and functional disturbances of specific organs and organ systems. The lectures integrate disease pathology with mechanisms of drug action, usage, metabolism, pharmacokinetics, side effects, toxicology, contraindications and dosage of relevant drug classes. Basic principles of clinical pharmacology and pharmacotherapy will be covered.

Prerequisites / notice

Voraussetzungen: Abschluss Grundstudium

535-0810-00L Gene Technology W 2 credits 2G D. Neri

Abstract
The course will provide a solid overview of the science and issues in gene technology and its pharmaceutical applications.

Objective
The aim of the lecture course is to provide a solid overview of gene technology, with a special focus on drug development. Topics: Antibody phage technology, DNA-encoded chemistry, protein modification technology, genome sequencing, transcriptomics, proteomics, functional genomics, principle of drug discovery. The course is suited for advanced undergraduate and early graduate students in pharmaceutical sciences or related fields.
1. Antibody phage technology
   - The antibody molecule
   - V genes, CDRs, basics of antibody engineering
   - Principles of phage display
   - Phagemid and phage vectors
   - Antibody libraries
   - Phage display selection methodologies
   - Other phage libraries (peptides, globular proteins, enzymes)
   - Alternative screening/selection methodologies
   - DNA-encoded chemical libraries

2. Proteins: chemical modification and detection of biomolecular interactions
   - Homo- and hetero-dimerization of proteins
   - Chemical modifications of proteins
   - Antibody-drug conjugates
   - Radioactive labeling of proteins
   - Kinetic association and dissociation constants
   - Affinity constant: definition and its experimental measurement

3. Genomics: Applications to Human Biology
   - Protein cloning and expression
   - DNA sequencing
   - Some foundations of genetic analysis
   - Knock-out technologies
   - Transcriptomics
   - Proteomics
   - Recombinant vaccines

4. Pharmaceuticals: Focus on Discovery
   - Ligand Discovery
   - Half-life extension
   - Cancer therapy
   - Gene therapy

Lecture notes
- Skript "Gene Technology" by Prof. Dario Neri and slides of the lecture
- "Gene Technology" by Prof. Dario Neri and slides of the lecture
The full-year course (551-0319-00 & 551-0320-00) focuses on the molecular mechanisms and concepts underlying the biochemistry of cellular physiology, investigating how these processes are integrated to carry out highly coordinated cellular functions. The molecular characterisation of complex cellular functions requires a combination of approaches such as biochemistry, but also cell biology and genetics. This course is therefore the occasion to discuss these techniques and their integration in modern cellular biochemistry.

The students will be able to describe the structural and functional details of individual cell components, and the spatial and temporal regulation of their interactions. In particular, they will learn to explain the integration of different molecules and signaling pathways into complex and highly dynamic cellular processes such as intracellular transport, cytoskeletal rearrangements, cell motility, cell division and cell growth. In addition, they will be able to illustrate the relevance of particular signaling pathways for cellular pathologies such as cancer.

### Objective

To attend this course the students must have a solid basic knowledge in chemistry, biochemistry and general biology. The course will be taught in English.

### Content

Structural and functional details of individual cell components, regulation of their interactions, and various aspects of the regulation and compartmentalisation of biochemical processes.

Topics include: biophysical and electrical properties of membranes; viral membranes; structural and functional insights into intracellular transport and targeting; vesicular trafficking and phagocytosis; post-transcriptional regulation of gene expression.

### Lecture notes

Scripts and additional material will be provided during the semester. Please contact Dr. Alicia Smith for assistance with the learning materials. (alicia.smith@bc.biol.ethz.ch)

### Literature

Recommended supplementary literature (review articles and selected primary literature) will be provided during the course.

### Prerequisites / notice

Materials supporting the lectures and exercises will be made available via Moodle.

A comprehensive script is available in the HCI-Shop. A summary of the part "Spektroskopie" defines the relevant material for the exam.

### Literature

- Pretsch E., Bühmann P., Badertscher M., Spektroskopische Daten zur Strukturaufklärung organischer Verbindungen, fünfte Auflage, Springer-Verlag, Berlin 2010;
- K. Cammann, Instrumentelle Analytische Chemie, Verfahren, Anwendungen, Qualitätssicherung, Spektrum Akademischer Verlag, Heidelberg, 2001;

### Prerequisites / notice

- 529-1003-00 V "Allgemeine Chemie I (für Biol./Pharm.Wiss.)"
- 529-1003-00 P "Allgemeine Chemie I (für Biol./Pharm.Wiss.)"
- 529-1011-00 G "Organische Chemie I (für Biol./Pharm.Wiss.)"

### Objective

- Pretsch E., Bühmann P., Badertscher M., Spektroskopische Daten zur Strukturaufklärung organischer Verbindungen, fünfte Auflage, Springer-Verlag, Berlin 2010;
- K. Cammann, Instrumentelle Analytische Chemie, Verfahren, Anwendungen, Qualitätssicherung, Spektrum Akademischer Verlag, Heidelberg, 2001;

### Prerequisites / notice

- 529-1003-00 V "Allgemeine Chemie I (für Biol./Pharm.Wiss.)"
- 529-1003-00 P "Allgemeine Chemie I (für Biol./Pharm.Wiss.)"
- 529-1011-00 G "Organische Chemie I (für Biol./Pharm.Wiss.)"

### Objective

- 551-1003-00 L Introduction to Bioinformatics: Concepts and Applications
- 551-1003-00 W 6 credits 4G W. Gruissem, K. Bärenfeller, A. Callisch, G. Captari, J. Fütterer, M. Robinson, A. Wagner

### Objective

Introduction to Bioinformatics I: Concepts and Applications (formerly Bioinformatics I) will provide students with the theoretical background of approaches to store and retrieve information from large databases. Concepts will be developed how DNA sequence information can be used to understand phylogenetic relationships, how RNA sequence relates to structure, and how protein sequence information can be used for genome annotation and to predict protein folding and structure. Students will be introduced to quantitative methods for measuring gene expression and how this information can be used to model gene networks. Methods will be discussed to construct protein interaction maps and how this information can be used to simulate dynamic molecular networks.

In addition to the theoretical background, the students will develop hands-on experiences with the bioinformatics approaches through guided exercises. The course provides students from different backgrounds with basic training in bioinformatics approaches that have impact on biological, chemical and physics experimentation. Bioinformatics approaches draw significant expertise from mathematics, statistics and computational science.

Although "Introduction to Bioinformatics I" will focus on theory and praxis of bioinformatics approaches, the course provides an important foundation for the course "Introduction to Bioinformatics II: Fundamentals of computer science, modeling and algorithms" that will be offered in the following semester.
Content Bioinformatics I will cover the following topics:
From genes to databases and information
BLAST searches
Prediction of gene function and regulation
RNA structure prediction
Gene expression analysis using microarrays
Protein sequence and structure databases
WWW for bioinformatics
Protein sequence comparisons
Proteomics and de novo protein sequencing
Protein structure prediction
Cellular and protein interaction networks
Molecular dynamics simulation

551-1323-00L Fundamentals of Biology II: Biochemistry and Molecular Biology W 4 credits 4V K. Locher, N. Ban, R. Glockshuber, E. Weber-Ban

Abstract The course provides an introduction to Biochemistry / Molecular Biology with some emphasis on chemical and biophysical aspects.

Objective Topics include the structure-function relationship of proteins / nucleic acids, protein folding, enzymatic catalysis, cellular pathways involved in bioenergetics and the biosynthesis and breakdown of amino acids, glycans, nucleotides, fatty acids and phospholipids, and steroids. There will also be a discussion of DNA replication and repair, transcription, and translation.

Lecture notes none


Prerequisites / notice Some of the lectures are given in the English language.

752-2120-00L Consumer Behaviour I W 2 credits 2V M. Siegrist, C. Keller, B. S. Sütterlin

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

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

752-4005-00L Food Microbiology I W 3 credits 2V M. Loessner

Abstract This lecture is the first part of a one-year course. It offers insights into the fundamentals and applications of Food Microbiology. Contents include basic microbiology of the different bacteria, yeasts and molds present in foods, as well as the occurrence and control of foodborne pathogens and spoilage organisms.

Objective The lecture offers insights into the basics, practical consequences and applications of Food Microbiology. Contents include basic microbiology of the different bacteria, yeasts, molds and protozoa in foods, as well as the occurrence and control of foodborne pathogens and spoilage organisms.

The focus of this first part of the lecture will be on the organisms, but also on the factors which determine spoilage and foodborne disease.


Lecture notes Electronic copies of the presentation slides (PDF) and additional material will be made available for download.

Literature Recommendations will be given in the first lecture

752-6001-00L Introduction to Nutritional Science W 3 credits 2V M. B. Zimmermann, C. Wolfrum

Abstract This course introduces basic concepts of micro- and macronutrient nutrition. Micronutrients studied include fat-soluble and water-soluble vitamins, minerals and trace elements. Macronutrients include proteins, fat and carbohydrates. Special attention is given to nutrient digestion, bioavailability, metabolism and excretion with some focus on energy metabolism.

Objective To introduce the students to the both macro- and micronutrients in relation to food and metabolism.
The course is divided into two parts. The lectures on micronutrients are given by Prof. Wolfrum. Prof. Zimmermann discusses the micronutrients, including fat-soluble vitamins, water-soluble vitamins, minerals, and trace elements. Prof. Wolfrum introduces basic nutritional aspects of proteins, fats, carbohydrates, and energy metabolism. The nutrients are described in relation to digestion, absorption, and metabolism. Special aspects of homeostasis and homeorhesis are emphasized.

Lecture notes: There is no script. Powerpoint presentations will be made available.

Elmadfa I, & Leitzmann C: Ernährung des Menschen
UTB Ulmer, Stuttgart, 4. überarb. Ausgabe 2004

Garrow J.S. and James W.P.T: Human Nutrition and Dietetics
Churchill Livingstone, Edinburgh, 11th rev. ed. 2005

The course is divided into two parts. The lectures on micronutrients are given by Prof. Zimmermann and the lectures on macronutrients are given by W. Langhans.

Objective: To understand the potential effects of nutrition on exercise performance, with a focus on concepts and principles of nutrition before, during, and after exercise.

Handouts for each lecture will be made available every week: http://www.fpb.ethz.ch/teaching/handouts.html

The course introduces basic concepts of the interaction between nutrition and exercise and cognitive performance. The course will cover elementary aspects of sports nutrition physiology, including carbohydrate, glycogen, fat, protein, and energy metabolism. A main focus will be to understand nutritional aspects before exercise to be prepared for intensive exercise bouts, how exercise performance can be supported by nutrition during exercise and how recovery can be assisted by nutrition after exercise.

Although this is a scientific course, it is a goal of the course to translate basic sports nutrition science into practical sports nutrition examples.

The course is designed for 3rd year Bachelor students, Master students and postgraduate students (MAS/CAS).

Language: English

It is strongly recommended to attend the lectures. The lecture (including the handouts) is not designed for distance education.

The aim of the course is to give students an introductory overview of relevant topics regarding leadership research and practice, thus enabling them to gain a deeper understanding of the leadership phenomenon. Students should understand different concepts of leadership in the complex interaction between individuals, groups, organisation, context and situation. They should be informed about the evolution of the understanding of mankind in relation to working processes and its impact on organizations and the understanding of leadership theory in the past 100 years. They should grasp the concept of leadership responsibility (leadership ethics) and be able to derive consequences for leadership in practical situations. They should recognize the fundamental importance of communication in leadership situations and receive input which enables them to communicate adequately in specific situations.

1-hour written exam will take place during the last lecture in the semester.

GESS Science in Perspective

Science in Perspective

Recommended Science in Perspective (Type B) for D-HEST.

see Science in Perspective: Type A: Enhancement of Reflection Capability

Language Courses

see Science in Perspective: Language Courses ETH/UZH

Sport Practical

Assessments

Sport Practical Basic Education

Sport Practical Advanced Education

Health Sciences and Technology Bachelor - Key for Type

O Compulsory
W+ Eligible for credits and recommended
W Eligible for credits
E- Recommended, not eligible for credits
Z Courses outside the curriculum
Dr Suitable for doctorate
<table>
<thead>
<tr>
<th>Key for Hours</th>
<th>ECTS</th>
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<tbody>
<tr>
<td>V lecture</td>
<td>European Credit Transfer and Accumulation System</td>
</tr>
<tr>
<td>G lecture with exercise</td>
<td>Special students and auditors need special permission from the lecturers.</td>
</tr>
<tr>
<td>U exercise</td>
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<tr>
<td>S seminar</td>
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<td>K colloquium</td>
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<td>P practical/laboratory course</td>
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<td>A independent project</td>
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<td>D diploma thesis</td>
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<td>R revision course / private study</td>
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## Educational Science

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>851-0240-00L</td>
<td>Human Learning (EW1)</td>
<td>O</td>
<td>2</td>
<td>2G</td>
<td>E. Stern</td>
</tr>
</tbody>
</table>

**Abstract**

This course looks into scientific theories and also empirical studies on human learning and relates them to the school.

**Objective**

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

**Content**

Thematische Schwerpunkte:

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

Lernformen:


**Lecture notes**

Folien werden zur Verfügung gestellt.

**Literature**


**Prerequisites / notice**

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

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<th>Number</th>
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<th>Type</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>851-0240-03L</td>
<td>Introduction to Test Theory and Test Construction in Educational Contexts (University of Zürich)</td>
<td>W</td>
<td>4</td>
<td>2S</td>
<td>University lecturers</td>
</tr>
</tbody>
</table>

**Abstract**

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

**Objective**

At the end of the seminar, participants will be in a position to:

- describe the scientific fundamentals of test theory and test structure.
- evaluate examples of scientifically-developed tests in their application context.
- if necessary, critically question the performance assessment that they employ in practice and professionalise it still further.

**Content**

Die konkreten Inhalte des Seminars ergeben sich aufgrund der Präferenzen der Teilnehmenden und der daraus abgeleiteten Themenübersicht für Vorträge und Seminararbeiten. Im Rahmen der Startveranstaltung wird eine Liste mit möglichen Themen abgegeben und erläutert. Schwerpunkte der Themenvorschläge sind:

- Testentwicklung
- Gütekriterien von Tests
- Aufgabenkonstruktion
- Datenauswertung
- Rasch-Modell
- Internationale Vergleichstests
- Zulassungstests

**Lecture notes**

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

**Literature**

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

**Prerequisites / notice**

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

- Präsenz und aktive mündliche Mitarbeit in der Lehrveranstaltung (MA)
- Pflichtlektüre entsprechend der Angaben in der Lehrveranstaltung
- Referat (RE)
- Schreiben einer schriftlichen Arbeit

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

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<tr>
<td>851-0240-15L</td>
<td>Colloquium on the Science of Learning and Instruction</td>
<td>W</td>
<td>1</td>
<td>1K</td>
<td>E. Stern, P. Greutmann, further lecturers</td>
</tr>
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</table>

**Abstract**

In the colloquium we discuss scientific projects concerning the teaching in mathematics, computer science, natural sciences and technology (STEM). The colloquium is conducted by the professorships participating in the Competence Center EducETH (ETH) and in the Institute for Educational Sciences (UZH).

**Objective**

Participants are exemplarily introduced to different research methods used in research on learning and instruction and learn to weigh advantages and disadvantages of these approaches.

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**Notice**

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

1. They know the basic rules of negotiation and conflict management (e.g., mediation) and can apply them in the school context (e.g., in conversations with parents).
2. They can apply diverse techniques of classroom management (e.g., prevention of disciplinary problems in the classroom) and know relevant authorities for further information (e.g., legal conditions).

**Course Details**

**Number of Participants:** Limited to 20.

**Enrollment:** Successful participation in EW1 ("Human Learning") and EW2 ("Designing Learning Environments for School") is recommended, but not a mandatory prerequisite.

**Objective:**

- Students possess theoretical knowledge and practical competences to be able to cope with the psychosocial demands of teaching.

- Students know how to prepare, conduct and reflect a single lesson based on educational requirements.
- Students take the learning goals as a starting point considering previous knowledge as well as the professional environment and the ambitions of the learners.
- Students apply the basic teaching techniques of their subject area in a sensible way and know how to appropriately arrange the phases of learning.
- Students know how to simplify and present complex technical contents of their subject area.

**Prerequisites**

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

**Enrollment:** Only for Health Sciences and Technology TC students.
Objective

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

Further Subject Didactics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-8011-00L</td>
<td>Mentored Work Subject Didactics Health Sciences and Technology TC students.</td>
<td></td>
<td>2 credits</td>
<td>4A</td>
<td>S. Maurer</td>
</tr>
</tbody>
</table>

Abstract

The mentored paper is designed to bring together the findings from the FD1 and the FD2. By using various teaching techniques and methods a semester plan, which is based on various curricula will be elaborated for a given topic.

Objective

1. The students have planned a curriculum for a semester course.
2. Students reflect on formative and summative ways such a teaching unit to examine and implement parts of it.
3. The students have implemented parts of the semester curriculum.
4. The students deal with the question to what extend teaching techniques, teaching methods but also sequences of self-study must be involved in the planning.

Health Sciences and Technology TC - Key for Type

<table>
<thead>
<tr>
<th>Key for Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
</tbody>
</table>

Key for Hours

<table>
<thead>
<tr>
<th>Key for Hours</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course/private study</td>
</tr>
</tbody>
</table>

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
**Health Sciences and Technology Master**

► Major in Human Movement Science and Sport

►► Compulsory Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-0300-00L</td>
<td>Translational Science for Health and Medicine ■</td>
<td>O</td>
<td>3</td>
<td>G</td>
<td>J. Goldhahn, C. Wolfrum</td>
</tr>
</tbody>
</table>

**Abstract**
Translational science is a cross disciplinary scientific research that is motivated by the need for practical applications that help people. The course will help to clarify basics of translational science, illustrate successful applications and should enable students to integrate key features into their future projects.

**Objective**
After completing this course, students will be able to understand:
- Principles of translational science (including project planning, ethics application, basics of resource management and interdisciplinary communication)
- Disease concepts and consequences for research
- Basics about incidence, prevalence etc., and orphan indications
- How to choose the appropriate research type and methodology
- Ethical considerations including ethics application
- Pros and cons of different types of research
- Coordination of complex approaches incl. timing and resources
- How to measure success?
- Outcome variables
- Improving the translational process
- Challenges of communication?
- How independent is translational science?
- Academic boundary conditions vs. industrial influences

Positive and negative examples will be illustrated by distinguished guest speakers.

►► Electives

►►► Electives Courses I

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-0221-00L</td>
<td>Methods and Concepts in Human Systems Neuroscience and Motor Control ■</td>
<td>W</td>
<td>3</td>
<td>P</td>
<td>N. Wenderoth</td>
</tr>
</tbody>
</table>

**Abstract**
This course provides hands-on experience with measurement and analysis methods relevant for Humans Systems Neuroscience and Motor control (nerve/brain stimulation, EMG, EEG, psycho-physical paradigms etc). Students read scientific material, set up experiments, perform measurements in the lab, analyse data, apply statistics and write short reports or essays.

**Objective**
This course will prepare students for experimental work as it is typically done during the master thesis. The goal is to gain hands-on experience with measurement and analysis methods relevant for Humans Systems Neuroscience and Motor control (for example peripheral nerve stimulation, electrical and magnetic brain stimulation, EMG, EEG, psycho-physical paradigms etc). Students will learn how to perform small scientific projects in this area. Students will work individually or in small groups and solve scientific problems which require them to perform measurements in human participants, extract relevant readouts from the data, apply appropriate statistics and interpret the results. They will also be required to write small essays and reports and they will get feedback on their writing throughout the course.

**Prerequisites / notice**
Students are required to have successfully completed the course "Neural control of movement and motor learning" and to have basic knowledge of applied statistics. Self-study material about applied statistics will be available at the beginning of the course and statistical knowledge will be tested (central element) in the second course week. Passing this test is a requirement for continuing the course.

Students will have to solve scientific problems, requiring them to independently study scientific material, apply statistics and report their results in the form of written reports and essays. Assessments will be made on the basis of the completed theoretical and practical work that will be performed either in small groups or individually.

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-0223-00L</td>
<td>Advanced Topics in Exercise Physiology ■</td>
<td>W</td>
<td>3</td>
<td>S</td>
<td>C. Spengler, F. Gabe Beltrami, J. M. Kroegpfl</td>
</tr>
</tbody>
</table>

**Abstract**
In this course, students read, present and discuss seminal publications in the area of exercise physiology. The focus lies on critical analysis of scientific content, conceptual as well as ethical aspects of publications. Students are trained in the most common scientific presentation techniques such as oral and poster presentations.

**Objective**
Students gain further knowledge and a deeper understanding of concepts in exercise physiology. Emphasis is put on critical analysis of scientific content, conceptual as well as ethical aspects of publications. Students are trained in the most common scientific presentation techniques such as oral and poster presentations.

**Literature**
Material will be provided in moodle.

**Prerequisites / notice**
Successful completion of the Exercise Physiology Course.

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-0225-00L</td>
<td>Physical Activities and Health ■</td>
<td>W</td>
<td>3</td>
<td>V</td>
<td>E. de Bruin</td>
</tr>
</tbody>
</table>

**Abstract**
This course introduces/explores the complex relationship between physical activity, sedentary behavior and health. It will discuss the evolution of current physical activity recommendations. It will examine the current evidence base that has informed physical activity recommendations and that identified physical activity as a key modifiable lifestyle behavior contributing to disease and mortality.

**Objective**
On completion of this course students will be able to demonstrate:
1. knowledge of and critical awareness of the role of physical activity and sedentary behavior in the maintenance of health and the aetiology, prevention and treatment of disease.
2. thorough knowledge and critical awareness of current recommendations for physical activity, and current prevalence and trends of physical activity and associated diseases
3. awareness of current national and international physical activity policies and how these impact on global challenges

**Content**
- Introduction to Physical Activity for Health, including sedentary behavior
- Physical activity epidemiology; concepts principles and approaches
- Physical activity and all cause morbidity and mortality
- Physical activity and chronic disease; Coronary heart disease, diabetes, bone health, cancer and obesity
- Physical activity and brain health
- Physical activity and sedentary behavior recommendations
- Population prevalence of physical activity and sedentary behavior
- Physical activity policies
- Physical activity assessment
To examine and understand the protective effect of foods and food ingredients in the maintenance of health and the prevention of chronic diseases, as well as the progression of complications of the chronic diseases.

Prerequisites / notice

From the BSc-course the following book is recommended: ‘Essentials of strength training and conditioning’ T. Baechle, R. Earle (3rd Edition)

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>376-1651-00L</td>
<td>Clinical and Movement Biomechanics</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>S. Lorenzetti, R. List, N. Singh</td>
</tr>
<tr>
<td>Abstract</td>
<td>Measurement and modeling of the human movement during daily activities and in a clinical environment.</td>
<td></td>
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<tr>
<td>Objective</td>
<td>The students are able to analyse the human movement from a technical point of view, to process the data and perform modeling with a focus towards clinical application.</td>
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<tr>
<td>Content</td>
<td>This course includes study design, measurement techniques, clinical testing, accessing movement data and analysis as well as modeling with regards to human movement.</td>
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752-6101-00L Dietary Etiologies of Chronic Disease

Abstract

To have the student gain understanding of the links between the diet and the etiology and progression of chronic diseases, including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

Objective

To examine and understand the protective effects of foods and food ingredients in the maintenance of health and the prevention of chronic disease, as well as the progression of complications of the chronic diseases.

Content

The course evaluates food and food ingredients in relation to primary and secondary prevention of chronic diseases including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

Lecture notes

There is no script. Powerpoint presentations will be made available on-line to students.

Literature

To be provided by the individual lecturers, at their discretion.

Prerequisites / notice

No compulsory prerequisites, but prior completion of Human Nutrition I + II (Humanernährung I + II) is strongly advised.

Elective Courses II

Number | Title                                      | Type | ECTS | Hours | Lecturers                  |
<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>151-0104-00L</td>
<td>Uncertainty Quantification for Engineering &amp; Life Sciences</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>P. Koumoutsakos</td>
</tr>
<tr>
<td>Abstract</td>
<td>Quantification of uncertainties in computational models pertaining to applications in engineering and life sciences. Exploitation of massively available data to develop computational models with quantifiable predictive capabilities. Applications of Uncertainty Quantification and Propagation to problems in mechanics, control, systems and cell biology.</td>
<td></td>
<td></td>
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<tr>
<td>Objective</td>
<td>The course will teach fundamental concepts of Uncertainty Quantification and Propagation (UQ+P) for computational models of systems in Engineering and Life Sciences. Emphasis will be placed on practical and computational aspects of UQ+P including the implementation of relevant algorithms in multicore architectures.</td>
<td></td>
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<tr>
<td>Content</td>
<td>Topics that will be covered include: Uncertainty quantification under parametric and non-parametric modelling uncertainty, Bayesian inference with model class assessment, Markov Chain Monte Carlo simulation, prior and posterior reliability analysis.</td>
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<td></td>
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</tr>
<tr>
<td>Lecture notes</td>
<td>The class will be largely based on the book: Data Analysis: A Bayesian Tutorial by Devinderjit Sivia as well as on class notes and related literature that will be distributed in class.</td>
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<td></td>
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<tr>
<td>Prerequisites / notice</td>
<td>Fundamentals of Probability, Fundamentals of Computational Modeling</td>
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</tbody>
</table>

227-0385-10L Biomedical Imaging

Abstract

Introduction and analysis of medical imaging technology including X-ray procedures, computed tomography, nuclear imaging techniques using single photon and positron emission tomography, magnetic resonance imaging and ultrasound imaging techniques.

Objective

To understand the physical and technical principles underlying X-ray imaging, computed tomography, single photon and positron emission tomography, magnetic resonance imaging, ultrasound and Doppler imaging techniques. The mathematical framework is developed to describe image encoding/decoding, point-spread function/modular transfer function, signal-to-noise ratio, contrast behavior for each of the methods. Matlab exercises are used to implement and study basic concepts.

Content

- X-ray imaging
- Computed tomography
- Single photon emission tomography
- Positron emission tomography
- Magnetic resonance imaging
- Ultrasound/Doppler imaging

Lecture notes

Lecture notes and handouts.

Literature

Webb A, Smith N.B. Introduction to Medical Imaging: Physics, Engineering and Clinical Applications; Cambridge University Press 2011 Analysis, Linear Algebra, Physics, Basics of Signal Theory, Basic skills in Matlab programming

Prerequisites / notice

An extensive overview of the various topics of the different tracks of the biomedical engineering master course and helps orienting the students in selecting their specialized classes and project locations.

227-0386-00L Biomedical Engineering

Abstract

Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The course provides an overview of the various topics of the different tracks of the biomedical engineering master course and helps orienting the students in selecting their specialized classes and project locations.

Objective

Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The course provides an overview of the various topics of the different tracks of the biomedical engineering master course and helps orienting the students in selecting their specialized classes and project locations.
Content

Lecture notes
Introduction to Biomedical Engineering by Enderle, Banchard, and Bronzino

AND
https://www1.ehtz.ch/ibb/Education/BME

227-0447-00L Image Analysis and Computer Vision
W 6 credits 3V+1U L. Van Gool, O. Göksel, E. Konukoglu

Abstract

Objective
Overview of the most important concepts of image formation, perception and analysis, and Computer Vision. Gaining own experience through practical computer and programming exercises.

Content
The first part of the course starts off from an overview of existing and emerging applications that need computer vision. It shows that the realm of image processing is no longer restricted to the factory floor, but is entering several fields of our daily life. First it is investigated how the parameters of the electromagnetic waves are related to our perception. Also the interaction of light with matter is considered. The most important hardware components of technical vision systems, such as cameras, optical devices and illumination sources are discussed. The course then turns to the steps that are necessary to arrive at the discrete images that serve as input to algorithms. The next part describes necessary preprocessing steps of image analysis, that enhance image quality and/or detect specific features. Linear and non-linear filters are introduced for that purpose. The course will continue by analyzing procedures allowing to extract additional types of basic information from multiple images, with motion and depth as two important examples. The estimation of image velocities (optical flow) will get due attention and methods for object tracking will be presented. Several techniques are discussed to extract three-dimensional information about objects and scenes. Finally, approaches for the recognition of specific objects as well as object classes will be discussed and analyzed.

Lecture notes
Course material Script, computer demonstrations, exercises and problem solutions

Prerequisites / notice
Basic concepts of mathematical analysis and linear algebra. The computer exercises are based on Linux and C. The course language is English.

327-2125-00L Microscopy Training SEM I - Introduction to SEM
W 1 credit 3P S. Rodighiero, A. G. Bittermann, K. Kunze, J. Reuteler

Abstract
The introductory course on Scanning Electron Microscopy (SEM) emphasizes hands-on learning. Using 2 SEM instruments, students have the opportunity to study their own samples, or standard test samples, as well as solving exercises provided by ScopeM scientists.

Objective
- Set-up, align and operate a SEM successfully and safely.
- Accomplish imaging tasks successfully and optimize microscope performances.
- Master the operation of a low-vacuum and field-emission SEM and EDX instrument.
- Perform sample preparation with corresponding techniques and equipment for imaging and analysis
- Acquire techniques in obtaining secondary electron and backscatter electron micrographs
- Perform EDX qualitative and semi-quantitative analysis

Content
During the course, students learn through lectures, demonstrations, and hands-on sessions how to setup and operate SEM instruments, including low-vacuum and low-voltage applications. This course gives basic skills for students new to SEM. At the end of the course, students with no prior experience are able to align a SEM, to obtain secondary electron (SE) and backscatter electron (BSE) micrographs and to perform energy dispersive X-ray spectroscopy (EDX) qualitative and semi-quantitative analysis. The procedures to better utilize SEM to solve practical problems and to optimize SEM analysis for a wide range of materials will be emphasized.

- Discussion of students' sample/interest
- Introduction and discussion on Electron Microscopy and instrumentation
- Lectures on electron sources, electron lenses and probe formation
- Lectures on beam/specimen interaction, image formation, image contrast and imaging modes.
- Lectures on sample preparation techniques for EM
- Brief description and demonstration of the SEM microscope
- Practice on beam/specimen interaction, image formation, image contrast (and image processing)
- Student participation on sample preparation techniques
- Scanning Electron Microscopy lab exercises: setup and operate the instrument under various imaging modalities
- Lecture and demonstrations on X-ray micro-analysis (theory and detection), qualitative and semi-quantitative EDX and point analysis, linescans and spectral mapping
- Practice on real-world samples and report results

Literature
- Detailed course manual

Prerequisites / notice
No mandatory prerequisites. Please consider the prior attendance to EM Basic lectures (551- 1618-00V; 227-0390-00L; 327-0703-00L) as suggested prerequisite.

327-2126-00L Microscopy Training TEM I - Introduction to TEM
Does not take place this semester.
W 1 credit 3P

The participants will be chosen based on a short motivation letter. Please send this letter to S. Rodighiero (main lecturer).

Abstract
The introductory course on Transmission Electron Microscopy (TEM) provides theoretical and hands-on learning for new operators, utilizing lectures, demonstrations, and hands-on sessions.

Prerequisites / notice
Number of participants limited to 6. Does not take place this semester.

Literature
- No mandatory prerequisites. Please consider the prior attendance to EM Basic lectures (551- 1618-00V; 227-0390-00L; 327-0703-00L) as suggested prerequisite.

Data: 06.03.2019 12:57 Autumn Semester 2016 Page 753 of 1571
Work Design and Organizational Change

- Overview of TEM theory, instrumentation, operation and applications.
- Alignment and operation of a TEM, as well as acquisition and interpretation of images, diffraction patterns, accomplishing basic tasks successfully.
- Knowledge of electron imaging modes (including Scanning Transmission Electron Microscopy), magnification calibration, and image acquisition using CCD cameras.
- To set up the TEM to acquire diffraction patterns, perform camera length calibration, as well as measure and interpret diffraction patterns.
- Overview of techniques for specimen preparation.

Using two Transmission Electron Microscopes the participants learn how to align a TEM, select parameters for acquisition of images in bright field (BF) and dark field (DF), perform scanning transmission electron microscopy (STEM) imaging, phase contrast imaging, and acquire electron diffraction patterns. The participants will also learn basic and advanced use of digital cameras and digital imaging methods.

- Introduction and discussion on Electron Microscopy and instrumentation.
- Lectures on electron sources, electron lenses and probe formation.
- Lectures on beam/specimen interaction, image formation, image contrast and imaging modes.
- Lectures on sample preparation techniques for EM.
- Brief description and demonstration of the TEM microscope.
- Practice on beam/specimen interaction, image formation, Image contrast (and image processing).
- Demonstration of Transmission Electron Microscopes and imaging modes (Phase contrast, BF, DF, STEM).
- Student participation on sample preparation techniques.
- Transmission Electron Microscopy lab exercises: setup and operate the instrument under various imaging modalities.
- TEM alignment, calibration, correction to improve image contrast and quality.
- Electron diffraction.
- Practice on real-world samples and report results.

Literature
- Detailed course manual

Prerequisites / notice
No mandatory prerequisites. Please consider the prior attendance to EM Basic lectures (551-1618-00V; 227-0390-00L; 327-0703-00L) as suggested prerequisite.

Technology Entrepreneurship

- Technology ventures are significantly changing the global economic picture. Technological skills increasingly need to be complemented by entrepreneurial understanding.
- This course offers the fundamentals in theory and practice of entrepreneurship in new technology ventures. Main topics covered are success factors in the creation of new firms, including founding, financing and growing a venture.

Content
- Work design: From Adam Smith to job crafting
- Examples Flexible working arrangements
- The organization-technology interaction and its impact on work design and organizational change
- Strategic choices for work design

Literature
No mandatory prerequisites. Please consider the prior attendance to EM Basic lectures (551-1618-00V; 227-0390-00L; 327-0703-00L) as suggested prerequisite.

Laboratory Course in Exercise Physiology

Number of participants limited to 48.

Abstract
Conduct physical performance tests and measurements that are typically used to assess performance of athletes and/or patients and that deepen the understanding of physiological processes in response to physical exertion.

Objective
Gain hands-on experience in exercise physiology and consolidate knowledge on physiological adaptations to different types and degrees of physical activity and climatic influences. Learn fundamental assessment techniques of the muscular system, the cardio-respiratory system and of whole-body performance, learn scientifically correct data analysis and interpretation of results. Insight into today's Sports Medicine.

Content
- Laboratory course:
  - Various exercise tests assessing human performance and assessments of physiological responses to activity (examples are VO2max-test, Conconi-Tests, Determination of anaerobic threshold, Cooper-Test, 1-repetition maximum test, lactate minimum test), dynamometry, mechanography, body composition etc.). Insight into measurements in Sports Medicine.

Literature
- Schmidt/Lang/Heckmann: Physiologie des Menschen, Springer-Verlag, Heidelberg
- Kenney/Wilmore/Costill: Physiology of Sport and Exercise, Human Kinetics
By the end of the course students are able to plan, draft, and edit academic English papers and theses; structure and write clear texts in a scientific English. We'll prepare you to produce your MSc thesis. You'll learn how to structure your thesis, write scientific English, and manage your writing according to the laws of mechanics. Students are able to describe the human body as a mechanical system. They analyse and describe human movement according to the laws of mechanics. Movement- and sports biomechanics deals with the attributes of the human body and their link to mechanics. The course includes topics such as functional anatomy, biomechanics of daily activities (gait, running, etc.) and looks at movement in sport from a mechanical point of view. Furthermore, simple reflections on the loading analysis of joints, various situations are discussed. Additionally, questions covering the statics and dynamics of rigid bodies, and inverse dynamics, relevant to biomechanics are investigated.

This course provides an overview over molecular and systemic aspects of neuromuscular, cardiovascular and respiratory adaptations to acute and chronic exercise as well as the interactions of the different systems influencing factors, e.g. genetics, gender, age, altitude/depth, heat/cold, with respect to performance and health.

The aim of this course is to understand molecular and systemic aspects of neuromuscular, cardiovascular and respiratory adaptations to acute and chronic exercise as well as the interaction of the different systems regarding health-relevant aspects and performance in healthy people and persons with selected diseases. Furthermore, students will understand the influence of genetics, gender, age, altitude/depth, heat and cold on the named factors.

History of Exercise Physiology, research methods, fibertype heterogeneity and its functional significance, neural control of muscle force, molecular and cellular mechanisms of muscle adaptation to resistance, endurance and stretching exercise, interindividual variability in the response to training, cardiorespiratory and metabolic responses to acute and chronic exercise, sex differences relevant to exercise performance, exercise in hot and cold environment, children and adolescents in sport and exercise, exercise at altitude and depth, aging and exercise performance, exercise for health, exercise in the context of disease.

Online material is provided during the course. Recommended textbooks:
- Anatomy and Physiology I + II

Does not take place this semester.

Attention: Registration is only possible from 12.9. (from 11.30h) - 15.9.2016.

We'll prepare you to produce your MSc thesis. You'll learn how to structure your thesis, write scientific English, and manage your writing efficiently. You'll receive detailed feedback on work in progress.

By the end of the course students are able to plan, draft, and edit academic English papers and theses; structure and write clear texts in a style which is acceptable to their academic discourse community; manage the writing process efficiently; select formal vocabulary and use it in a generally accurate and correct manner; choose and use generally suitable grammatical structures, punctuation, and orthographic conventions, assess their own effectiveness as writers of academic English, and identify areas in which further development is needed.

The course covers the writing context; the writing process; structuring sentences, paragraphs, longer sections (such as introduction, methods, results, and discussion), and whole texts; presenting and integrating non-textual elements such as graphs and tables; and editing and correcting drafts and proofs. Each lesson comprises a mixture of elements, including specialist input, individual tasks, pairwork, and groupwork. Active participation is expected.

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Attention: Registration is only possible from 12.9. (from 11.30h) - 15.9.2016.

We'll prepare you to produce your MSc thesis. You'll learn how to structure your thesis, write scientific English, and manage your writing efficiently. You'll receive detailed feedback on work in progress.

By the end of the course students are able to plan, draft, and edit academic English papers and theses; structure and write clear texts in a style which is acceptable to their academic discourse community; manage the writing process efficiently; select formal vocabulary and use it in a generally accurate and correct manner; choose and use generally suitable grammatical structures, punctuation, and orthographic conventions, assess their own effectiveness as writers of academic English, and identify areas in which further development is needed.

The course covers the writing context; the writing process; structuring sentences, paragraphs, longer sections (such as introduction, methods, results, and discussion), and whole texts; presenting and integrating non-textual elements such as graphs and tables; and editing and correcting drafts and proofs. Each lesson comprises a mixture of elements, including specialist input, individual tasks, pairwork, and groupwork. Active participation is expected.

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Inhaltliche Schwerpunkte der Vorlesung sind:
- Einführung in die Sportpädagogik und die pädagogische Psychologie des Sportunterrichts
- Bedeutung des Sports im Jugendalter
- Zeitgenässer Sportunterricht
- Sport und Leistung
- Heterogenität im Sportunterricht
- Sport und Gesundheit
- Geschlechterfragen im Sport
- Soziale und moralische Entwicklung im Sportunterricht

Lecture notes
Unterrichtsmaterialien zu den einzelnen Veranstaltungen werden den Studierenden zur Verfügung gestellt.

376-1127-00L Sociology of Sport W 2 credits 2V M. Lamprecht

Abstract
These lectures deal with the current changes in society and sport and provide an overview of the many different problems and perspectives of sport sociology.

Objective
- present the different dimensions, functions and interrelationships of present-day sport
- provide an introduction to the central theories and models of (sport) sociology
- show how far sport reflects society and how it changes and becomes more differentiated in the process
- take current examples from newspapers, magazines and television to highlight the sociological view of sport.

Content
- Sport and social change: developments and trends
- The economy and the media: dependencies, consequences, scandals
- Social inequalities and distinctions: gender differences and group behavior
- Conflicts and politics: sports organizations, doping, violence

Literature

A detailed program with additional references will be delivered at the beginning of the lecture.

376-1117-00L Sport Psychology W 2 credits 2V H. Gubelmann

Abstract
This lecture is intended as an introduction to sport psychology and imparts knowledge on selected areas of the subject.

Objective
- Students are given insight into different work areas of sport psychology. In order to understand what «sport psychology» is, it is necessary to explain the essence and tasks of sport psychology and what it relates to, and to work out an underlying basis for key topics, such as cognition and emotions. Students' expertise is furthered by presenting and providing in-depth topics of sport psychology. Selected intervention forms are intended to provide insight into applied sport psychology and ensure that mental processes and their impact in sport can be recognised. Case studies and practical exercises (e.g. objective training) are intended to prompt students to reflect to a greater extent on the forms in which sport psychology can be applied in their practice of sports and to integrate these in their teaching.

Content
- Main Topics
  - Introduction to sport psychology
  - Cognitions in sports: mental rehearsal and mental training
  - Emotions and stress
  - Motivation: goal-setting in sports
  - Career and career transition in elite sport
  - Coach-Athlete-Interaction
  - Psychological aspects of sport-injury rehabilitation
  - Group dynamics in sport

Literature

Abstract
Rehabilitation Engng is the application of science and technology to ameliorate the handicaps of individuals with disabilities to reintegrate them into society. The goal is to present classical and new rehabilitation engineering principles applied to compensate or enhance motor, sensory, and cognitive deficits. Focus is on the restoration and treatment of the human sensory and vegetative system.

Objective
Provide knowledge on the anatomy and physiology of the human sensory system, related dysfunctions and pathologies, and how rehabilitation engineering can provide sensory restoration and substitution.

This lecture is independent from Rehabilitation Engineering I. Thus, both lectures can be visited in arbitrary order.

Content
Introduction, problem definition, overview
Rehabilitation of visual function
- Anatomy and physiology of the visual sense
- Technical aids (glasses, sensor substitution)
- Retina and cortex implants
Rehabilitation of hearing function
- Anatomy and physiology of the auditory sense
- Hearing aids
- Cochlea Implants
Rehabilitation and use of kinesthetic and tactile function
- Anatomy and physiology of the kinesthetic and tactile sense
- Tactile/haptic displays for motion therapy (incl. electrical stimulation)
- Role of displays in motor learning
Rehabilitation of vestibular function
- Anatomy and physiology of the vestibular sense
- Rehabilitation strategies and devices (e.g., BrainPort)
Rehabilitation of vegetative Functions
- Cardiac Pacemaker
- Phrenic stimulation, artificial breathing aids
- Bladder stimulation, artificial sphincter
Brain stimulation and recording
- Deep brain stimulation for patients with Parkinson, epilepsy, depression
- Brain-Computer Interfaces
Literature

Introductory Books:


Selected Journal Articles and Web Links:


VideoTact, ForeThought Development, LLC. http://my.execpc.com/?dwysocki/videotac.html

Prerequisites / notice

Target Group:
Students of higher semesters and PhD students of
- D-MAVT, D-ITET, D-INFK, D-HEST
- Biomedical Engineering, Robotics, Systems and Control
- Medical Faculty, University of Zurich

Students of other departments, faculties, courses are also welcome

This lecture is independent from Rehabilitation Engineering I. Thus, both lectures can be visited in arbitrary order.

376-1714-00L Biocompatible Materials W 4 credits 3G K. Maniura, J. Möller, M. Zenobi-Wong

Abstract

Introduction to molecules used for biomaterials, molecular interactions between different materials and biological systems (molecules, cells, tissues). The concept of biocompatibility is discussed and important techniques from biomaterials research and development are introduced.

Objective

The class consists of three parts:
1. Introduction into molecular characteristics of molecules involved in the materials-to-biology interface. Molecular design of biomaterials.
2. The concept of biocompatibility.
3. Introduction into methodology used in biomaterials research and application.

Content

Introduction into native and polymeric biomaterials used for medical applications. The concepts of biocompatibility, biodegradation and the consequences of degradation products are discussed on the molecular level. Different classes of materials with respect to potential applications in tissue engineering and drug delivery are introduced. Strong focus lies on the molecular interactions between materials having very different bulk and/or surface chemistry with living cells, tissues and organs. In particular the interface between the materials surfaces and the eukaryotic cell surface and possible reactions of the cells with an implant material are elucidated. Techniques to design, produce and characterize materials in vitro as well as in vivo analysis of implanted and explanted materials are discussed.

In addition, a link between academic research and industrial entrepreneurship is established by external guest speakers.

Lecture notes

Handouts can be accessed online.
<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
<th>Language</th>
<th>Authors/Editors</th>
<th>ISBN</th>
<th>Publisher</th>
<th>Year</th>
</tr>
</thead>
</table>

**Prerequisites / notice:**
- For 376-1720-00L: A Laptop with MATLAB installed (v2009 or higher) and wireless internet access is mandatory. Two students can share a laptop if necessary. A MATLAB student version can be obtained at Stud-IDES for free.
- For 376-1722-00L: A Laptop with MATLAB installed (v2009 or higher) and wireless internet access is mandatory. Two students can share a laptop if necessary. A MATLAB student version can be obtained at Stud-IDES for free.
- For 376-1974-00L: A Laptop with MATLAB installed (v2009 or higher) and wireless internet access is mandatory. Two students can share a laptop if necessary. A MATLAB student version can be obtained at Stud-IDES for free.

For 376-1985-00L: A Laptop with MATLAB installed (v2009 or higher) and wireless internet access is mandatory. Two students can share a laptop if necessary. A MATLAB student version can be obtained at Stud-IDES for free.

**Prerequisites / notice:**
- For 376-2017-00L: A Laptop with MATLAB installed (v2009 or higher) and wireless internet access is mandatory. Two students can share a laptop if necessary. A MATLAB student version can be obtained at Stud-IDES for free.

**Prerequisites / notice:**
- For 376-2019-00L: A Laptop with MATLAB installed (v2009 or higher) and wireless internet access is mandatory. Two students can share a laptop if necessary. A MATLAB student version can be obtained at Stud-IDES for free.
Based on practical examples out of sport, everyday movement and therapy, students use and compare different methods of movement analysis.

Objective
Students are able to assess human movement using different methods of movement analysis.

Content
During the course students get acquainted with different methods of movement analysis such as: functional, morphological, clinical, mechanical, and others.

Based on practical examples, these methods are used and compared. The examples range from sport, everyday movement and therapy, such as hockey, gymnastics, acrobatics, badminton, gait / running and strength training. In the first phase of the class, the different approaches are applied. In the second phase, small teams are working on individual projects. These will be discussed and presented in plenum.

Lecture notes
Class material will be distributed using the moodle platform.

551-1153-00L Systems Biology of Metabolism

Abstract
Starting from contemporary biological problems related to metabolism, the course focuses on systems biological approaches to address them. In a problem-oriented, this-is-how-it-is-done manner, we thereby teach modern methods and concepts.

Objective
Develop a deeper understanding of how relevant biological problems can be solved, thereby providing advanced insights to key experimental and computational methods in systems biology.

Content
The course will be given as a mixture of lectures, studies of original research and guided discussions that focus on current research topics. For each particular problem studied, we will work out how the various methods work and what their capabilities/limits are. The problem areas range from microbial metabolism to cancer cell metabolism and from metabolic networks to regulation networks in populations and single cells. Key methods to be covered are various modeling approaches, metabolic flux analyses, metabolomics and other omics.

Lecture notes
Script and original publications will be supplied during the course.

Prerequisites / notice
The course extends many of the generally introduced concepts and methods of the Concept Course in Systems Biology. It requires a good knowledge of biochemistry and basics of mathematics and chemistry.

572-6105-00L Epidemiology and Prevention

Abstract
Enrolment to this course unit only possible at ETH. No enrolment to module CS16_101 at UZH.

Objective
The module Epidemiology and prevention describes the process of scientific discovery from the detection of a disease and its causes, to the development and evaluation of preventive and treatment interventions and to improved population health.

Content
The overall goal of the course is to introduce students to epidemiological thinking and methods, which are critical pillars for medical and public health research. Students will also become aware on how epidemiological facts are used in prevention, practice and politics.

Lecture notes
Handouts are provided to students in the classroom.

Prerequisites / notice
The course offers an introduction to key principles of public health. Students get acquainted with the concepts and methods of epidemiology. Students also learn to use epidemiological data for prevention and health promotion purposes. Public health concepts and intervention strategies are presented, using examples from infectious and chronic diseases.

752-6151-00L Public Health Concepts

Abstract
The module "public health concepts" offers an introduction to key principles of public health. Students get acquainted with the concepts and methods of epidemiology. Students also learn to use epidemiological data for prevention and health promotion purposes. Public health concepts and intervention strategies are presented, using examples from infectious and chronic diseases.

Objective
At the end of this module students are able:
- to interpret the results of epidemiological studies
- to critically assess scientific literature
- to know the definition, dimensions and determinants of health
- to plan public health interventions and health promotion projects

Content
The module Epidemiology and prevention follows an overall framework that describes the course of scientific discovery from the detection of a disease to the development of prevention and treatment interventions and their evaluation in clinical trials and real world settings. We will discuss study designs in the context of existing knowledge and the type of evidence needed to advance knowledge. Examples form nutrition, chronic and infectious diseases will be used in order to show the underlying concepts and methods.

752-6403-00L Nutrition and Performance

Abstract
The course introduces basic concepts of the interaction between nutrition and exercise and cognitive performance.

Objective
To understand the potential effects of nutrition on exercise performance, with a focus on concepts and principles of nutrition before, during and after exercise.

Content
The course will cover elementary aspects of sports nutrition physiology, including carbohydrate, glycogen, fat, protein and energy metabolism. A main focus will be to understand nutritional aspects before exercise to be prepared for intensive exercise bouts, how exercise performance can be supported by nutrition during exercise and how recovery can be assisted by nutrition after exercise. Although this is a scientific course, it is a goal of the course to translate basic sports nutrition science into practical sports nutrition examples.

Lecture notes
Lecture slides and required handouts will be available on the ETH website.

Literature
Information on further reading will be announced during the lecture. There will be some mandatory as well as voluntary readings.

Prerequisites / notice
General knowledge about nutrition, human biology, physiology and biochemistry is a prerequisite for this course. The course builds on basic nutrition and biochemistry knowledge to address exercise and performance related aspects of nutrition.

Language: English

It is strongly recommended to attend the lectures. The lecture (including the handouts) is not designed for distance education.
Human Health, Nutrition and Environment: Term Paper

Only for students of the Major Human Health, Nutrition and Environment.

Abstract
Writing of a review paper of scientific quality on a topic in the domain of Human Health, Nutrition and Environment based on critical evaluation of scientific literature.

Objective
- Acquisition of knowledge in the field of the review paper
- Assessment of original literature as well as synthesis and analysis of the findings
- Practising of academic writing in English
- Giving an oral presentation with discussion on the topic of the review paper

Content
Topics are offered in the domains of the major ‘Human Health, Nutrition and Environment’ covering ‘Public Health’, ‘Infectious Diseases’, ‘Nutrition and Health’ and ‘Environment and Health’.

Lecture notes
Guidelines will be handed out in the beginning.

Literature
Literature will be identified based on the topic chosen.

Translational Science for Health and Medicine

Abstract
Translational science is a cross disciplinary scientific research that is motivated by the need for practical applications that help people. The course should help to clarify basics of translational science, illustrate successful applications and should enable students to integrate key features into their future projects.

Objective
After completing this course, students will be able to understand:
- Principles of translational science (including project planning, ethics application, basics of resource management and interdisciplinary communication)

Content
What is translational science and what is it not?
- How to identify need?
- Disease concepts and consequences for research
- Basics about incidence, prevalence etc., and orphan indications
- How to choose the appropriate research type and methodology
- Ethical considerations including ethics application
- Pros and cons of different types of research
- Coordination of complex approaches incl. timing and resources
- How to measure success?
- Outcome variables
- Improving the translational process
- Challenges of communication?
- How independent is translational science?
- Academic boundary conditions vs. industrial influences

Positive and negative examples will be illustrated by distinguished guest speakers.

Electives

Elective Courses I

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>401-0629-00L</td>
<td>Applied Biostatistics</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>M. Müller</td>
</tr>
<tr>
<td>Abstract</td>
<td>Principles and main methods in biostatistics with emphasis on practical aspects. Experimental and observational studies. Regression and analysis of variance. Introduction into survival analysis.</td>
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<tr>
<td>Objective</td>
<td>Getting an overview of the problems and statistical methods used in health sciences. Practise in using the software R to analyze data and interpreting the suits.</td>
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<tr>
<td>Lecture notes</td>
<td>see teaching document repository</td>
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</tbody>
</table>


Prerequisites / notice
The statistical package R will be used in the exercises.
If you are unfamiliar with R, I highly recommend the online R course etutoR.

Epidemiology and Prevention

Information for UZH students:
Enrolment to this course unit only possible at ETH. No enrolment to module CS16_101 at UZH.

Please mind the ETH enrolment deadlines for UZH students: https://www.ethz.ch/en/studies/non-degree-courses/special-students-special-students-university-of-zurich.html

Abstract
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The overall goal of the course is to introduce students to epidemiological thinking and methods, which are critical pillars for medical and public health research. Students will also become aware on how epidemiological facts are used in prevention, practice and politics.

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The module Epidemiology and prevention follows an overall framework that describes the course of scientific discovery from the detection of a disease to the development of prevention and treatment interventions and their evaluation in clinical trials and real world settings. We will discuss study designs in the context of existing knowledge and the type of evidence needed to advance knowledge. Examples form nutrition, chronic and infectious diseases will be used in order to show the underlying concepts and methods.

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At the end of this module students are able:
- to interpret the results of epidemiological studies
- to critically assess scientific literature
- to know the definition, dimensions and determinants of health
- to plan public health interventions and health promotion projects

Concepts of descriptive and analytical epidemiology, study designs, measures of effect, confounding and bias, screening, surveillance, definition of health and health promotion, health dimensions and health determinants, prevention strategies, public health interventions, public health action cycle, epidemiology and prevention of infectious and chronic diseases (HIV, Tuberculosis, Obesity, Public health nutrition).

Handouts are provided to students in the classroom.

The course is not based on any of the textbooks below, but they are excellent choices as accompanying material:
* Drummond, A. & Bouckaert, R. 2015. Bayesian evolutionary analysis with BEAST
* Yang, Z. 2006. Computational Molecular Evolution.

The course provides a detailed understanding of
- the development, activation, and differentiation of different types of T cells and their effector mechanisms during immune responses,
- Recognition of pathogenic microorganisms by the host cells and molecular events thereafter,
- events and signals for maturation of naive B cells to antibody producing plasma cells and memory B cells.
- Optimization of B cell responses by intelligent design of new vaccines

Key experimental results will be shown to help understanding how immunological text book knowledge has evolved.

Obtain a detailed understanding of
- the development, activation, and differentiation of different types of T cells and their effector mechanisms during immune responses,
- Recognition of pathogenic microorganisms by the host cells and molecular events thereafter,
- events and signals for maturation of naive B cells to antibody producing plasma cells and memory B cells.
- Optimization of B cell responses by intelligent design of new vaccines

The course consists of four parts. We first introduce modern genetic sequencing technology, and algorithms to obtain sequence alignments from the output of the sequencers. We then present methods to directly analyze this alignment (such as BLAST algorithm, GWAS approaches). Second, we introduce mechanisms and concepts of molecular evolution, i.e. we discuss how genetic sequences change over time. Third, we employ evolutionary concepts to infer ancestral relationships between organisms based on their genetic sequences, i.e. we discuss methods to infer genealogies and phylogenies. We finally introduce the field of phylodynamics. The aim of that field is to understand and quantify the population dynamic processes (such as transmission in epidemiology or speciation & extinction in macroevolution) based on a phylogeny. Throughout the class, the models and methods are illustrated on different datasets giving insight into the epidemiology and evolution of a range of infectious diseases (e.g. HIV, HCV, influenza, Ebola). Applications of the methods to the field of macroevolution provide insight into the evolution and ecology of different species clades. Students will be trained in the algorithms and their application both on paper and in silico as part of the exercises.

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

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

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

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

701-1703-00L  
**Evolutionary Medicine for Infectious Diseases**  
**W** 3 credits  
**2V** A. Hall

**Abstract**  
This course explores infectious disease from both the host and pathogen perspective. Through short lectures, reading and active discussion, students will identify areas where evolutionary thinking can improve our understanding of infectious diseases and, ultimately, our ability to treat them effectively.

**Objective**  
Students will learn to (i) identify evolutionary explanations for the origins and characteristics of infectious diseases in a range of organisms and (ii) evaluate ways of integrating evolutionary thinking into improved strategies for treating infections of humans and animals. This will incorporate principles that apply across any host-pathogen interaction, as well as system-specific mechanistic information, with particular emphasis on bacteria and viruses.

**Content**  
We will cover several topics where evolutionary thinking is relevant to understanding or treating infectious diseases. This includes: (i) determinants of host range and virulence, (ii) dynamics of host-parasite coevolution, (iii) pathogen adaptation to evade or suppress immune responses, (iv) antimicrobial resistance, (v) evolution-proof medicine. For each topic there will be a short (< 30 minutes) introductory lecture, before students independently research the primary literature and develop half a page of discussion points and questions, followed by interactive discussion in class.

**Literature**  
Students will read the primary literature on each topic, and in places we will use the following books:

- M. Siegrist  
- M. Schuppler  
- A. Hall

**Prerequisites / notice**  
A basic understanding of evolutionary biology, microbiology or parasitology will be advantageous but is not essential.

### Module: Nutrition and Health

#### Number 752-4009-00L  
**Molecular Biology of Foodborne Pathogens**  
**W** 3 credits  
**2V** M. Loessner, M. Schupper

**Abstract**  
The course offers detailed information on selected foodborne pathogens and toxin producing organisms; the focus lies on relevant molecular biological aspects of pathogenicity and virulence, as well as on the occurrence and survival of these organisms in foods.

**Objective**  
Detailed and current status of research and insights into the molecular basis of foodborne diseases, with focus on interactions of the microorganism or the toxins they produce with the human system. Understanding the relationship between specific types of food and the associated pathogens and microbial risks. Another focus lies on the currently available methods and techniques useful for the various purposes, i.e., detection, differentiation (typing), and antimicrobial agents.

**Content**  
Molecular biology of infectious foodborne pathogens (Listeria, Vibrio, E. coli, Campylobacter, etc) and toxin-producing organisms (Bacillus, Clostridium, Staphylococcus). How and under which conditions will toxins and virulence factors be produced, and how do they work? How is the interaction between the human host and the microbial pathogen? What are the roles of food and the environment? What can be done to interfere with the potential risks? Which methods are best suited for what approach? Last, but not least, the role of bacteriophages in microbial pathogenicity will be highlighted, in addition to various applications of bacteriophage for both diagnostics and antimicrobial intervention.

**Lecture notes**  
Electronic copies of the presentation slides (PDF) and additional material will be made available for download to registered students.

**Literature**  
Recommendations will be given in the first lecture

**Prerequisites / notice**  
Lectures (2 hours) will be held as a single session of approximately 60+ minutes (10:15 until approx. 11:15 h), with no break !
The course covers qualitative (chemistry and microbiology) and quantitative aspects of drinking water from the resource to the tap. To examine and understand the protective effect of foods and food ingredients in the maintenance of health and the prevention of chronic diseases, as well as the progression of complications of the chronic diseases.

Lecturers
G. Vergères
J. Goldhahn

Content
The course evaluates food and food ingredients in relation to primary and secondary prevention of chronic diseases including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

Lecture notes
There is no script. Powerpoint presentations will be made available on-line to students.

Literature
To be provided by the individual lecturers, at their discretion.

Prerequisites / notice
No compulsory prerequisites, but prior completion of Human Nutrition I + II (Humanernährung I+II) is strongly advised.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>752-6402-00L</td>
<td>Nutrigenomics</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>G. Vergères</td>
</tr>
<tr>
<td>Abstract</td>
<td>Nutrigenomics - toward personalized nutrition?</td>
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</tr>
</tbody>
</table>
| Objective    | - Overall understanding of the transdisciplinary research being conducted under the term nutrigenomics.
|              | - Overall understanding of the omics technologies used in nutrigenomics and their applications to human nutrition and food science.
|              | - Ability to critically evaluate the potential and risks associated with the field of nutrigenomics |      |       |                            |
| Content      | - For the content of the script see section "Skript" below
|              | - The lecture is completed by an optional project entitled ‘Personalized Nutrition’ in which the students have the opportunity to receive a personalized nutritional guidance that is based on their own genetic makeup. The scientific literature on which the genetic tests are based is presented by the students during the lecture. |      |       |                            |
| Lecture notes| The script is composed of circa 450 slides (ca 18 slides/lecture) organized in 9 modules |      |       |                            |
| Module A     | From biochemical nutrition research to nutrigenomics |      |       |       |                            |
| Module B     | Nutritional genomics          |      |       |       |                            |
| Module C     | Nutrigenetics                 |      |       |       |                            |
| Module D     | Nutri-epigenomics             |      |       |       |                            |
| Module E     | Transcriptomics in nutrition research |      |       |       |                            |
| Module F     | Proteomics in nutrition research |      |       |       |                            |
| Module G     | Metabolomics in nutrition research |      |       |       |                            |
| Module H     | Nutritional systems biology   |      |       |       |                            |
| Module I     | Individualized nutrition - opportunities and challenges |      |       |       |                            |
| Literature   | No extra reading requested. Most slides in the lecture are referenced with web adresses. |      |       |       |                            |
| Prerequisites / notice | Basic training in biochemistry, molecular biology, physiology, and human nutrition. Interest in interdisciplinary sciences linking molecular biology to human health. Interest in the application of analytical laboratory methods to the understanding of human biology, in particular nutrition. |      |       |       |                            |

Module: Environment and Health

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<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>701-1341-00L</td>
<td>Water Resources and Drinking Water</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>S. Hug, M. Berg, F. Hammes, U. von Gunten</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course covers qualitative (chemistry and microbiology) and quantitative aspects of drinking water from the resource to the tap. Natural processes, anthropogenic pollution, legislation of groundwater and surface water and of drinking water as well as water treatment will be discussed for industrialized and developing countries.</td>
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<tr>
<td>Objective</td>
<td>The goal of this lecture is to give an overview over the whole path of drinking water from the source to the tap and understand the involved physical, chemical and biological processes which determine the drinking water quality.</td>
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<tr>
<td>Content</td>
<td>The course covers qualitative (chemistry and microbiology) and quantitative aspects of drinking water from the resource to the tap. The various water resources, particularly groundwater and surface water, are discussed as part of the natural water cycle influenced by anthropogenic activities such as agriculture, industry, urban water systems. Furthermore legislation related to water resources and drinking water will be discussed. The lecture is focused on industrialized countries, but also addresses global water issues and problems in the developing world. Finally unit processes for drinking water treatment (filtration, adsorption, oxidation, disinfection etc.) will be presented and discussed.</td>
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</tr>
<tr>
<td>Lecture notes</td>
<td>Handouts will be distributed</td>
<td></td>
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</tr>
<tr>
<td>Literature</td>
<td>Will be mentioned in handouts</td>
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</tbody>
</table>

Major in Medical Technology

Compulsory Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-0300-00L</td>
<td>Translational Science for Health and Medicine</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>J. Goldhahn, C. Wolfrum</td>
</tr>
<tr>
<td>Abstract</td>
<td>Translational science is a cross disciplinary scientific research that is motivated by the need for practical applications that help people. The course should help to clarify basics of translational science, illustrate successful applications and should enable students to integrate key features into their future projects.</td>
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</table>
Objective  After completing this course, students will be able to understand:
Principles of translational science (including project planning, ethics application, basics of resource management and interdisciplinary communication)

Content  What is translational science and what is it not?
How to identify need?
- Disease concepts and consequences for research
- Basics about incidence, prevalence etc., and orphan indications
- How to choose the appropriate research type and methodology
- Ethical considerations including ethics application
- Pros and cons of different types of research
- Coordination of complex approaches incl. timing and resources
How to measure success?
- Outcome variables
- Improving the translational process
Challenges of communication?
How independent is translational science?
- Academic boundary conditions vs. industrial influences
Positive and negative examples will be illustrated by distinguished guest speakers.

### Electives

#### Elective Courses I

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-0021-00L</td>
<td>Introduction to Biomedical Engineering I</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>P. Christen, R. Müller, J. G. Snedeker, M. Zenobi-Wong</td>
</tr>
<tr>
<td></td>
<td>Introduction to biomechanics, biomaterials, tissue engineering, medical imaging as well as the history of biomedical engineering. Mathematical description and problem solving. Knowledge of biomedical engineering applications in research and clinical practice.</td>
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<tr>
<td></td>
<td>Understanding of physical and technical principles in biomechanics, biomaterials, tissue engineering, medical imaging as well as the history of biomedical engineering. Mathematical description and problem solving. Knowledge of biomedical engineering applications in research and clinical practice.</td>
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<td></td>
<td>Tissue and Cellular Biomechanics, Molecular Biomechanics and Biopolymers, Computational Biomechanics, Biomaterials, Tissue Engineering, Radiation and Radiographic Imaging, Diagnostic Ultrasound Imaging, Magnetic Resonance Imaging, Biomedical Optics and Lasers.</td>
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<td></td>
<td>Stored on ILIAS.</td>
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<td></td>
<td>Academic Press</td>
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<tr>
<td>376-1714-00L</td>
<td>Biocompatible Materials</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>K. Maniura, J. Möller, M. Zenobi-Wong</td>
</tr>
<tr>
<td></td>
<td>Introduction to molecules used for biomaterials, molecular interactions between different materials and biological systems (molecules, cells, tissues). The concept of biocompatibility is discussed and important techniques from biomaterials research and development are introduced.</td>
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<td>The class consists of three parts: 1. Introduction into molecular characteristics of molecules involved in the materials-to-biology interface. Molecular design of biomaterials. 2. The concept of biocompatibility. 3. Introduction into methodology used in biomedical research and application.</td>
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<td></td>
<td>Introduction into native and polymeric biomaterials used for medical applications. The concepts of biocompatibility, biodegradation and the consequences of degradation products are discussed on the molecular level. Different classes of materials with respect to potential applications in tissue engineering and drug delivery are introduced. Strong focus lies on the molecular interactions between materials having very different bulk and/or surface chemistry with living cells, tissues and organs. In particular the interface between the materials surfaces and the eukaryotic cell surface and possible reactions of the cells with an implant material are elucidated. Techniques to design, produce and characterize materials in vitro as well as in vivo analysis of implanted and explanted materials are discussed. In addition, a link between academic research and industrial entrepreneurship is established by external guest speakers.</td>
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<tr>
<td></td>
<td>Handouts can be accessed online.</td>
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<tr>
<td></td>
<td>Literature</td>
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<tr>
<td></td>
<td>Handouts provided during the classes and references therein.</td>
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</table>

#### Elective Courses II

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0255-00L</td>
<td>Energy Conversion and Transport in Biosystems</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>D. Poulikakos, A. Ferrari</td>
</tr>
<tr>
<td></td>
<td>Theory and application of thermodynamics and energy conversion in biological systems with focus on the cellular level.</td>
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<tr>
<td></td>
<td>Theory and application of energy conversion at the cellular level. Understanding of the basic features governing solutes transport in the principal systems of the human cell. Connection of characteristics and patterns from other fields of engineering to biofluidics. Heat and mass transport processes in the cell, generation of forces, work and relation to biomedical technologies.</td>
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<td></td>
<td>Mass transfer models for the transport of chemical species in the human cell. Organization and function of the cell membrane and of the cell cytoskeleton. The role of molecular motors in cellular force generation and their function in cell migration. Description of the functionality of these systems and of analytical experimental and computational techniques for understanding of their operation. Introduction to cell metabolism, cellular energy transport and cellular thermodynamics.</td>
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<tr>
<td></td>
<td>Material in the form of hand-outs will be distributed.</td>
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<tr>
<td></td>
<td>Lecture notes and references therein.</td>
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<tr>
<td>151-0604-00L</td>
<td>Microrobotics</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>B. Nelson</td>
</tr>
<tr>
<td></td>
<td>Does not take place this semester.</td>
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<td></td>
<td>Microrobotics is an interdisciplinary field that combines aspects of robotics, micro and nanotechnology, biomedical engineering, and materials science. The aim of this course is to expose students to the fundamentals of this emerging field. Throughout the course students are expected to submit assignments. The course concludes with an end-of-semester examination.</td>
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</table>
Objective

The objective of this course is to expose students to the fundamental aspects of the emerging field of microrobotics. This includes a focus on physical laws that predominate at the microscale, technologies for fabricating small devices, bio-inspired design, and applications of the field.

Content

Main topics of the course include:
- Scaling laws at micro/nano scales
- Electrostatics
- Electromagnetism
- Low Reynolds number flows
- Observation tools
- Materials and fabrication methods
- Applications of biomedical microrobots

Lecture notes

The powerpoint slides presented in the lectures will be made available in hardcopy and as pdf files. Several readings will also be made available electronically.

Prerequisites / notice

The lecture will be taught in English.
Overview of the most important concepts of image formation, perception and analysis, and Computer Vision. Gaining own experience
The lecture introduces the physical and technical know-how of X-ray tomographic microscopy. Several X-ray imaging techniques
M. Stampanoni
Micro and Nano-Tomography of Biological Tissues
- Acoustics sensors
  - Differential equation for quartz crystal resonance
  - Acoustic sensors and their applications
L. Van Gool, O. Gökse, E. Konukoglu

L12. Functional electric stimulation and recording
- MEA and CMOS based recording
- Applying potential in liquid - simulation of fields and relevance to electric stimulation

L10. Channels, amplification, signal gating, and patch clamp Y4

L11. Action potentials and impulse propagation

L13. Neural networks memory and learning

Prerequisites:
Supervised exercises solving real-world problems. Some Matlab based exercises in groups.

227-0447-00L Image Analysis and Computer Vision W 6 credits 3V+1U L. Van Gool, O. Gökse, E. Konukoglu
Abstract
Objective
Overview of the most important concepts of image formation, perception and analysis, and Computer Vision. Gaining own experience through practical computer and programming exercises.
Content
The first part of the course starts off from an overview of existing and emerging applications that need computer vision. It shows that the realm of image processing is no longer restricted to the factory floor, but is entering several fields of our daily life. First it is investigated how the parameters of the electromagnetic waves are related to our perception. Also the interaction of light with matter is considered. The most important hardware components of technical vision systems, such as cameras, optical devices and illumination sources are discussed. The course then turns to the steps that are necessary to arrive at the discrete images that serve as input to algorithms. The next part describes necessary preprocessing steps of image analysis, that enhance image quality and/or detect specific features. Linear and non-linear filters are introduced for that purpose. The course will continue by analyzing procedures allowing to extract additional types of basic information from multiple images, with motion and depth as two important examples. The estimation of image velocities (optical flow) get due attention and methods for object tracking will be presented. Several techniques are discussed to extract three-dimensional information about objects and scenes. Finally, approaches for the recognition of specific objects as well as object classes will be discussed and analyzed.

Lecture notes
Course material Script, computer demonstrations, exercises and problem solutions
Prerequisites:
Prerequisites: Basic concepts of mathematical analysis and linear algebra. The computer exercises are based on Linux and C.
The course language is English.

227-0965-00L Micro and Nano-Tomography of Biological Tissues W 4 credits 3G M. Stampanoni, P. A. Kaestner
Abstract
The lecture introduces the physical and technical know-how of X-ray tomographic microscopy. Several X-ray imaging techniques (absorption-, phase- and darkfield contrast) will be discussed and their use in daily research, in particular biology, is presented. The course discusses the aspects of quantitative evaluation of tomographic data sets like segmentation, morphometry and statistics.
Objective
Introduction to the basic concepts of X-ray tomographic imaging, image analysis and data quantification at the micro and nano scale with particular emphasis on biological applications.
Content
Synchrotron-based X-ray micro- and nano-tomography is today a powerful technique for non-destructive, high-resolution investigations of a broad range of materials. The high-brilliance and high-coherence of third generation synchrotron radiation facilities allow quantitative, three-dimensional imaging at the micro and nanometer scale and extend the traditional absorption imaging technique to edge-enhanced and phase-sensitive measurements, which are particularly suited for investigating biological samples.

The lecture includes a general introduction to the principles of tomographic imaging from image formation to image reconstruction. It provides the physical and engineering basics to understand how imaging beamlines at synchrotron facilities work, looks into the recently developed phase contrast methods, and explores the first applications of X-ray nano-tomographic experiments.

The course finally provides the necessary background to understand the quantitative evaluation of tomographic data, from basic image analysis to complex morphometrical computations and 3D visualization, keeping the focus on biomedical applications.
To gain an understanding of the physical and chemical principles, as well as the tools and applications of surface science, and to be able to choose appropriate surface-analytical approaches for solving problems.

Objective
To gain an understanding of the physical and chemical principles, as well as the tools and applications of surface science, and to be able to choose appropriate surface-analytical approaches for solving problems.

Content
Introduction to Surface Science
Physical Structure of Surfaces
Surface Forces (static and dynamic)
Adsorbates on Surfaces
Surface Thermodynamics and Kinetics
The Solid-Liquid Interface
Electron Spectroscopy
Vibrational Spectroscopy on Surfaces
Scanning Probe Microscopy
Introduction to Tribology
Introduction to Corrosion Science

Lecture notes

Literature
Script (20 CHF)

Prerequisites / notice
Physics: General undergraduate physics including basic theory of diffusion and basic knowledge of crystal structures
Chemistry: General undergraduate chemistry including basic chemical kinetics and thermodynamics

327-0505-00L Surfaces, Interfaces and their Applications I

Abstract
After being introduced to the physical/chemical principles and importance of surfaces and interfaces, the student is introduced to the most important techniques that can be used to characterize surfaces. Later, liquid interfaces are treated, followed by an introduction to the fields of tribology (friction, lubrication, and wear) and corrosion.

Objective
To gain an understanding of the physical and chemical principles, as well as the tools and applications of surface science, and to be able to choose appropriate surface-analytical approaches for solving problems.

Content
Introduction to Surface Science
Physical Structure of Surfaces
Surface Forces (static and dynamic)
Adsorbates on Surfaces
Surface Thermodynamics and Kinetics
The Solid-Liquid Interface
Electron Spectroscopy
Vibrational Spectroscopy on Surfaces
Scanning Probe Microscopy
Introduction to Tribology
Introduction to Corrosion Science

Lecture notes

Prerequisites / notice
Physics: General undergraduate physics including basic theory of diffusion and basic knowledge of crystal structures
Chemistry: General undergraduate chemistry including basic chemical kinetics and thermodynamics

327-2125-00L Microscopy Training SEM I - Introduction to SEM

Abstract
The introductory course on Scanning Electron Microscopy (SEM) emphasizes hands-on learning. Using 2 SEM instruments, students have the opportunity to study their own samples, or standard test samples, as well as solving exercises provided by ScopeM scientists.

Objective
- Set-up, align and operate a SEM successfully and safely.
- Accomplish imaging tasks successfully and optimize microscope performances.
- Master the operation of a low-vacuum and field-emission SEM and EDX instrument.
- Perform sample preparation with corresponding techniques and equipment for imaging and analysis
- Acquire techniques in obtaining secondary electron and backscatter electron micrographs
- Perform EDX qualitative and semi-quantitative analysis
- Discussion of students' sample/interest
- Introduction and discussion on Electron Microscopy and instrumentation
- Lectures on electron sources, electron lenses and probe formation
- Lectures on beam/specimen interaction, image formation, image contrast and imaging modes.
- Lectures on sample preparation techniques for EM
- Brief description and demonstration of the SEM microscope
- Practice on beam/specimen interaction, image formation, image contrast (and image processing)
- Student participation on sample preparation techniques
- Scanning Electron Microscopy lab exercises: setup and operate the instrument under various imaging modalities
- Lecture and demonstrations on X-ray micro-analysis (theory and detection), qualitative and semi-quantitative EDX and point analysis, linescans and spectral mapping
- Practice on real-world samples and report results

Literature
- Detailed course manual

Prerequisites / notice
No mandatory prerequisites. Please consider the prior attendance to EM Basic lectures (551-1618-00V; 227-0390-00L; 327-0703-00L) as suggested prerequisite.

327-2126-00L Microscopy Training TEM I - Introduction to TEM

Abstract
This course teaches methods and models for fMRI data analysis. It covers all aspects of statistical parametric mapping (SPM), incl. preprocessing, the general linear model, statistical inference, multiple comparison corrections, event-related designs, and Dynamic Causal Modelling (DCM), a Bayesian framework for identification of nonlinear neuronal systems from neurophysiological data.

Objective
To obtain in-depth knowledge of the theoretical foundations of SPM and DCM and of their application to empirical fMRI data.

Content
This course teaches state-of-the-art methods and models for fMRI data analysis. It covers all aspects of statistical parametric mapping (SPM), incl. preprocessing, the general linear model, frequentist and Bayesian inference, multiple comparison corrections, and event-related designs, and Dynamic Causal Modelling (DCM), a Bayesian framework for identification of nonlinear neuronal systems from neurophysiological data. A particular emphasis of the course will be on methodological questions arising in the context of studies in psychiatry, neurology and neuroeconomics.

Literature
- Practice on real-world samples and report results
- Discussion of students' sample/interest
- Introduction and discussion on Electron Microscopy and instrumentation
- Lectures on electron sources, electron lenses and probe formation
- Lectures on beam/specimen interaction, image formation, image contrast and imaging modes.
- Lectures on sample preparation techniques for EM
- Brief description and demonstration of the SEM microscope
- Practice on beam/specimen interaction, image formation, image contrast (and image processing)
- Student participation on sample preparation techniques
- Scanning Electron Microscopy lab exercises: setup and operate the instrument under various imaging modalities
- Lecture and demonstrations on X-ray micro-analysis (theory and detection), qualitative and semi-quantitative EDX and point analysis, linescans and spectral mapping
- Practice on real-world samples and report results

Prerequisites / notice
No mandatory prerequisites. Please consider the prior attendance to EM Basic lectures (551-1618-00V; 227-0390-00L; 327-0703-00L) as suggested prerequisite.
Technology Entrepreneurship

The introductory course on Transmission Electron Microscopy (TEM) provides theoretical and hands-on learning for new operators, utilizing lectures, demonstrations, and hands-on sessions.

Objective

- Overview of TEM theory, instrumentation, operation and applications.
- Alignment and operation of a TEM, as well as acquisition and interpretation of images, diffraction patterns, accomplishing basic tasks successfully.
- Knowledge of electron imaging modes (including Scanning Transmission Electron Microscopy), magnification calibration, and image acquisition using CCD cameras.
- To set up the TEM to acquire diffraction patterns, perform camera length calibration, as well as measure and interpret diffraction patterns.
- Overview of techniques for specimen preparation.

Content

Using two Transmission Electron Microscopes the students learn how to align a TEM, select parameters for acquisition of images in bright field (BF) and dark field (DF), perform scanning transmission electron microscopy (STEM) imaging, phase contrast imaging, and acquire electron diffraction patterns. The participants will also learn basic and advanced use of digital cameras and digital imaging methods.

- Introduction and discussion on Electron Microscopy and instrumentation.
- Lectures on electron sources, electron lenses and probe formation.
- Lectures on beam/specimen interaction, image formation, image contrast and imaging modes.
- Lectures on sample preparation techniques for EM.
- Brief description and demonstration of the TEM microscope.
- Practice on beam/specimen interaction, image formation, Image contrast (and image processing).
- Demonstration of Transmission Electron Microscopes and imaging modes (Phase contrast, BF, DF, STEM).
- Student participation on sample preparation techniques.
- Transmission Electron Microscopy lab exercises: setup and operate the instrument under various imaging modalities.
- TEM alignment, calibration, correction to improve image contrast and quality.
- Electron diffraction.
- Practice on real-world samples and report results.

Literature

- Detailed course manual

Prerequisites / notice

No mandatory prerequisites. Please consider the prior attendance to EM Basic lectures (551-1618-00V; 227-0390-00L; 327-0703-00L) as suggested prerequisite.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Time</th>
<th>Credits</th>
<th>Type</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-0790-00L</td>
<td>Technology Entrepreneurship</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>5</td>
</tr>
<tr>
<td>376-0815-00L</td>
<td>Writing your Master's Thesis: Natural Sciences and Engineering C1-C2</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>S. Milligan</td>
</tr>
<tr>
<td>363-1065-00L</td>
<td>Design Thinking: Human-Centred Solutions to Real World Challenges</td>
<td>W</td>
<td>5</td>
<td>5G</td>
<td>A. Cabello Llamas, F. Rittiner, S. Brusoni, C. Hölischer, M. Meboldt</td>
</tr>
</tbody>
</table>

Abstract

The participants will be chosen based on a short motivation letter. Please send this letter to S. Rodighiero (main lecturer).

Objective

This course offers the fundamentals in theory and practice of entrepreneurship in new technology ventures. Main topics covered are success factors in the creation of new firms, including founding, financing and growing a venture.

Content

See course website: http://www.entrepreneurship.ethz.ch/sresources/courses/tech-entrepreneurship.html

Lecture notes

Lecture slides and case material

Attention: Registration is only possible from 12.9. (from 11.30h) - 15.9.2016

Abstract

We'll prepare you to produce your MSc thesis. You'll learn how to structure your thesis, write scientific English, and manage your writing efficiently. You'll receive detailed feedback on work in progress.

Objective

By the end of the course students are able to plan, draft, and edit academic English papers and theses; structure and write clear texts in a style which is acceptable to their academic discourse community; manage the writing process efficiently; select formal vocabulary and use it in a generally accurate and correct manner; choose and use generally suitable grammatical structures, punctuation, and orthographic conventions, assess their own effectiveness as writers of academic English, and identify areas in which further development is needed.

Content

The course covers the writing context; the writing process; structuring sentences, paragraphs, longer sections (such as introduction, methods, results, and discussion), and whole texts; presenting and integrating non-textual elements such as graphs and tables; and editing and correcting drafts and proofs. Each lesson comprises a mixture of elements, including specialist input, individual tasks, pairwork, and groupwork. Active participation is expected.

Information and application: www.sparklabs.ch/ethz

Autumn Semester 2016
Objective
During the course, students will learn about different design thinking methods and tools. This will enable them to:
- Generate deep insights through the systematic observation and interaction of key stakeholders.
- Engage in collaborative ideation with a multidisciplinary (student) team.
- Rapidly prototype and iteratively test ideas and concepts by using various materials and techniques.

Content
The purpose of this course is to equip the students with methods and tools to tackle a broad range of problems. Following a Design Thinking approach, the students will learn how to observe and interact with key stakeholders in order to develop an in-depth understanding of what is truly important and emotionally meaningful to the people at the center of a problem. Based on these insights, the students ideate on possible solutions and immediately validate them through quick iterations of prototyping and testing using different tools and materials. The students will work in multidisciplinary teams on a set of challenges that are organized as a one-week, a two-week, and a final six-week project with an external project partner. In this course, the students will learn about the different Design Thinking methods and tools that are needed to generate deep insights, to engage in collaborative ideation, rapid prototyping and iterative testing.

Design Thinking is a deeply human process that taps into the creative abilities we all have, but that get often overlooked by more conventional problem solving practices. It relies on our ability to be intuitive, to recognize patterns, to construct ideas that are emotionally meaningful as well as functional, and to express ourselves through means beyond words or symbols. Design Thinking provides an integrated way by incorporating tools, processes and techniques from design, engineering, the humanities and social sciences to identify, define and address diverse challenges. This integration leads to a highly productive collaboration between different disciplines.

For more information and the application visit: http://sparklabs.ch/ethz

Prerequisites / notice
Class attendance and active participation is crucial as much of the learning occurs through the work in teams during class. Therefore, attendance is obligatory for every session. Please also note that the group work outside class is an essential element of this course, so that students must expect an above-average workload.

<table>
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<tr>
<th>Code</th>
<th>Title</th>
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<th>Credits</th>
<th>Units</th>
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<tbody>
<tr>
<td>376-1103-00L</td>
<td>Frontiers in Nanotechnology</td>
<td>W</td>
<td>4</td>
<td>V</td>
</tr>
<tr>
<td>Abstract</td>
<td>Many disciplines are meeting at the nanoscale, from physics, chemistry to engineering, from the life sciences to medicine. The course will prepare students to communicate more effectively across disciplinary boundaries, and will provide them with deep insights into the various frontiers.</td>
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<tr>
<td>Objective</td>
<td>Building upon advanced technologies to create, visualize, analyze and manipulate nano-structures, as well as to probe their nano-chemistry, nano-mechanics and other properties within manmade and living systems, many exciting discoveries are currently made. They change the way we do science and result in so many new technologies.</td>
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<tr>
<td>Content</td>
<td>The goal of the course is to give Master and Graduate students from all interested departments an overview of what nanotechnology is all about, from analytical techniques to nanosystems, from physics to biology. Students will start to appreciate the extent to which scientific communities are meeting at the nanoscale. They will learn about the specific challenges, and what is currently sizzling in the respective fields, and learn the vocabulary that is necessary to communicate effectively across departmental boundaries.</td>
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<tr>
<td>Lecture notes</td>
<td>Each lecturer will first give an overview of the state-of-the art in his/her field, and then describe the research highlights in his/her own research group. While preparing their Final Projects and discussing them in front of the class, the students will deepen their understanding of how to apply a range of new technologies to solve specific scientific problems and technical challenges. Exposure to the different frontiers will also improve their ability to conduct effective nanoscale research, recognize the broader significance of their work and to start collaborations.</td>
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<tr>
<td>Literature</td>
<td>Starting with the fabrication and analysis of nanoparticles and nanostructured materials that enable a variety of scientific and technical applications, we will transition to discussing biological nanosystems, how they work and what bioinspired engineering principles can be derived, to finally discussing biomedical applications and potential health risk issues. Scientific aspects as well as the many of the emerging technologies will be covered that start impacting so many aspects of our lives. This includes new phenomena in physics, advanced materials, novel technologies and new methods to address major medical challenges.</td>
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<tr>
<td>Notice</td>
<td>All the enrolled students will get access to a password protected website where they can find pdf files of the lecture notes, and typically 1-2 journal articles per lecture that cover selected topics.</td>
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<tr>
<th>Code</th>
<th>Title</th>
<th>Type</th>
<th>Credits</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-1177-00L</td>
<td>Human Factors I</td>
<td>W</td>
<td>2</td>
<td>2V</td>
</tr>
<tr>
<td>Objective</td>
<td>Every day humans interact with various systems. Strategies of interaction, individual needs, physical &amp; mental abilities, and system properties are important factors in controlling the quality and performance in interaction processes. In the lecture, factors are investigated by basic scientific approaches. Discussed topics are important for optimizing people's satisfaction &amp; overall performance.</td>
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<tr>
<td>Content</td>
<td>The goal of the lecture is to enable our students to better understand the applied theories, principles, and methods in various applications. Students are expected to learn about how to enable an efficient and qualitatively high standing interaction between human and the environment, considering costs, benefits, health, and safety as well. Thus, an ergonomic design and evaluation process of products, tasks, and environments may be promoted in different disciplines. The goal is achieved in addressing a broad variety of topics and embedding the discussion in macroscopic factors such as the behavior of consumers and objectives of economy.</td>
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<tr>
<td>Literature</td>
<td>- Physiological, physical, and cognitive factors in sensation and perception - Body spaces and functional anthropometry, Digital Human Models - Experimental techniques in assessing human performance and well-being - Human factors and ergonomics in system designs, product development and innovation - Human information processing and biological cybernetics - Interaction among consumers, environments, behavior, and tasks</td>
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<tr>
<td>Notice</td>
<td>- Gavriel Salvendy, Handbook of Human Factors and Ergonomics, 4th edition (2012), is available on NEBIS as electronic version and for free to ETH students - Further textbooks are introduced in the lecture - Brochures, checklists, key articles etc. are uploaded in IJIAS</td>
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<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Type</th>
<th>Credits</th>
<th>Units</th>
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<tbody>
<tr>
<td>376-1179-00L</td>
<td>Applications of Cybernetics in Ergonomics</td>
<td>W</td>
<td>1</td>
<td>1U</td>
</tr>
<tr>
<td>Abstract</td>
<td>Cybernetics systems have been studied and applied in various research fields, such as applications in the ergonomics domain. Research interests include the man-machine interaction (MMI) topic which involving the performance in multi-model interactions, quantification in gestalt principles in product development; or the information processing matter.</td>
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<tr>
<td>Objective</td>
<td>To learn and practice cybernetics principles in interface designs and product development.</td>
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<tr>
<td>Content</td>
<td>- Fitt's law applied in manipulation tasks - Hick-Hyman law applied in design of the driver assistance systems - Vigilance applied in quality inspection - Accommodationvergence crosslink function - Cross-link models in neurobiology- the ocular motor control system - Human performance in optimization of production lines</td>
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<tr>
<th>Code</th>
<th>Title</th>
<th>Type</th>
<th>Credits</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>376-1219-00L</td>
<td>Rehabilitation Engineering II: Rehabilitation of Sensory and Vegetative Functions</td>
<td>W</td>
<td>3</td>
<td>2V</td>
</tr>
<tr>
<td>Objective</td>
<td></td>
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<tr>
<td>Content</td>
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<tr>
<td>Literature</td>
<td>R. Riener, R. Gassett, L. Marchal Crespo</td>
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</table>

Data: 06.03.2019 12:57  Autumn Semester 2016  Page 770 of 1571
Abstract
Rehabilitation Engng is the application of science and technology to ameliorate the handicaps of individuals with disabilities to reintegrate them into society. The goal is to present classical and new rehabilitation engineering principles applied to compensate or enhance motor, sensory, and cognitive deficits. Focus is on the restoration and treatment of the human sensory and vegetative system.

Objective
Provide knowledge on the anatomy and physiology of the human sensory system, related dysfunctions and pathologies, and how rehabilitation engineering can provide sensory restoration and substitution.

This lecture is independent from Rehabilitation Engineering I. Thus, both lectures can be visited in arbitrary order.

Content
Introduction, problem definition, overview

Rehabilitation of visual function
- Anatomy and physiology of the visual sense
- Technical aids (glasses, sensor substitution)
- Retina and cortex implants

Rehabilitation of hearing function
- Anatomy and physiology of the auditory sense
- Hearing aids
- Cochlea Implants

Rehabilitation and use of kinesthetic and tactile function
- Anatomy and physiology of the kinesthetic and tactile sense
- Tactile/haptic displays for motion therapy (incl. electrical stimulation)

Rehabilitation of vestibular function
- Anatomy and physiology of the vestibular sense
- Rehabilitation strategies and devices (e.g. BrainPort)

Rehabilitation of vegetative Functions
- Cardiac Pacemaker
- Phrenic stimulation, artificial breathing aids
- Bladder stimulation, artificial sphincter
- Brain stimulation and recording
- Deep brain stimulation for patients with Parkinson, epilepsy, depression
- Brain-Computer Interfaces

Literature
Introductory Books:


Selected Journal Articles and Web Links:


VideoTact, ForeThought Development, LLC. http://my.execpc.com/?dwysocki/videotac.html
### 376-1279-00L Virtual Reality in Medicine

- **Credit Hours:** 2
- **Target Group:** Students of higher semesters and PhD students
- **Prerequisites:**
  - 376-1351-00L
  - 376-1279-00L
  - Biomedical Engineering, Robotics, Systems and Control
  - Medical Faculty, University of Zurich

- **Objective:** Provide theoretical and practical knowledge of new principles and applications of multi-modal simulation and interface technologies in medical education, therapy, and rehabilitation.

- **Abstract:** Virtual Reality has the potential to support medical training and therapy. This lecture will derive the technical principles of multi-modal (auditory, haptic, tactile etc.) input devices, displays, and rendering techniques. Examples are presented in the fields of surgical training, intra-operative augmentation, and rehabilitation. The lecture is accompanied by practical courses and excursions.

- **Content:**
  - Virtual Reality has the potential to provide descriptive and practical information for medical training and therapy while relieving the patient and/or the physician. Multi-modal interactions between the user and the virtual environment facilitate the generation of high-fidelity sensory impressions, by using not only visual and auditory modalities, but also kinesthetic, tactile, and even olfactory feedback. On the basis of the existing physiological constraints, this lecture will derive the technical requirements and principles of multi-modal input devices, displays, and rendering techniques. Several examples are presented that are currently being developed or already applied for surgical training, intra-operative augmentation, and rehabilitation. The lecture will be accompanied by several practical courses on graphical and haptic display devices as well as excursions to facilities equipped with large-scale VR equipment.

- **Literature:**

- **Prerequisites:** Basic experience in Information Technology and Computer Science will be of advantage.

- **Notice:** More details will be announced in the lecture.

### 376-1351-00L Micro/Nanotechnology and Microfluidics for Biomedical Applications

- **Credit Hours:** 2
- **Target Group:** Students of higher semesters and PhD students
- **Prerequisites:**
  - 376-1351-00L
  - 376-1279-00L
  - Biomedical Engineering, Robotics, Systems and Control

- **Objective:** The main objective of the course is to introduce micro/nanotechnology and microfluidics to students having a background in the life sciences. The course should familiarize the students with the techniques used in micro/nanotechnology and show them how micro/nanotechnology pervades throughout life sciences. Microfluidics will be emphasized due to their increasing importance in research and medical applications. The second objective is to have life students less intimidated by micro/nanotechnology and make them able to link instruments and techniques to specific problems that they might have in their projects/studies. This will also help students getting access to the ETHZ/IBM Nanotech Center infrastructure if needed.

- **Abstract:** This course is an introduction to techniques in micro/nanotechnology and to microfluidics. It reviews how many familiar devices are built and can be used for research and biomedical applications. Transistors for DNA sequencing, beamers for patterning proteins, hard-disk technology for biosensing and scanning microfluidics for analyzing tissue sections are just a few examples of the covered topics.

- **Content:**
  - Mostly formal lectures (2 x 45 min), with a 2-hour visit and introduction to cleanroom and micro/nanotechnology instruments, last 3 sessions would be dedicated to the presentation and evaluation of projects by students (3 students per team).

- **Notice:** Nanotech center and lab visit at IBM would be mandatory, as well as attending the student project presentations.

### 376-1504-00L Physical Human Robot Interaction (pHRI)

- **Credit Hours:** 4
- **Target Group:** Students of higher semesters and PhD students
- **Prerequisites:** Basic knowledge in Information Technology and Computer Science will be of advantage.

- **Objective:** The objective of this course is to give an introduction to the fundamentals of physical human robot interaction, through lectures on the underlying theoretical/mechatronics aspects and application fields, in combination with a hands-on lab tutorial. The course will guide students through the design and evaluation process of such systems.

- **Abstract:** This course focuses on the emerging, interdisciplinary field of physical human-robot interaction, bringing together themes from robotics, real-time control, human factors, haptics, virtual environments, interaction design and other fields to enable the development of human-oriented robotic systems.

- **Content:**
  - By the end of this course, you should understand the critical elements in human-robot interactions - both in terms of engineering and human factors - and use these to evaluate and design safe and efficient assistive and rehabilitative robotic systems. Specifically, you should be able to:
    1) identify critical human factors in physical human-robot interaction and use these to derive design requirements;
    2) compare and select mechatronic components that optimally fulfill the design requirements;
    3) derive a model of the device dynamics to guide and optimize the selection and integration of selected components into a functional system;
    4) design control hardware and software and implement and test human-robot interaction strategies on the physical setup;
    5) characterize and optimize such systems using both engineering and psychophysical evaluation metrics;
    6) investigate and optimize one aspect of the physical setup and convey and defend the gained insights in a technical presentation.

- **Lecture notes:** Will be distributed through the document repository before the lectures.

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This lecture serves as an introduction to the field of trauma biomechanics. Emphasis is placed on the interdisciplinary nature of impact forces and their effects on injury mechanisms.


Prerequisites / notice

The registration is limited to 26 students.

There are 4 credit points for this lecture.

The lecture will be held in English.

The students are expected to have basic control knowledge from previous classes.

http://www.relab.ethz.ch/education/courses/phri.html

Literature

Schmitt K-U., Niederer P., M. Muser, Walz F. "Trauma Biomechanics - An Introduction to Injury Biomechanics", Springer Verlag

see teaching document repository


The students dispose of an overview on current principles and systems for the controlled delivery and targeting of drugs. The focus of the course lies on developing a capacity to understand the involved technologies and methods, as well as an appreciation of the chances and constraints of their therapeutic usage, with prime attention on anticancer drugs, therapeutic peptides, proteins, nucleic acids and vaccines. The course covers the following topics: drug targeting and delivery principles, radiopharmaceuticals, macromolecular drug carriers, liposomes, micelles, micro/nanoparticles, gels and implants, administration of vaccines, delivery of active agents in tissue engineering, targeting at the gastrointestinal level, synthetic carriers for nucleic acid drugs, ophthalmic devices and novel trends in transdermal and nasal drug delivery.

The statistical package R will be used in the exercises. If you are unfamiliar with R, I highly recommend the online R course etutoR.

The students gain an overview on current principles, methodologies and systems for controlled delivery and targeting of drugs. This will enable the students to understand and evaluate the field in terms of scientific criteria. Visiting clinical research in a leading university hospital will show the usefulness of the lecture series.
551-0319-00L

#### Cellular Biochemistry (Part I)

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<th>3 credits</th>
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**Abstract**
Concepts and molecular mechanisms underlying the biochemistry of the cell, providing advanced insights into structure, function and regulation of individual cell components. Particular emphasis will be put on the spatial and temporal integration of different molecules and signaling pathways into global cellular processes such as intracellular transport, cell division & growth, and cell migration.

**Objective**
The full-year course (551-0319-00 & 551-0320-00) focuses on the molecular mechanisms and concepts underlying the biochemistry of cellular physiology, investigating how these processes are integrated to carry out highly coordinated cellular functions. The molecular characterisation of complex cellular functions requires a combination of approaches such as biochemistry, but also cell biology and genetics. This course is therefore the occasion to discuss these techniques and their integration in modern cellular biochemistry. The students will be able to describe the structural and functional details of individual cell components, and the spatial and temporal regulation of their interactions. In particular, they will learn to explain the integration of different molecules and signaling pathways into complex and highly dynamic cellular processes such as intracellular transport, cytoskeletal rearrangements, cell motility, cell division and cell growth. In addition, they will be able to illustrate the relevance of particular signaling pathways for cellular pathologies such as cancer.

**Content**
Structural and functional details of individual cell components, regulation of their interactions, and various aspects of the regulation and compartmentalisation of biochemical processes.

**Topics include:** biophysical and electrical properties of membranes; viral membranes; structural and functional insights into intracellular transport and targeting; vesicular trafficking and phagocytosis; post-transcriptional regulation of gene expression.

**Lecture notes**
Scripts and additional material will be provided during the semester. Please contact Dr. Alicia Smith for assistance with the learning materials. (alicia.smith@bc.biol.ethz.ch)

**Literature**
Recommended supplementary literature (review articles and selected primary literature) will be provided during the course.

**Prerequisites / notice**
To attend this course the students must have a solid basic knowledge in chemistry, biochemistry and general biology. The course will be taught in English.

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636-0003-00L

#### Biological Engineering and Biotechnology

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<th>W</th>
<th>6 credits</th>
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**Abstract**
Biological Engineering and Biotechnology will cover the latest biotechnological advances as well as their industrial implementation to engineer mammalian cells for use in human therapy. This lecture will provide forefront insights into key scientific aspects and the main points in industrial decision-making to bring a therapeutic from target to market.

**Objective**
1. Insight Into The Mammalian Cell Cycle. Cycling, The Balance Between Proliferation and Cancer - Implications For Biopharmaceutical Manufacturing.
2. The Licence To Kill. Apoptosis Regulatory Networks - Engineering of Survival Pathways To Increase Robustness of Production Cell Lines.
5. From Target To Market. An Antibody's Journey From Cell Culture to The Clinics.
6. Development of Biological Weapons?
7. Functional Food. Enjoy your Meal!

**Lecture notes**
Handouts during the course.

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#### Major in Molecular Science Courses

##### Compulsory Courses

**Number**
376-0300-00L

**Title**
Translational Science for Health and Medicine

**Type**
O

**ECTS**
3 credits

**Hours**
2G

**Lecturers**
J. Goldhahn, C. Wolfrum

**Abstract**
Translational science is a cross disciplinary scientific research that is motivated by the need for practical applications that help people. The course should help to clarify basics of translational science, illustrate successful applications and should enable students to integrate key features into their future projects.

**Objective**
After completing this course, students will be able to understand:
- Principles of translational science (including project planning, ethics application, basics of resource management and interdisciplinary communication)

**Content**
What is translational science and what is it not?
- How to identify need?
- Disease concepts and consequences for research
- Basics about incidence, prevalence etc., and orphan indications
- How to choose the appropriate research type and methodology
- Ethical considerations including ethics application
- Pros and cons of different types of research
- Coordination of complex approaches incl. timing and resources
- How to measure success?
- Outcome variables
- Improving the translational process
- Challenges of communication?
- How independent is translational science?
- Academic boundary conditions vs. industrial influences

Positive and negative examples will be illustrated by distinguished guest speakers.

---

##### Electives

#### Elective Courses I

**Number**
551-0309-00L

**Title**
Concepts in Modern Genetics

**Type**
W

**ECTS**
6 credits

**Hours**
4V

**Lecturers**
Y. Bariul, D. Bopp, A. Hajnal, M. Stoffel, O. Voinmet

**Abstract**
Concepts of modern genetics and genomics, including principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

**Objective**
This course focuses on the concepts of classical and modern genetics and genomics.

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Content

The topics include principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

Lecture notes

Scripts and additional material will be provided during the semester.

Prerequisites / notice

This course is a co-production of the University of Zurich and ETH Zurich, and will be taught in English. The course takes place on Monday afternoon at ETH Hoenggerberg, and on Tuesday morning at UZH Irchel.

#### Elective Courses II

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>327-2125-00L</td>
<td>Microscopy Training SEM I - Introduction to SEM</td>
<td>W</td>
<td>1 credit</td>
<td>3P</td>
<td>S. Rodighiero, A. G. Bittermann, K. Kunze, J. Reuteler</td>
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<td></td>
<td>Number of participants limited to 6.</td>
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<td></td>
<td>The participants will be chosen based on a short motivation letter. Please send this letter to S. Rodighiero (main lecturer) as soon as possible.</td>
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<tr>
<td>Abstract</td>
<td>The introductory course on Scanning Electron Microscopy (SEM) emphasizes hands-on learning. Using 2 SEM instruments, students have the opportunity to study their own samples, or standard test samples, as well as solving exercises provided by ScopeM scientists.</td>
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<td>Objective</td>
<td>- Set-up, align and operate a SEM successfully and safely.</td>
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<td></td>
<td>- Accomplish imaging tasks successfully and optimize microscope performances.</td>
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<td></td>
<td>- Master the operation of a low-vacuum and field-emission SEM and EDX instrument.</td>
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<td></td>
<td>- Perform sample preparation with corresponding techniques and equipment for imaging and analysis</td>
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<td></td>
<td>- Acquire techniques in obtaining secondary electron and backscatter electron micrographs</td>
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<td></td>
<td>- Perform EDX qualitative and semi-quantitative analysis</td>
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<td>Content</td>
<td>During the course, students learn through lectures, demonstrations, and hands-on sessions how to setup and operate SEM instruments, including low-vacuum and low-voltage applications.</td>
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<td>This course gives basic skills for students new to SEM. At the end of the course, students with no prior experience are able to align a SEM, to obtain secondary electron (SE) and backscatter electron (BSE) micrographs and to perform energy dispersive X-ray spectroscopy (EDX) qualitative and semi-quantitative analysis. The procedures to better utilize SEM to solve practical problems and to optimize SEM analysis for a wide range of materials will be emphasized.</td>
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<td>- Discussion of students’ sample/interest</td>
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<td></td>
<td>- Introduction and discussion on Electron Microscopy and instrumentation</td>
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<td></td>
<td>- Lectures on electron sources, electron lenses and probe formation</td>
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<td></td>
<td>- Lectures on beam/specimen interaction, image formation, image contrast and imaging modes.</td>
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<td></td>
<td>- Lectures on sample preparation techniques for EM</td>
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<td></td>
<td>- Brief description and demonstration of the SEM microscope</td>
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<td></td>
<td>- Practice on beam/specimen interaction, image formation, image contrast (and image processing)</td>
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<td></td>
<td>- Student participation on sample preparation techniques</td>
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<td>- Scanning Electron Microscopy lab exercises: setup and operate the instrument under various imaging modalities</td>
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<td></td>
<td>- Lecture and demonstrations on X-ray micro-analysis (theory and detection), qualitative and semi-quantitative EDX and point analysis, linescans and spectral mapping</td>
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<td></td>
<td>- Practice on real-world samples and report results</td>
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<tr>
<td>Literature</td>
<td>Detailed course manual</td>
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<tr>
<td>Prerequisites / notice</td>
<td>No mandatory prerequisites. Please consider the prior attendance to EM Basic lectures (551-1618-00V; 227-0390-00L; 327-0703-00L) as suggested prerequisite.</td>
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<tr>
<td>327-2126-00L</td>
<td>Microscopy Training TEM I - Introduction to TEM</td>
<td>W</td>
<td>1 credit</td>
<td>3P</td>
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<td></td>
<td>Does not take place this semester.</td>
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<td></td>
<td>Number of participants limited to 6.</td>
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<td>The participants will be chosen based on a short motivation letter. Please send this letter to S. Rodighiero (main lecturer).</td>
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<tr>
<td>Abstract</td>
<td>The introductory course on Transmission Electron Microscopy (TEM) provides theoretical and hands-on learning for new operators, utilizing lectures, demonstrations, and hands-on sessions.</td>
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<tr>
<td>Objective</td>
<td>- Overview of TEM theory, instrumentation, operation and applications.</td>
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<td></td>
<td>- Alignment and operation of a TEM, as well as acquisition and interpretation of images, diffraction patterns, accomplishing basic tasks successfully.</td>
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<td>- Knowledge of electron imaging modes (including Scanning Transmission Electron Microscopy), magnification calibration, and image acquisition using CCD cameras.</td>
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<td>- To set up the TEM to acquire diffraction patterns, perform camera length calibration, as well as measure and interpret diffraction patterns.</td>
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<td></td>
<td>- Overview of techniques for specimen preparation.</td>
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<tr>
<td>Content</td>
<td>Using two Transmission Electron Microscopes, the students learn how to align a TEM, select parameters for acquisition of images in bright field (BF) and dark field (DF), perform scanning transmission electron microscopy (STEM) imaging, phase contrast imaging, and acquire electron diffraction patterns. The participants will also learn basic and advanced use of digital cameras and digital imaging methods.</td>
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<td></td>
<td>- Introduction and discussion on Electron Microscopy and instrumentation.</td>
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<td></td>
<td>- Lectures on electron sources, electron lenses and probe formation.</td>
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<tr>
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<td>- Lectures on beam/specimen interaction, image formation, image contrast and imaging modes.</td>
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<td></td>
<td>- Lectures on sample preparation techniques for EM.</td>
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<tr>
<td></td>
<td>- Brief description and demonstration of the TEM microscope.</td>
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<tr>
<td></td>
<td>- Practice on beam/specimen interaction, image formation, Image contrast (and image processing).</td>
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<tr>
<td></td>
<td>- Demonstration of Transmission Electron Microscopes and imaging modes (Phase contrast, BF, DF, STEM).</td>
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<td>- Student participation on sample preparation techniques.</td>
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<td></td>
<td>- Transmission Electron Microscopy lab exercises: setup and operate the instrument under various imaging modalities.</td>
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<td>- TEM alignment, calibration, correction to improve image contrast and quality.</td>
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<td>- Electron diffraction.</td>
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<td></td>
<td>- Practice on real-world samples and report results.</td>
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<tr>
<td>Literature</td>
<td>Detailed course manual</td>
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</table>
Introduction and historical background

The course is a literature seminar or "journal club". Each Friday a student, or a member of the Suter Lab in the Institute of Molecular Health Immunology I, W. Suter. The course introduces you to recent developments in the fields of cellular and molecular neurobiology. It also supports you to develop your skills in critically reading the scientific literature. You should be able to grasp what the authors wanted to learn i.e. their goals, why the authors chose the experimental approach they used, the strengths and weaknesses of the experiments and the data presented, and how the work fits into the wider literature in the field. You will present one paper yourself, which provides you with practice in public speaking.

Number of participants limited to 15 (3 courses are available).

Attention: Registration is only possible from 12.9. (from 11.30h) - 15.9.2016

Abstract

We'll prepare you to produce your MSc thesis. You'll learn how to structure your thesis, write scientific English, and manage your writing efficiently. You'll receive detailed feedback on work in progress.

Objective

By the end of the course students are able to plan, draft, and edit academic English papers and theses; structure and write clear texts in a style which is acceptable to their academic discourse community; manage the writing process efficiently; select formal vocabulary and use it in a generally accurate and correct manner; choose and use generally suitable grammatical structures, punctuation, and orthographic conventions, assess their own effectiveness as writers of academic English, and identify areas in which further development is needed.

Content

The course covers the writing context; the writing process; structuring sentences, paragraphs, longer sections (such as introduction, conclusion), data presentation, and correcting drafts and proofs. Each lesson comprises a mixture of elements, including specialist input, individual tasks, pairwork, and groupwork. Active participation is expected.

551-0223-00L Immunology III

Abstract

This course provides a detailed understanding of development of T and B cells, the dynamics of a immune response during acute and chronic infection, mechanisms of immunopathology, modern vaccination strategies. Key experimental results will be shown to help understanding how immunological text book knowledge has evolved.

Objective

Obtain a detailed understanding of the development, activation, and differentiation of different types of T cells and their effectormechanisms during immune responses, recognition of pathogenic microorganisms by the host cells and molecular events thereafter, events and signals for maturation of naive B cells to antibody producing plasma cells and memory B cells, optimization of B cell responses by intelligent design of new vaccines.

Content

- Development and selection of CD4 and CD8 T cells, natural killer T cells (NKT), and regulatory T cells (Treg)
- NK T cells and responses to lipid antigens
- Differentiation, characterization, and function of CD4 T cell subsets such as Th1, Th2, and Th17
- Overview of cytokines and their effector function
- Co-stimulation (signals 1-3)
- Dendritic cells
- Evolution of the "Danger" concept
- Cells expressing Pattern Recognition Receptors and their downstream signals
- T cell function and dysfunction in acute and chronic viral infections
- B cell function and antigen processing and presentation.

Literature

Documents of the lectures are available for download at: https://moodle-app2.let.ethz.ch/course/view.php?id=2581&notifyeditingon=1

Prerequisites / notice

Immunology I and II recommended but not compulsory.

551-0317-00L Immunology I

Abstract

Introduction into structural and functional aspects of the immune system. Basic knowledge of the mechanisms and the regulation of an immune response.

Objective

Introduction into structural and functional aspects of the immune system. Basic knowledge of the mechanisms and the regulation of an immune response.

Content

- Introduction and historical background
- Innate and adaptive immunity, Cells and organs of the immune system
- B cells and antibodies
- Generation of diversity
- Antigen presentation and Major Histoincompatibility (MHC) antigens
- Thymus and T cell selection
- Autoimmunity
- Cytotoxic T cells and NK cells
- Th1 and Th2 cells, regulatory T cells
- Allergies
- Hypersensitivities
- Vaccines, immune-therapeutic interventions

Literature

Electronic access to the documentation will be provided. The link can be found at "Lernmaterialien" - Kuby, Immunology, 7th edition, Freeman + Co., New York, 2009

Prerequisites / notice

Immunology I (WS) and Immunology II (SS) will be examined as one learning entity in a "Sessionsprüfung".


Attention: Registration is only possible from 12.9. (from 11.30h) - 15.9.2016

Number of participants limited to 15 (3 courses are available).

551-0512-00L Current Topics in Molecular and Cellular Neurobiology

Abstract

The course is a literature seminar or "journal club". Each Friday a student, or a member of the Suter Lab in the Institute of Molecular Health Sciences, will present a paper from the recent literature.

Objective

The course introduces you to recent developments in the fields of cellular and molecular neurobiology. It also supports you to develop your skills in critically reading the scientific literature. You should be able to grasp what the authors wanted to learn i.e. their goals, why the authors chose the experimental approach they used, the strengths and weaknesses of the experiments and the data presented, and how the work fits into the wider literature in the field. You will present one paper yourself, which provides you with practice in public speaking.

Data: 06.03.2019 12:57
Autumn Semester 2016
You will present one paper yourself. Give an introduction to the field of the paper, then show and comment on the main results (all the papers we present are available online, so you can show original figures with a beamer). Finish with a summary of the main points and a discussion of their significance.

You are expected to take part in the discussion and to ask questions. To prepare for this you should read all the papers beforehand (they will be announced a week in advance of the presentation).

Presentations will be made available after the seminars.

You must attend at least 80% of the journal clubs, and give a presentation of your own. At the end of the semester there will be a 30 minute oral exam on the material presented during the semester. The grade will be based on the exam (45%), your presentation (45%), and a contribution based on your active participation in discussion of other presentations (10%).
Starting from contemporary biological problems related to metabolism, the course focuses on systems biological approaches to address these problems. Students will work with experts toward a critical analysis of cutting-edge research in the domain of cellular biochemistry, with emphasis on viral and non-viral vector systems. Knowledge of important viral and non-viral vector systems is mandatory. "Biochemistry", Knowledge of application in human diseases.

**Objective**
Knowledge of application in human diseases.
Knowledge of limiting factors.

**551-1145-00L**  
Viral and non-Viral Vectors for Human Gene-Therapy - from Pathogens to Safe Medical Applications

- **Prerequisites / notice:** The course will be given in English. It will include the preparation of short essays (marked) about defined topics in Glycobiology.

- **Literature:**
  - Introduction to Glycobiology; M.E.Taylor, K.Drickamer, Oxford University Press, 2003
  - Basic aspects of virology, the viral mechanisms for transfer of genetic material into cells, different vector-systems and target cells, animal models, specific applications for inborn diseases of the immune system and of metabolism, adverse effects, and new developments of vector systems will be taught.

- **Abstract:**
Basic aspects of virology, the viral mechanisms for transfer of genetic material into cells, different vector-systems and target cells, animal models, specific applications for inborn diseases of the immune system and of metabolism, adverse effects, and new developments of vector systems will be taught.

- **Objective:**
Knowledge of important viral and non-viral vector systems.
Knowledge of application in human diseases.
Knowledge of limiting factors.

- **551-1153-00L**  
Systems Biology of Metabolism

- **Prerequisites / notice:**
The course will cover six grand topics in immunology (B cells, innate immunity, antigen presentation, tumor immunity, thymus and T cells, cytotoxic T cells and NK cells) and for each grand topic four hours will be allocated. During the first double hour, historical milestone papers will be presented by the supervisor providing an overview on the development of the conceptual framework and critical technological advances. The students will also prepare themselves for this double lecture by reading the historical milestone papers and contributing to the discussion. In the following lecture up to four students will present each a recent high impact research paper which emerged from the landmark achievements of the previously discussed milestone concepts.

- **Abstract:**
Starting from contemporary biological problems related to metabolism, the course focuses on systems biological approaches to address them. In a problem-oriented, this-is-how-it-is-done manner, we thereby teach modern methods and concepts.

- **Objective:**
Develop a deeper understanding of how relevant biological problems can be solved, thereby providing advanced insights to key experimental and computational methods in systems biology.

- **Content:**
The course will be given as a mixture of lectures, studies of original research and guided discussions that focus on current research topics. For each particular problem studied, we will work out how the various methods work and what their capabilities/limits are. The problem areas range from microbial metabolism to cancer cell metabolism and from metabolic networks to regulation networks in populations and single cells. Key methods to be covered are various modeling approaches, metabolic flux analyses, metabolomics and other omics.

- **Lecture notes:**
Script and original publications will be supplied during the course.

- **Literature:**
Lectureunterlagen werden vor Beginn des Kurses auf folgender website zugänglich sein: Moodle Course https://moodle-2V

- **Prerequisites / notice:**
The course extends many of the generally introduced concepts and methods of the Concept Course in Systems Biology. It requires a good knowledge of biochemistry and basics of mathematics and chemistry.

- **551-1171-00L**  
Immunology: from Milestones to Current Topics

- **Prerequisites / notice:**

- **Abstract:**
Milestones in Immunology: on old concepts and modern experiments

- **Objective:**
The course will cover six grand topics in immunology (B cells, innate immunity, antigen presentation, tumor immunity, thymus and T cells, cytotoxic T cells and NK cells) and for each grand topic four hours will be allocated. During the first double hour, historical milestone papers will be presented by the supervisor providing an overview on the development of the conceptual framework and critical technological advances. The students will also prepare themselves for this double lecture by reading the historical milestone papers and contributing to the discussion. In the following lecture up to four students will present each a recent high impact research paper which emerged from the landmark achievements of the previously discussed milestone concepts.

- **Content:**
Milestones and current topics of innate immunity, antigen presenting, B cells, thymus and T cells, cytotoxic T cells and NK cells, and tumor immunology.

- **Lecture notes:**
Original and review articles will be distributed by the lecturer.

- **Literature:**
Lecturerunterlagen werden vor Beginn des Kurses auf folgender website zugänglich sein: Moodle Course https://moodle-app2.let.ethz.ch/course/view.php?id=1002

- **551-1303-00L**  
Cellular Biochemistry of Health and Disease

- **Prerequisites / notice:**
The literature will be provided during the course.

- **Abstract:**
During this Masters level seminar style course, students will explore current research topics in cellular biochemistry focused on the structure, function and regulation of selected cell components, and the consequences of dysregulation for pathologies.

- **Objective:**
Students will work with experts toward a critical analysis of cutting-edge research in the domain of cellular biochemistry, with emphasis on normal cellular processes and the consequences of their dysregulation. At the end of the course, students will be able to introduce, present, evaluate, critically discuss and write about recent scientific articles in the research area of cellular biochemistry.

- **Content:**
Guided by an expert in the field, students will engage in classical round-table style discussions of current literature with occasional frontal presentations. Students will alternate as discussion leaders throughout the semester, with the student leader responsible to briefly summarize key general knowledge and context of the assigned primary research paper. Together with the faculty expert, all students will participate in discussion of the primary paper, including the foundation of the biological question, specific questions addressed, key methods, key results, remaining gaps and research implications.

- **Literature:**
The literature will be provided during the course.

- **Prerequisites / notice:**
The course will be taught in English.

- **551-1323-00L**  
Fundamentals of Biology II: Biochemistry and Molecular Biology

- **Prerequisites / notice:**
The course provides an introduction to Biochemistry / Molecular Biology with some emphasis on chemical and biophysical aspects.

- **Abstract:**
Topics include the structure-function relationship of proteins / nucleic acids, protein folding, enzymatic catalysis, cellular pathways involved in bioenergetics and the biosynthesis and breakdown of amino acids, glycans, nucleotides, fatty acids and phospholipids, and steroids. There will also be a discussion of DNA replication and repair, transcription, and translation.

- **Objective:**
Some of the lectures are given in the English language.
The aim of the course is to provide up-to-date knowledge on how we can study biological processes using genetic sequencing data. Synthetic Biology II

Objective
1. Insight Into The Mammalian Cell Cycle. Cycling, The Balance Between Proliferation and Cancer - Implications For Biopharmaceutical Manufacturing.
2. The Licence To Kill. Apoptosis Regulatory Networks - Engineered Survival Pathways To Increase Robustness of Production Cell Lines.
5. From Target To Market. An Antibody's Journey From Cell Culture to The Clinics.
6. Development of Biological Weapons?
7. Functional Food. Enjoy your Meal!

The students are supposed to acquire a deep understanding of the process of biological design including model representation of a biological system, its thorough analysis, and the subsequent experimental implementation of the system and the related problems. Results are presented at an international student competition at the MIT (Cambridge).

Preparatory course:
The students are supposed to acquire a deep understanding of the process of biological design including model representation of the system and the related problems.

Computational Biology

Objective
Attendees will learn which information is contained in genetic sequencing data and how to extract information from them using computational tools. The main concepts introduced are:
- stochastic models in molecular evolution
- phylogenetic & phylodynamic inference
- * maximum likelihood and Bayesian statistics

Attendees will apply these concepts to a number of applications yielding biological insight into:
- * epidemiology
- * pathogen evolution
- * macroevolution of species

Content
The course consists of four parts. We first introduce modern genetic sequencing technology, and algorithms to obtain sequence alignments from the output of the sequencers. We then present methods to directly analyze this alignment (such as BLAST algorithm, GWAS approaches). Second, we introduce methods and mechanisms of molecular evolution, i.e. we discuss how genetic sequences change over time. Third, we employ evolutionary concepts to infer ancestral relationships between organisms based on their genetic sequences, i.e. we discuss methods to infer geneologies and phylogenies. We finally introduce the field of phyloodynamics. The aim of that field is to understand and quantify the population dynamic processes (such as transmission in epidemiology or speciation & extinction in macroevolution) based on a phylogeny. Throughout the class, the models and methods are illustrated on different datasets giving insight into the epidemiology and evolution of a range of infectious diseases (e.g. HIV, HCV, influenza, Ebola). Applications of the methods to the field of macroevolution provide insight into the evolution and ecology of different species clades. Students will be trained in the algorithms and their application both on paper and in silico as part of the exercises.

Prerequisites / notice
Basic knowledge in linear algebra, analysis, and statistics will be helpful. Some programming experience will be useful for the exercises, but is not required. Programming skills will not be tested in the examination.

Synthetic Biology II

Objective
The students are supposed to acquire a deep understanding of the process of biological design including model representation of a biological system, its thorough analysis, and the subsequent experimental implementation of the system and the related problems. Results are presented at an international student competition at the MIT (Cambridge).

Content
Presentations on advanced synthetic biology topics (eg genetic circuit design, adaptation of systems dynamics, analytical concepts, large scale de novo DNA synthesis), project selection, modeling of selected biological system, design space exploration, sensitivity analysis, conversion into DNA sequence, (DNA synthesis external) implementation and analysis of design, summary of results in form of scientific presentation and poster, presentation of results at the iGEM international student competition (www.igem.org).

Prerequisites / notice
The final presentation of the project is typically at the MIT (Cambridge, US). Other competing schools include regularly Imperial College, Cambridge University, Harvard University, UC Berkeley, Princeton University, CalTech, etc.

This project takes place between end of Spring Semester and beginning of Autumn Semester. Registration in April.

Please note that the number of ECTS credits and the actual work load are disconnected.

Evolutionary Medicine for Infectious Diseases

Objective
Students will learn to (i) identify evolutionary explanations for the origins and characteristics of infectious diseases in a range of organisms and (ii) evaluate ways of integrating evolutionary thinking into improved strategies for treating infections of humans and animals. This will incorporate principles that apply across any host-pathogen interaction, as well as system-specific mechanistic information, with particular emphasis on bacteria and viruses.

Content
We will cover several topics where evolutionary thinking is relevant to understanding or treating infectious diseases. This includes: (i) determinants of pathogen host-range and virulence, (ii) pathogen adaptation to evade or suppress immune responses, (iv) antimicrobial resistance, (v) evolution-proof medicine. For each topic there will be a short (~30 minutes) introductory lecture, before students independently research the primary literature and develop half a page of discussion points and questions, followed by interactive discussion in class.

Biological Engineering and Biotechnology

Objective
Biological Engineering and Biotechnology will cover the latest biotechnological advances as well as their industrial implementation to engineer mammalian cells for use in human therapy. This lecture will provide forefront insights into key scientific aspects and the main points in industrial decision-making to bring a therapeutic from target to market.

Synthetic Biology II

Presentations on advanced synthetic biology topics (eg genetic circuit design, adaptation of systems dynamics, analytical concepts, large scale de novo DNA synthesis), project selection, modeling of selected biological system, design space exploration, sensitivity analysis, conversion into DNA sequence, (DNA synthesis external) implementation and analysis of design, summary of results in form of scientific presentation and poster, presentation of results at the iGEM international student competition (www.igem.org).

Prerequisites / notice
Basic knowledge in linear algebra, analysis, and statistics will be helpful. Some programming experience will be useful for the exercises, but is not required. Programming skills will not be tested in the examination.

Computational Biology

Objective
The aim of the course is to provide up-to-date knowledge on how we can study biological processes using genetic sequencing data. Computational algorithms extracting biological information from genetic sequence data are discussed, and statistical tools to understand this information in detail are introduced.

Content
The course is based on any of the textbooks below, but they are excellent choices as accompanying material:
- * Drummond, A. & Bouckaert, R. 2015. Bayesian evolutionary analysis with BEAST

Prerequisites / notice
Basic knowledge in linear algebra, analysis, and statistics will be helpful. Some programming experience will be useful for the exercises, but is not required. Programming skills will not be tested in the examination.
Students will read the primary literature on each topic, and in places we will use the following books:

- Schmid Hempel 2011 *Evolutionary Parasitology*
- Stearns & Medzhitov 2016 *Evolutionary Medicine*

A basic understanding of evolutionary biology, microbiology or parasitology will be advantageous but is not essential.

### 752-4000-09L Molecular Biology of Foodborne Pathogens

<table>
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<tr>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>M. Loesner, M. Schuppler</td>
</tr>
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</table>

**Abstract**
The course offers detailed information on selected foodborne pathogens and toxin producing organisms; the focus lies on relevant molecular biological aspects of pathogenicity and virulence, as well as on the occurrence and survival of these organisms in foods.

**Objective**
Detailed and current status of research and insights into the molecular basis of foodborne diseases, with focus on interactions of the microorganism or the toxins they produce with the human system. Understanding the relationship between specific types of food and the associated pathogenic microorganisms may lead to microbial risks. Another focus lies on the currently available methods and techniques useful for the various purposes, i.e., detection, differentiation (typing), and antimicrobial agents.

**Content**
Molecular biology of infectious foodborne pathogens (Listeria, Vibrio, E. coli, Campylobacter, etc) and toxin-producing organisms (Bacillus, Clostridium, Staphylococcus). How and under which conditions will toxins and virulence factors be produced, and how do they work? How is the interaction between the human host and the microbial pathogen? What are the roles of food and the environment? What can be done to interfere with the potential risks? Which methods are best suited for what approach? Last, but not least, the role of bacteriophages in microbial pathogenicity will be highlighted, in addition to various applications of bacteriophage for both diagnostics and antimicrobial intervention.

**Lecture notes / literature**
Electronic copies of the presentation slides (PDF) and additional material will be made available for download to registered students.

**Prerequisites**
Lectures (2 hours) will be held as a single session of approximately 60+ minutes (10:15 until approx. 11:15 h), with no break!

### 752-6101-00L Dietary Etiologies of Chronic Disease

<table>
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<th>Type</th>
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<tbody>
<tr>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>M. B. Zimmermann</td>
</tr>
</tbody>
</table>

**Abstract**
To have the student gain understanding of the links between the diet and the etiology and progression of chronic diseases, including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

**Objective**
To examine and understand the protective effect of foods and food ingredients in the maintenance of health and the prevention of chronic disease, as well as the progression of complications of the chronic diseases.

**Content**
The course evaluates food and food ingredients in relation to primary and secondary prevention of chronic diseases including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

**Lecture notes / literature**
There is no script. Powerpoint presentations will be made available on-line to students.

**Prerequisites**
To be provided by the individual lecturers, at their discretion.

### 752-6105-00L Epidemiology and Prevention

<table>
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<th>Type</th>
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<tbody>
<tr>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>M. Puhan, R. Heusser</td>
</tr>
</tbody>
</table>

**Abstract**
The Module Epidemiology and prevention describes the process of scientific discovery from the detection of a disease and its causes, to the development and evaluation of preventive and treatment interventions and to improved population health.

**Objective**
The overall goal of the course is to introduce students to epidemiological thinking and methods, which are critical pillars for medical and public health research. Students will also become aware on how epidemiological facts are used in prevention, practice and politics.

**Content**
The module Epidemiology and prevention follows an overall framework that describes the course of scientific discovery from the detection of a disease to the development of prevention and treatment interventions and their evaluation in clinical trials and real world settings. We will discuss study designs in the context of existing knowledge and the type of evidence needed to advance knowledge. Examples form nutrition, chronic and infectious diseases will be used in order to show the underlying concepts and methods.

### Major in Neurosciences

#### Compulsory Courses

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>376-0300-00L</td>
<td>Translational Science for Health and Medicine</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>J. Goldhahn, C. Wolfrum</td>
</tr>
</tbody>
</table>

**Abstract**
Translational science is a cross disciplinary scientific research that is motivated by the need for practical applications that help people. The course should help to clarify basics of translational science, illustrate successful applications and should enable students to integrate key features into their future projects.

**Objective**
After completing this course, students will be able to understand:
- Principles of translational science (including project planning, ethics application, basics of resource management and interdisciplinary communication)

**Content**
- What is translational science and what is it not?
- How to identify need?
- Disease concepts and consequences for research
- Basics about incidence, prevalence etc., and orphan indications
- How to choose the appropriate research type and methodology
- Ethical considerations including ethics application
- Pros and cons of different types of research
- Coordination of complex approaches incl. timing and resources
- How to measure success?
- Outcome variables
- Improving the translational process
- Challenges of communication?
- How independent is translational science?
- Academic boundary conditions vs. industrial influences
- Positive and negative examples will be illustrated by distinguished guest speakers.

#### Electives
Overview of the most important concepts of image formation, perception and analysis, and Computer Vision. Gaining own experience

### Elective Courses I

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-1305-00L</td>
<td>Development of the Nervous System</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>E. Stoeckli, further lecturers</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course covers the development of the nervous system (NS) with a focus on neurogenesis and migration, axon growth, synapse formation, mol. &amp; cell. mechanisms, and diseases of the developing NS.</td>
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<tr>
<td>Objective</td>
<td>The aim is to give a deepened insight on the normal development, of the nervous system based on molecular, cellular and biochemical approaches.</td>
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<tr>
<td>Content</td>
<td>The main focus is on the development of the NS: Early development of the NS, cellular processes, nerve fiber growth, building of synapses and neuronal networks.</td>
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<tr>
<td>Lecture notes</td>
<td>Must be downloaded from OLAT: <a href="https://www.olat.uzh.ch/olat/dmz/">https://www.olat.uzh.ch/olat/dmz/</a> as BIO344</td>
<td></td>
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<tr>
<td>Literature</td>
<td>The lecture requires reading of book chapters, handouts and original scientific papers. Further information will be given in the individual lectures and are mentioned on OLAT.</td>
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<tr>
<td>Prerequisites/notice</td>
<td>Auxiliary tools: None. Bring something to write and your student ID</td>
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</tbody>
</table>

| 376-1305-01L | Structure, Plasticity and Repair of the Nervous System | W    | 3    | 2V    | M. E. Schwab, L. Fili, K. A. Martin, further lecturers |
| Abstract     | The course covers the structure, plasticity and regeneration of the adult nervous system (NS) with focus on: sensory systems, cognitive functions, learning and memory, molecular and cellular mechanisms, animal models, and diseases of the NS. |
| Objective    | The aim is to give a deepened insight into the structure, plasticity and regeneration of the nervous system based on molecular, cellular and biochemical approaches. |
| Content      | The main focus is on the structure, plasticity and regeneration of the NS: biology of the adult nervous system; structural plasticity of the adult nervous system, regeneration and repair: networks and nerve fibers, regeneration, pathological loss of cells. |
| Lecture notes| ETH students: Lecture notes will be provided on Moodle https://moodle-app2.let.ethz.ch/course/view.php?id=694 |
| Literature   | Password will be provided at the beginning of the lecture. |

| 551-0309-00L | Concepts in Modern Genetics                       | W    | 6    | 4V    | Y. Barral, D. Bopp, A. Hajnal, M. Stoffel, O. Voinnet |
| Abstract     | Concepts of modern genetics and genomics, including principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference. |
| Objective    | This course focuses on the concepts of classical and modern genetics and genomics. |
| Content      | The topics include principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference. |
| Lecture notes| Scripts and additional material will be provided during the semester. |
| Prerequisites/notice| This course is a co-production of the University of Zurich and ETH Zurich, and will be taught in English. The course takes place on Monday afternoon at ETH Hoenggerberg, and on Tuesday morning at UZH Irchel. |

### Elective Courses II

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0104-00L</td>
<td>Uncertainty Quantification for Engineering &amp; Life Sciences</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>P. Koumoutsakos</td>
</tr>
<tr>
<td>Abstract</td>
<td>Quantification of uncertainties in computational models pertaining to applications in engineering and life sciences. Exploitation of massively available data to develop computational models with quantifiable predictive capabilities. Applications of Uncertainty Quantification and Propagation to problems in mechanics, control, systems and cell biology.</td>
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<tr>
<td>Objective</td>
<td>This course focuses on the concepts of classical and modern genetics and genomics.</td>
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<tr>
<td>Content</td>
<td>Topics that will be covered include: Uncertainty quantification under parametric and non-parametric modelling uncertainty, Bayesian inference with model class assessment, Markov Chain Monte Carlo simulation, prior and posterior reliability analysis.</td>
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<tr>
<td>Lecture notes</td>
<td>The class will be largely based on the book: Data Analysis: A Bayesian Tutorial by Devinderjit Sivia as well as on class notes and related literature that will be distributed in class.</td>
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<tr>
<td>Literature</td>
<td>1. Data Analysis: A Bayesian Tutorial by Devinderjit Sivia</td>
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<tr>
<td></td>
<td>2. Probability Theory: The Logic of Science by E. T. Jaynes</td>
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<td></td>
<td>3. Class Notes</td>
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<tr>
<td>Prerequisites/notice</td>
<td>Fundamentals of Probability, Fundamentals of Computational Modeling</td>
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</table>

| 227-0447-00L | Image Analysis and Computer Vision                 | W    | 6    | 3V+1U | L. Van Gool, O. Göksel, E. Konukoglu |
| Objective    | Overview of the most important concepts of image formation, perception and analysis, and Computer Vision. Gaining own experience through practical computer and programming exercises. |

Data: 06.03.2019 12:57 Autumn Semester 2016 Page 782 of 1571
The first part of the course starts off from an overview of existing and emerging applications that need computer vision. It shows that the realm of image processing is no longer restricted to the factory floor, but is entering several fields of our daily life. First it is investigated how the parameters of the electromagnetic waves are related to our perception. Also the interaction of light with matter is considered. The most important hardware components of technical vision systems, such as cameras, optical devices and illumination sources are discussed. The course then turns to the steps that are necessary to arrive at a high quality and reliable image of the target. The pre-processing steps of image analysis, that enhance image quality and/or detect specific features. Linear and non-linear filters are introduced for that purpose. The course will continue by analyzing procedures allowing to extract additional types of basic information from multiple images, with motion and depth as two important examples. The estimation of image velocities (optical flow) will get due attention and methods for object tracking will be presented. Several current applications and trends about objects and scenes. Finally, approaches for the recognition of specific objects as well as object classes will be discussed and analyzed.

**Lecture notes**
Course material Script, computer demonstrations, exercises and problem solutions

**Prerequisites**

- **Prerequisites:**
  - Basic concepts of mathematical analysis and linear algebra. The computer exercises are based on Linux and C.

- **The course language is English.**

---

**227-1037-00L**

**Introduction to Neuroinformatics**

<table>
<thead>
<tr>
<th>W</th>
<th>6 credits</th>
<th>2V+1U</th>
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</thead>
<tbody>
<tr>
<td>K. A. Martin, M. Cook, V. Mante, M. Pfeiffer</td>
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</tbody>
</table>

**Abstract**

The course provides an introduction to the functional properties of neurons. Particularly the description of membrane electrical properties (action potentials, channels), neuronal anatomy, synaptic structures, and neuronal networks. Simple models of computation, learning, and behavior will be explained. Some artificial systems (robot, chip) are presented.

**Objective**

Understanding computation by neurons and neuronal circuits is one of the great challenges of science. Many different disciplines can contribute their tools and concepts to solving mysteries of neural computation. The goal of this introductory course is to introduce the monochromes of physics, maths, computer science, engineering, biology, psychology, and even philosophy and history, to discover the enchemist and challenges that we face in taking on this major 21st century problem and how each discipline can contribute to discovering solutions.

**Content**

This course considers the structure and function of biological neural networks at different levels. The function of neural networks lies fundamentally in their wiring and in the electro-chemical properties of nerve cell membranes. Thus, the biological structure of the nerve cell needs to be understood if biologically-realistic models are to be constructed. These simpler models are used to estimate the electrical current flow through dendritic cables and explore how a more complex geometry of neurons influences this current flow. The active properties of nerves are studied and the scientists attempt to understand both sensory transduction and the generation of nerve impulses along axons. The concept of local neuronal circuits arises in the context of the rules governing the formation of nerve connections and theognic projections within the nervous system. Communication between neurons in the network can be thought of as information flow across synapses, which can be modified by experience. We need an understanding of the action of inhibitory and excitatory neurotransmitters and neuromodulators, so that the dynamics of the synapses can be understood. Finally, the neural architectures of feedforward and recurrent networks will be discussed in the context of co-ordination, control, and integration of sensory and motor information in neural networks.

---

**227-1045-00L**

**Readings in Neuroinformatics (University of Zurich)**

*W* 3 credits

G. Indiveri, M. Cook, D. Kiper

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.

**UZH Module Code:** IN447

**Abstract**

Thirteen major areas of research have been selected, which cover the key concepts that have led to our current ideas of how the nervous system is built and functions. We will read both original papers and explore the conceptual links between them and discuss the 'sociology' of science, the pursuit of basic science questions over a century of research.

**Objective**

It is a commonplace that scientists rarely cite literature that is older than 10 years and when they do, they usually cite one paper that serves as the representative for a larger body of work that has long since been incorporated anonymously in textbooks. Worse than that, many authors have not even read the papers they cite in their own publications. This course, Foundations of Neuroscience is one antidote.

Thirteen major areas of research have been selected, which cover the key concepts that have led to our current ideas of how the nervous system is built and functions. Unusually, we will explore these areas of research by reading the original publications, instead of reading someone else's digested summary from a textbook or a review. By doing this, we will learn how the discoveries were made, what instrumentation was used, how the scientists interpreted their own findings, and how their work, often over many decades and links together with related findings from many different scientists, generate the current views of mechanisms and structure of the nervous system.

To give one concrete example, in 1890 Roy and Sherrington showed that there was a neural activity-dependent regulation of blood flow in the brain. One hundred years later, Ogawa discovered that they could use Nuclear Magnetic Resonance (NMR) to measure a blood oxygen-level dependent (BOLD) signal, which they showed was neural activity-dependent. This discovery led to the development of human functional Magnetic Resonance Imaging (fMRI), which has revolutionized neuropsychology and neuropsychiatry. We will read both these original papers and explore the conceptual links between them and discuss the sociology of science, which in this case, the pursuit of basic science questions over a century of research, led to an explosion in applications. We will also explore the personalities of the scientists and the context in which they made their seminal discoveries. Each week the course members will be given original papers to read for homework, they will have to write a short abstract for each paper. We will then meet weekly with the course leader (KACM) and an assistant for an hour-or-so long interactive seminar. An intimate knowledge of the papers will be assumed so that the discussion does not center simply on an explication of the contents of the papers. Assessment will in the form of a written exam in which the students will be given a paper and asked to write a short abstract of the contents.

**Content**

It is a commonplace that scientists rarely cite literature that is older than 10 years and when they do, they usually cite one paper that serves as the representative for a larger body of work that has long since been incorporated anonymously in textbooks. Worse than that, many authors have not even read the papers they cite in their own publications. This course, Foundations of Neuroscience is one antidote.

Thirteen major areas of research have been selected, which cover the key concepts that have led to our current ideas of how the nervous system is built and functions. Unusually, we will explore these areas of research by reading the original publications, instead of reading someone else’s digested summary from a textbook or review. By doing this, we will learn how the discoveries were made, what instrumentation was used, how the scientists interpreted their own findings, and how their work, often over many decades and links together with related findings from many different scientists, generate the current views of mechanisms and structure of the nervous system. To give one concrete example, in 1890 Roy and Sherrington showed that there was a neural activity-dependent regulation of blood flow in the brain. One hundred years later, Ogawa discovered that they could use Nuclear Magnetic Resonance (NMR) to measure a blood oxygen-level dependent (BOLD) signal, which they showed was neural activity-dependent. This discovery led to the development of human functional Magnetic Resonance Imaging (fMRI), which has revolutionized neuropsychology and neuropsychiatry. We will read both these original papers and explore the conceptual links between them and discuss the sociology of science, which in this case, the pursuit of basic science questions over a century of research, led to an explosion in applications. Each week the course members will be given original papers to read for homework, they will have to write a short abstract for each paper. We will then meet weekly with the course leader (KACM) and an assistant for an hour-or-so long interactive seminar. An intimate knowledge of the papers will be assumed so that the discussion does not center simply on an explication of the contents of the papers. Assessment will in the form of a written exam in which the students will be given a paper and asked to write a short abstract of the contents.

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**227-1047-00L**

**Consciousness: From Philosophy to Neuroscience**

*W* 3 credits

D. Kiper, A. Gamma
This seminar reviews the philosophical and phenomenological as well as the neurobiological aspects of consciousness. The subjective features of consciousness are explored, and modern research into its neural substrate, particularly in the visual domain, is explained. Emphasis is placed on students developing their own thinking through a discussion-centered course structure.

The introductory course on Scanning Electron Microscopy (SEM) emphasizes hands-on learning. Using 2 SEM instruments, students have the opportunity to study their own samples, or standard test samples, as well as solving exercises provided by ScopeM scientists.

The course's goal is to give an overview of the contemporary state of consciousness research, with emphasis on the contributions brought by modern cognitive neuroscience. We aim to clarify concepts, explain their philosophical and scientific backgrounds, and to present experimental protocols that shed light on a variety of consciousness related issues.

The course includes discussions of scientific as well as philosophical articles. We review current schools of thought, models of consciousness, and proposals for the neural correlate of consciousness (NCC).

Since we are all experts on consciousness, we expect active participation and discussions!

**Microscopy Training SEM I - Introduction to SEM**

**Number of participants limited to 6.**

The participants will be chosen based on a short motivation letter. Please send this letter to S. Rodighiero (main lecturer) as soon as possible.

**Microscopy Training TEM I - Introduction to TEM**

Does not take place this semester.

Number of participants limited to 6.

The participants will be chosen based on a short motivation letter. Please send this letter to S. Rodighiero (main lecturer).

**Objective**

- Set-up, align and operate a TEM successfully and safely.
- Accomplish imaging tasks successfully and optimize microscope performances.
- Master the operation of a low-vacuum and field-emission SEM and EDX instrument.
- Perform sample preparation with corresponding techniques and equipment for imaging and analysis.
- Acquire techniques in obtaining secondary electron and backscatter electron micrographs.
- Perform EDX qualitative and semi-quantitative analysis.

**Content**

During the course, students learn through lectures, demonstrations, and hands-on sessions how to setup and operate SEM instruments, including low-vacuum and low-voltage applications.

This course gives basic skills for students new to SEM. At the end of the course, students with no prior experience are able to align a SEM, to obtain secondary electron (SE) and backscatter electron (BSE) micrographs, and to perform energy dispersive X-ray spectroscopy (EDX) qualitative and semi-quantitative analysis. The procedures to better utilize SEM to solve practical problems and to optimize SEM analysis for a wide range of materials will be emphasized.

- Discussion of students' sample/interest.
- Introduction and discussion on Electron Microscopy and instrumentation.
- Lectures on electron sources, electron lenses and probe formation.
- Lectures on beam/specimen interaction, image formation, image contrast and imaging modes.
- Lectures on sample preparation techniques for EM.
- Brief description and demonstration of the SEM microscope.
- Practice on beam/specimen interaction, image formation, image contrast (and image processing).
- Student participation on sample preparation techniques.
- Scanning Electron Microscopy lab exercises: setup and operate the instrument under various imaging modalities.
- Lectures and demonstrations on X-ray micro-analysis (theory and detection), qualitative and semi-quantitative EDX and point analysis, linescans and spectral mapping.
- Practice on real-world samples and report results.

**Literature**

- Detailed course manual.

No mandatory prerequisites. Please consider the prior attendance to EM Basic lectures (551-1618-00V; 227-0390-00L; 327-0703-00L) as suggested prerequisite.
Applications of Cybernetics in Ergonomics

M. Menozzi Jäckli

Every day humans interact with various systems. Strategies of interaction, individual needs, physical & mental abilities, and system

The goal of the lecture is to empower students in better understanding the applied theories, principles, and methods in various applications.

By the end of the course students are able to plan, draft, and edit academic English papers and theses; structure and write clear texts in a

We'll prepare you to produce your MSc thesis. You'll learn how to structure your thesis, write scientific English, and manage your writing

Writing your Master's Thesis: Natural Sciences and

M. Menozzi Jäckli

3P

- Physiological, physical, and cognitive factors in sensation and perception
- Experimental techniques in assessing human performance and well-being
- Human factors and ergonomics in system designs, product development and innovation
- Human information processing and biological cybernetics
- Interaction among consumers, environments, behavior, and tasks

Literature:
- Gavriel Salvendy, Handbook of Human Factors and Ergonomics, 4th edition (2012), is available on NEBIS as electronic version and for

Number of participants limited to 15 (3 courses are available).

Attention: Registration is only possible from 12.9. (from 11.30h) - 15.9.2016

Abstract
We'll prepare you to produce your MSc thesis. You'll learn how to structure your thesis, write scientific English, and manage your writing efficiently. You'll receive detailed feedback on work in progress.

Objective
By the end of the course students are able to plan, draft, and edit academic English papers and theses; structure and write clear texts in a style which is acceptable to their academic discourse community; manage the writing process efficiently; select formal vocabulary and use it in a generally accurate and correct manner; choose and use generally suitable grammatical structures, punctuation, and orthographic conventions, assess their own effectiveness as writers of academic English, and identify areas in which further development is needed.

Content
The course covers the writing context; the writing process; structuring sentences, paragraphs, longer sections (such as introduction, methods, results, and discussion), and whole texts; presenting and integrating non-textual elements such as graphs and tables; and editing and correcting drafts and proofs. Each lesson comprises a mixture of elements, including specialist input, individual tasks, pairwork, and groupwork. Active participation is expected.

Number of participants limited to 18


- Practice on beam/specimen interaction, image formation, image contrast (and image processing).
- Demonstration of Transmission Electron Microscopes and imaging modes (Phase contrast, BF, DF, STEM).
- Student participation on sample preparation techniques.
- Transmission Electron Microscopy lab exercises: setup and operate the instrument under various imaging modalities.
- TEM alignment, calibration, correction to improve image contrast and quality.
- Electron diffraction.
- Practice on real-world samples and report results.

Prerequisites / notice
No mandatory prerequisites. Please consider the prior attendance to EM Basic lectures (551-1618-00V; 227-0390-00L; 327-0703-00L) as suggested prerequisite.

376-2221-00L Methods and Concepts in Human Systems Neuroscience and Motor Control

Number of participants limited to 18

S. Milligan

Number of participants limited to 18 (3 courses are available).

Objective
This course will prepare students for experimental work as it is typically done for the master thesis. The goal is to gain hands-on experience with measurement and analysis methods relevant for Humans Systems Neuroscience and Motor control (for example peripheral nerve stimulation, electrical and magnetic brain stimulation, EMG, EEG, psycho-physical paradigms etc). Students learn scientific material, set up experiments, perform measurements in the lab, analyse data, apply statistics and write short reports or essays.

Content
Course participants will: Apply basic statistics and acquire knowledge of applied statistics. Self-study material about applied statistics will be available at the beginning of the course and statistical knowledge will be tested (central element) in the second course week. Passing this test is a requirement for continuing the course.

Students will have to solve scientific problems, requiring them to independently study scientific material, apply statistics and report their results in the form of written reports and essays. Assessments will be made on the basis of the completed theoretical and practical work that will be performed either in small groups or individually.

376-0815-00L Writing your Master's Thesis: Natural Sciences and Engineering C1-C2

Does not take place this semester.

Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.uzh.ch).

S. Milligan

Number of participants limited to 15 (3 courses are available).

Abstract
We'll prepare you to produce your MSc thesis. You'll learn how to structure your thesis, write scientific English, and manage your writing efficiently. You'll receive detailed feedback on work in progress.

Objective
By the end of the course students are able to plan, draft, and edit academic English papers and theses; structure and write clear texts in a style which is acceptable to their academic discourse community; manage the writing process efficiently; select formal vocabulary and use it in a generally accurate and correct manner; choose and use generally suitable grammatical structures, punctuation, and orthographic conventions, assess their own effectiveness as writers of academic English, and identify areas in which further development is needed.

Content
The course covers the writing context; the writing process; structuring sentences, paragraphs, longer sections (such as introduction, methods, results, and discussion), and whole texts; presenting and integrating non-textual elements such as graphs and tables; and editing and correcting drafts and proofs. Each lesson comprises a mixture of elements, including specialist input, individual tasks, pairwork, and groupwork. Active participation is expected.

376-1177-00L Applications of Cybernetics in Ergonomics

W 1 credit

M. Menozzi Jäckli

Y.Y. Hedinger Huang, R. Huang

- Introduction and discussion on Electron Microscopy and instrumentation.
- Lectures on electron sources, electron lenses and probe formation.
- Lectures on beam/specimen interaction, image formation, image contrast and imaging modes.
- Lectures on sample preparation techniques for EM.
- Brief description and demonstration of the TEM microscope.
- Practice on beam/specimen interaction, image formation, Image contrast (and image processing).
- Demonstration of Transmission Electron Microscopes and imaging modes (Phase contrast, BF, DF, STEM).
- Student participation on sample preparation techniques.
- Transmission Electron Microscopy lab exercises: setup and operate the instrument under various imaging modalities.
- TEM alignment, calibration, correction to improve image contrast and quality.
- Electron diffraction.
- Practice on real-world samples and report results.

Prerequisites / notice
No mandatory prerequisites. Please consider the prior attendance to EM Basic lectures (551-1618-00V; 227-0390-00L; 327-0703-00L) as suggested prerequisite.

376-1177-00L Applications of Cybernetics in Ergonomics

W 1 credit

M. Menozzi Jäckli

Y.Y. Hedinger Huang, R. Huang

- Data: 06.03.2019 12:57
- Autumn Semester 2016
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Abstract
Cybernetics systems have been studied and applied in various research fields, such as applications in the ergonomics domain. Research interests include the man-machine interaction (MMI) topic which involving the performance in multi-model interactions, quantification in gestalt principles in product development; or the information processing matter.

Objective
To learn and practice cybernetics principles in interface designs and product development.

Content
- Fitt's law applied in manipulation tasks
- Hick-Hyman law applied in design of the driver assistance systems - Vigilance applied in quality inspection
- Accommodation/vergence crosslink function
- Cross-link models in neurobiology- the ocular motor control system
- Human performance in optimization of production lines

Literature

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Type</th>
<th>Credits</th>
<th>Lecture</th>
<th>Laboratory</th>
<th>Literature</th>
</tr>
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<tbody>
<tr>
<td>376-1414-00L</td>
<td>Current Topics in Brain Research (HS)</td>
<td>W</td>
<td>1</td>
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</table>

Abstract
Different national and international scientific guests are invited to present and discuss their actual scientific results.

Objective
To exchange scientific knowledge and data and to promote communication and collaborations among researchers.

Content
Different scientific guests working in the field of molecular cognition, neurochemistry, neuromorphology and neurophysiology present their latest scientific results.

Lecture notes
no handout

Literature
no literature

376-1504-00L Physical Human Robot Interaction (pHRI)  ■ W 4 credits 2V+2U R. Gassert, O. Lambercy

Number of participants limited to 26.

Abstract
This course focuses on the emerging, interdisciplinary field of physical human-robot interaction, bringing together themes from robotics, real-time control, human factors, haptics, virtual environments, interaction design and other fields to enable the development of human-oriented robotic systems.

Objective
The objective of this course is to give an introduction to the fundamentals of physical human robot interaction, through lectures on the underlying theoretical/mechatronics aspects and application fields, in combination with a hands-on lab tutorial. The course will guide students through the design and evaluation process of such systems.

By the end of this course, you should understand the critical elements in human-robot interactions - both in terms of engineering and human factors - and use these to evaluate and design safe and efficient assistive and rehabilitative robotic systems. Specifically, you should be able to:

1) identify critical human factors in physical human-robot interaction and use these to derive design requirements;
2) compare and select mechatronic components that optimally fulfill the defined design requirements;
3) derive a model of the device dynamics to guide and optimize the selection and integration of selected components into a functional system;
4) design control hardware and software and implement and test human-interactive control strategies on the physical setup;
5) characterize and optimize such systems using both engineering and psychophysical evaluation metrics;
6) investigate and optimize one aspect of the physical system in a lab setting and defend the gained insights in a technical presentation.

Content
This course provides an introduction to fundamental aspects of physical human-robot interaction. After an overview of human haptic, visual and auditory sensing, neurophysiology and psychophysics, principles of human-robot interaction systems (kinematics, mechanical transmissions, robot sensors and actuators) will be introduced. Throughout the course, students will gain knowledge of interaction control strategies including impedance/admittance and force control, haptic rendering basics and issues in design for humans such as transparency and stability analysis, safety hardware and procedures. The course is organized into lectures that aim to bring students up to speed with the basics of these systems, readings on classical and current topics in physical human-robot interaction, laboratory sessions and lab visits. Students will attend periodic laboratory sessions where they will implement the theoretical aspects learned during the lectures. Here the salient features of haptic device design will be identified and theoretical aspects will be implemented in a haptic system based on the haptic paddle (http://www.relab.ethz.ch/education/courses/phri/request-ethz-haptic-paddle-hardware-documentation.html), by creating simple dynamic haptic virtual environments and understanding the performance limitations and causes of instabilities (direct/virtual coupling, friction, damping, time delays, sampling rate, sensor quantization, etc.) during rendering of different mechanical properties.

Lecture notes
Will be distributed through the document repository before the lectures.

http://www.relab.ethz.ch/education/courses/phri.html
The full-year course (551-0319-00 & 551-0320-00) focuses on the molecular mechanisms and concepts underlying the biochemistry of

A. Oxenius

Electronic access to the documentation will be provided. The link can be found at "Lernmaterialien"

R. I. Enchev,

W2V Introduction into structural and functional aspects of the immune system.

Introduction into structural and functional aspects of the immune system.


Structural and functional details of individual cell components, regulation of their interactions, and various aspects of the regulation and
cellular processes such as intracellular transport, cytoskeletal rearrangements, cell motility, cell division and

cell growth. In addition, they will be able to illustrate the relevance of particular signaling pathways for cellular pathologies such as cancer.


Proceedings. ICRA '03. IEEE International Conference on, volume 3, pages 3722 - 3728 vol.3.


Prerequisites / notice

Notice:
The registration is limited to 26 students
There are 4 credit points for this lecture.
The lecture will be held in English.
The students are expected to have basic control knowledge from previous classes.
http://www.relab.ethz.ch/education/courses/phri.html

551-0317-00L

Abstract

Introduction into structural and functional aspects of the immune system.

Basic knowledge of the mechanisms and the regulation of an immune response.

Objective

Introduction into structural and functional aspects of the immune system.

Basic knowledge of the mechanisms and the regulation of an immune response.

Content

- Introduction and historical background
- Innate and adaptive immunity, Cells and organs of the immune system
- B cells and antibodies
- Generation of diversity
- Antigen presentation and Major Histocompatibility (MHC) antigens
- Thymus and T cell selection
- Autoimmunity
- Cytotoxic T cells and NK cells
- Th1 and Th2 cells, regulatory T cells
- Allergies
- Hypersensitivities
- Vaccines, immune-therapeutic interventions

Lecture notes

Electronic access to the documentation will be provided. The link can be found at "Lernmaterialien"


Prerequisites / notice

Immunology I (WS) and Immunology II (SS) will be examined as one learning entity in a "Sessionsprüfung".

551-0319-00L

Abstract

Concepts and molecular mechanisms underlying the biochemistry of the cell, providing advanced insights into structure, function and
regulation of individual cell components. Particular emphasis will be put on the spatial and temporal integration of different molecules and
signaling pathways into global cellular processes such as intracellular transport, cell division & growth, and cell migration.

Objective

The full-year course (551-0319-00 & 551-0320-00) focuses on the molecular mechanisms and concepts underlying the biochemistry of
cellular physiology, investigating how these processes are integrated to carry out highly coordinated cellular functions. The molecular
characterisation of complex cellular functions requires a combination of approaches such as biochemistry, but also cell biology and
genetics. This course is therefore the occasion to discuss these techniques and their integration in modern cellular biochemistry.

The students will be able to describe the structural and functional details of individual cell components, and the spatial and temporal
regulation of their interactions. In particular, they will learn to explain the integration of different molecules and signaling pathways into
complex and highly dynamic cellular processes such as intracellular transport, cytoskeletal rearrangements, cell motility, cell division and
cell growth. In addition, they will be able to illustrate the relevance of particular signaling pathways for cellular pathologies such as cancer.

Content

Structural and functional details of individual cell components, regulation of their interactions, and various aspects of the regulation and
compartementalisation of biochemical processes.

Topics include: biophysical and electrical properties of membranes; viral membranes; structural and functional insights into intracellular
transport and targeting; vesicular trafficking and phagocytosis; post-transcriptional regulation of gene expression.

Data: 06.03.2019 12:57
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Practical Training and Semester Project

Practical Training and Semester Project only for majors below-mentioned:

- Human Movement Science and Sport
- Health Technologies
- Molecular Health Sciences
- Neurosciences

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>376-2110-00L</td>
<td>Internship 12 Weeks (Research or Job Oriented)</td>
<td>W</td>
<td>15</td>
<td>34P</td>
<td>Professors</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td>Practical Training Internships are either research-oriented for exercising scientific (laboratory) methods or job-related for giving insight into the future world of work (industry, services, school). Students should exercise scientific working and/or get realistic insights into future jobs. This version of internships lasts for at least 12 weeks full time equivalent.</td>
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<tr>
<td></td>
<td><strong>Objective</strong></td>
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<tr>
<td></td>
<td>Students should exercise scientific working and/or get realistic insights into future jobs.</td>
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<tr>
<td>376-2111-00L</td>
<td>Internship 8 Weeks (Research or Job Oriented)</td>
<td>W</td>
<td>10</td>
<td>23P</td>
<td>Professors</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<tr>
<td></td>
<td>Practical Training Internships are either research-oriented for exercising scientific (laboratory) methods or job-related for giving insight into the future world of work (industry, services, school). Students should exercise scientific working and/or get realistic insights into future jobs. This version of internships lasts for at least 8 weeks full time equivalent.</td>
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<td></td>
<td><strong>Objective</strong></td>
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<tr>
<td></td>
<td>Students should exercise scientific working and/or get realistic insights into future jobs.</td>
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</tr>
<tr>
<td>376-2112-00L</td>
<td>Internship 4 Weeks (Research or Job Oriented)</td>
<td>W</td>
<td>5</td>
<td>11P</td>
<td>Professors</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<tr>
<td></td>
<td>Practical Training Internships are either research-oriented for exercising scientific (laboratory) methods or job-related for giving insight into the future world of work (industry, services, school). Students should exercise scientific working and/or get realistic insights into future jobs.</td>
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<tr>
<td></td>
<td><strong>Objective</strong></td>
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<tr>
<td></td>
<td>Students should exercise scientific working and/or get realistic insights into future jobs.</td>
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</tbody>
</table>

It is strongly recommended to attend the lectures. The lecture (including the handouts) is not designed for distance education.

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Prerequisites / notice
This version of internships lasts for at least 4 weeks full time equivalent.

► GESS Science in Perspective
Recommended Science in Perspective (Type B) for D-HEST.

see Science in Perspective: Type A: Enhancement of Reflection Capability

see Science in Perspective: Language Courses ETH/UZH

► Research Internship

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-2100-00L</td>
<td>Research Internship</td>
<td>O</td>
<td>15</td>
<td>36A</td>
<td>Professors</td>
</tr>
<tr>
<td>Abstract</td>
<td>12-week internship intended for exercising (independent) scientific working.</td>
<td></td>
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<tr>
<td>Objective</td>
<td>Students shall exercise scientific working as preparation for their master thesis.</td>
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</tr>
<tr>
<td>Prerequisites / notice</td>
<td>The Research Internship lasts for at least 12 weeks full time equivalent. It can be combined with the Master Thesis.</td>
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</tbody>
</table>

► Master’s Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-2000-00L</td>
<td>Master’s Thesis</td>
<td>O</td>
<td>30</td>
<td>71D</td>
<td>Supervisors</td>
</tr>
<tr>
<td>Abstract</td>
<td>Only students fulfilling the following criteria can start with their master thesis: a. successful completion of the bachelor programme; b. fulfillment of any additional requirements necessary to gain admission to the master programme.</td>
<td></td>
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<tr>
<td>Objective</td>
<td>The students shall demonstrate their ability to carry out a structured, scientific piece of work independently.</td>
<td></td>
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</tr>
<tr>
<td>Prerequisites / notice</td>
<td>The Master Thesis can only be started after the Bachelor Degree was obtained and/or master admission requirements have been fulfilled.</td>
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</tbody>
</table>

► Course Units for Additional Admission Requirements
The courses below are only for MSc students with additional admission requirements.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>406-0253-AAL</td>
<td>Mathematics I &amp; II</td>
<td>E-</td>
<td>13</td>
<td>28R</td>
<td>A. Cannas da Silva</td>
</tr>
<tr>
<td>Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Abstract</td>
<td>Mathematics I covers mathematical concepts and techniques necessary to model, solve and discuss scientific problems - notably through ordinary differential equations.</td>
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<tr>
<td>Objective</td>
<td>Main focus of Mathematics II: multivariable calculus and partial differential equations.</td>
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</tr>
<tr>
<td>Content</td>
<td>Mathematics is of ever increasing importance to the Natural Sciences and Engineering. The key is the so-called mathematical modelling cycle, i.e. the translation of problems from outside of mathematics into mathematics, the study of the mathematical problems (often with the help of high level mathematical software packages) and the interpretation of the results in the original environment.</td>
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</tr>
<tr>
<td>Literature</td>
<td>The goal of Mathematics I and II is to provide the mathematical foundations relevant for this paradigm. Differential equations are by far the most important tool for modelling and are therefore a main focus of both of these courses.</td>
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</tr>
<tr>
<td>1. Linear Algebra and Complex Numbers: systems of linear equations, Gauss-Jordan elimination, matrices, determinants, eigenvalues and eigenvectors, cartesian and polar forms for complex numbers, complex powers, complex roots, fundamental theorem of algebra.</td>
<td></td>
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</tr>
<tr>
<td>3. Ordinary Differential Equations: separable ordinary differential equations (ODEs), integration by substitution, 1st and 2nd order linear ODEs, homogeneous systems of linear ODEs with constant coefficients, introduction to 2-dimensional dynamical systems.</td>
<td></td>
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</tr>
<tr>
<td>4. Multivariable Differential Calculus: functions of several variables, partial differentiation, curves and surfaces in space, scalar and vector fields, gradient, curl and divergence.</td>
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<tr>
<td>5. Multivariable Integral Calculus: multiple integrals, line and surface integrals, work and flow, Green, Gauss and Stokes theorems, applications.</td>
<td></td>
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</tr>
<tr>
<td>- Bretscher, O.: Linear Algebra with Applications (Pearson Prentice Hall).</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Prerequisites / notice</td>
<td>Prerequisites: familiarity with the basic notions from Calculus, in particular those of function and derivative.</td>
<td></td>
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</tr>
<tr>
<td>Assistance: Tuesdays and Wednesdays 17-19h, in Room HG E 41.</td>
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</tr>
</tbody>
</table>

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Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract
Learning to view the human body as a (bio-)mechanical system. Making the connections between everyday movements and sports activity with injury, discomfort, prevention and rehabilitation.

Objective
"Students are able to describe the human body as a mechanical system. They analyse and describe human movement according to the laws of mechanics."

Content
Movement- and sports biomechanics deals with the attributes of the human body and their link to mechanics. The course includes topics such as functional anatomy, biomechanics of daily activities (gait, running, etc.) and looks at movement in sport from a mechanical point of view. Furthermore, simple reflections on the loading analysis of joints in various situations are discussed. Additionally, questions covering the statics and dynamics of rigid bodies, and inverse dynamics, relevant to biomechanics are investigated.

406-0062-AAL  Physics I

Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract
Introduction to the concepts and tools in physics: mechanics of point-like and rigid bodies, elasticity theory, elements of hydrostatics and hydrodynamics, periodic motion and mechanical waves.

Objective
Introduction to the scientific methodology. The student should develop his/her capability to turn physical observations into mathematical models, and to solve the latter. The student should acquire an overview over the basic concepts in mechanics.

Content
Book:

Chapters:
1, 2, 3, 4, 5, 6 (without: 6-5, 6-6, 6-8), 7, 8 (without 8-9), 9, 10 (without 10-10), 11 (without 11-7), 13 (without 13-13, 13-14), 14 (without 14-6), 15 (without 15-3, 15-5)

Literature
see "Content"

Friedhelm Kuypers
Physik für Ingenieure und Naturwissenschaftler
Band 1: Mechanik und Thermodynamik
Wiley-VCH Verlag, 2002, 544 S, ca.: Fr. 68.-

Health Sciences and Technology Master - Key for Type

<table>
<thead>
<tr>
<th>Q</th>
<th>W+</th>
<th>W</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compulsory</td>
<td>Eligible for credits and recommended</td>
<td>Eligible for credits</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>E-</th>
<th>Z</th>
<th>Dr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recommended, not eligible for credits</td>
<td>Courses outside the curriculum</td>
<td>Suitable for doctorate</td>
</tr>
</tbody>
</table>

Key for Hours

<table>
<thead>
<tr>
<th>V</th>
<th>G</th>
<th>U</th>
<th>S</th>
<th>K</th>
</tr>
</thead>
<tbody>
<tr>
<td>lecture</td>
<td>lecture with exercise</td>
<td>exercise</td>
<td>seminar</td>
<td>colloquium</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>P</th>
<th>A</th>
<th>D</th>
<th>R</th>
</tr>
</thead>
<tbody>
<tr>
<td>practical/laboratory course</td>
<td>independent project</td>
<td>diploma thesis</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

ECTS
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
## Core Courses in Theoretical Physics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0843-00L</td>
<td>Quantum Field Theory I</td>
<td>W</td>
<td>10</td>
<td>4V+2U</td>
<td>C. Anastasiou</td>
</tr>
</tbody>
</table>

**Abstract**

This course discusses the quantisation of fields in order to introduce a coherent formalism for the combination of quantum mechanics and special relativity. Topics include:

- Relativistic quantum mechanics
- Quantisation of bosonic and fermionic fields
- Interactions in perturbation theory
- Scattering processes and decays
- Radiative corrections

**Objective**

The goal of this course is to provide a solid introduction to the formalism, the techniques, and important physical applications of quantum field theory. Furthermore, it prepares students for the advanced course in quantum field theory (Quantum Field Theory II), and for work on research projects in theoretical physics, particle physics, and condensed-matter physics.

## Core Courses in Experimental Physics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0891-00L</td>
<td>Phenomenology of Particle Physics I</td>
<td>W</td>
<td>10</td>
<td>3V+2U</td>
<td>A. Gehrmann-De Ridder, R. Walny</td>
</tr>
</tbody>
</table>

**Abstract**

Topics to be covered in Phenomenology of Particle Physics I:

- Relativistic kinematics
- Decay rates and cross sections
- The Dirac equation
- From the S-matrix to the Feynman rules of QED
- Scattering processes in QED
- Experimental tests of QED
- Hadron spectroscopy
- Unitary symmetries and QCD
- QCD and alpha_s running
- QCD in e^+e^- annihilation
- Experimental tests of QCD in e^+e^- annihilation

**Objective**

Introduction to modern particle physics

**Content**

Topics to be covered in Phenomenology of Particle Physics I:

- Relativistic kinematics
- Decay rates and cross sections
- The Dirac equation
- From the S-matrix to the Feynman rules of QED
- Scattering processes in QED
- Experimental tests of QED
- Hadron spectroscopy
- Unitary symmetries and QCD
- QCD and alpha_s running
- QCD in e^+e^- annihilation
- Experimental tests of QCD in e^+e^- annihilation

**Literature**

As described in the entity: Lernmaterialien

## Electives

### Optional Subjects in Physics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0715-00L</td>
<td>Low Energy Particle Physics</td>
<td>W</td>
<td>6</td>
<td>2V+1U</td>
<td>A. S. Antognini, P. A. Schmidt-Wellenburg</td>
</tr>
</tbody>
</table>

**Abstract**

Low energy particle physics provides complementary information to high energy physics with colliders. In this lecture, we will concentrate on selected experiments, using mainly neutrons and muons, which have significantly improved our understanding of particle physics today. Besides the sensitivity to effects related with new physics (e.g., lepton flavor violation, symmetry violations, CPT tests, search for electric dipole moments, new low mass exchange bosons etc.), low energy physics provides the best test of QED (electron g-2), the best tests of bound-state QED (atomic physics and exotic atoms), precise determinations of fundamental constants, information about the CKM matrix, precise information on the weak and strong force even in the non-perturbative regime etc.

In this lecture, we will concentrate on selected experiments, using mainly neutrons and muons, which have significantly improved our understanding of particle physics today. Starting from a general introduction on high intensity/high precision particle physics and the main characteristics of muons and neutrons and their production, we will then focus on the discussion of fundamental problems and groundbreaking experiments:

- Production and characteristics of muon and neutron beams
- Ultracold neutron production
- Measurement of the neutron lifetime and electric dipole moment
- The neutron in the gravitational field and its electric charge
- Muon and neutron decay correlations
- Lepton flavour violations with muons to search for new physics
- What atomic physics can do for particle physics and vice versa
- Laser experiments at accelerators
- From myonic hydrogen to the proton structure and bound-state QED
- From pionic hydrogen to the strong interaction and effective field theories
- etc.
Introduction to key concepts on the interface of Particle Physics and Early Universe cosmology. Topics include inflation and inflationary

A. Rubbia
Neutrino Physics

2V+1U
First semester (Astro-Particle Physics I):
To gain familiarity with the formalism of lattice field theories and their numerical simulation methods.

This course offers an introduction to quantum field theories, in particular QCD, formulated on a space-time lattice. The lattice provides a

A. Biland
Introduction to Lattice QCD

See lecture home page: http://ihp-lx2.ethz.ch/AstroTeilchen/

Experimental Methods and Instruments of Particle Physics

402-0725-00L

Abstract
Physics and design of particle accelerators.
Basics and concepts of particle detectors.
Track- and vertex-detectors, calorimetry, particle identification.
Special applications like Cherenkov detectors, air showers, direct detection of dark matter.
Simulation methods, readout electronics, trigger and data acquisition.
Examples of key experiments.

Objective
Acquire an in-depth understanding and overview of the essential elements of experimental methods in particle physics, including accelerators and experiments.

Content
1. Examples of modern experiments
2. Basics: Bethe-Bloch, radiation length, nucl. interaction length, fixed-target vs. collider, principles of measurements: energy- and momentum-conservation, etc
3. Physics and layout of accelerators
4. Charged particle tracking and vertexing
5. Calorimetry
6. Particle identification
7. Analysis methods: invariant and missing mass, jet algorithms, b-tagging
8. Special detectors: extended airshower detectors and cryogenic detectors
9. MC simulations (GEANT), trigger, readout, electronics

Lecture notes
Slides are handed out regularly, see http://www.physik.uzh.ch/en/teaching/PHY461/HS2016.html

Symmetries in Physics

402-0883-63L

Abstract
The course gives an introduction to symmetry groups in physics. It explains the relevant mathematical background (finite groups, Lie groups and algebras as well as their representations), and illustrates their important role in modern physics.

Objective
The aim of the course is to give a self-contained introduction into finite group theory as well as Lie theory from a physicists point of view.

Abstract mathematical constructions will be illustrated with examples from physics.


D.O. Caldwell, Current Aspects of Neutrino Physics, Springer.


Does not take place this semester.

Prerequisites / notice
Particle Physics Phenomenology 1 or Quantum Field Theory 1

Prerequisites: Particle Physics Phenomenology 1 or Quantum Field Theory 1

Background, relic abundances and primordial nucleosynthesis, baryogenesis, dark matter and more.

Does not take place this semester.

Prerequisites / notice

MC simulations (GEANT), trigger, readout, electronics

8. Special detectors: extended airshower detectors and cryogenic detectors
9. MC simulations (GEANT), trigger, readout, electronics

Lecture notes
See lecture home page: http://ihp-lx2.ethz.ch/AstroTeilchen/

Baseline, background, and background subtraction methods in particle physics.

Introduction to Lattice QCD

402-0849-00L

Abstract
This course offers an introduction to quantum field theories, in particular QCD, formulated on a space-time lattice. The lattice provides a

P. De Forcrand

Introduction to Particle Physics

402-0833-00L

Abstract
An introduction to key concepts on the interface of Particle Physics and Early Universe cosmology. Topics include inflation and inflationary

W
6 credits
2V+1U
A. Biland

W
6 credits
2V+1U
A. Rubbia

W
6 credits
2V+1U
A. Rubbia

W
6 credits
2V+1U
A. Rubbia

W
6 credits
2V+1U
A. Rubbia

W
6 credits
2V+1U
A. Rubbia

W
6 credits
2V+1U
M. Gaberdiel
The aim is to understand the need of physics beyond the Standard Model, the basic techniques of model building in theories BSM and the basic understanding of general relativity, its mathematical foundations, and some of the interesting phenomena it predicts.

After the course the student should have a good knowledge of some of the most relevant theories beyond the Standard Model and have an understanding of the mathematical foundations of general relativity and some of the interesting phenomena it predicts.

The course introduces the theory and phenomenology of the recently discovered Higgs boson. With this course the students will receive a detailed introduction to the physics of the Higgs boson in the Standard Model. They will acquire the necessary theoretical background to understand the main production and decay channels of the Higgs boson at high-energy colliders, and the corresponding experimental signatures.

The former title of this course unit was "The Physics Beyond the Standard Model". If you already got credits for "The Physics Beyond the Standard Model" (402-0898-00L), you cannot get credits for "The Physics of Electroweak Symmetry Breaking" (402-0898-00L).

Does not take place this semester.

- Higgs Hunter's Guide (by S.Dawson, J. Gunion, H. Haber and G. Kane)

Particle Accelerator Physics and Modeling I

This is the first of two courses, introducing particle accelerators from a theoretical point of view and covers state-of-the-art modeling techniques. It emphasizes the multidisciplinary aspect of the field, both in methodology (numerical and computational methods) and with regard to applications such as medical, industrial, material research and particle physics.

You understand the building blocks of particle accelerators. Modern analysis tools allows you to model state-of-the-art particle accelerators. In some of the exercises you will be confronted with next generation machines. We will develop a Python simulation tool (AceLEGO) that reflects the theory from the lecture.

Suggested textbooks:

- C. Misner, K. Thorne and J. Wheeler: Gravitation
- S. Carroll - Spacetime and Geometry: An Introduction to General Relativity
- R. Wald - General Relativity
- S. Weinberg - Gravitation and Cosmology
- N. Straumann - General Relativity with applications to Astrophysics
- M. Grazzini
- A. Adelmann

Higgs Physics

The course introduces the theory and phenomenology of the recently discovered Higgs boson. With this course the students will receive a detailed introduction to the physics of the Higgs boson in the Standard Model. They will acquire the necessary theoretical background to understand the main production and decay channels of the Higgs boson at high-energy colliders, and the corresponding experimental signatures.

Theory part:
- the Standard Model and the mass problem: WW scattering and the no-lose theorem
- the Higgs mechanism and its implementation in the Standard Model
- radiative corrections and the screening theorem
- theoretical constraints on the Higgs mass; the hierarchy problem
- Higgs production in e+e- collisions
- Higgs production at hadron colliders
- Higgs decays to fermions and vector bosons
- Higgs differential distributions, rapidity distribution, pt spectrum and jet vetoes
- Higgs properties and beyond the Standard Model perspective
- Outlook: The Higgs sector in weakly coupled and strongly coupled new physics scenarios.

Experimental part:
- Introductory material:
  - reminders of detectors/accelerators
  - reminders of statistics: likelihoods, hypothesis testing
  - reminders of multivariate techniques: Neural Networks, Decision Trees
- Main topics:
  - pre-history (pre-LEP)
  - LEP1: measurements at the Z-pole
  - LEP2: towards the limit mH<114 GeV
  - Tevatron searches
  - LHC:
    -- main channels overview
    -- dissect on analysis
    -- combine information from all channels
    -- differential measurements
    -- off-shell measurements
    -- Future:
      -- pseudo-observables / EFT
      -- Beyond Standard Model

Prerequisites:

- Higgs Hunter's Guide (by S.Dawson, J. Gunion, H. Haber and G. Kane)
- Prerequisites: Quantum Field Theory I, Phenomenology of Particle Physics I

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Here is the rough plan of the topics, however the actual pace may vary relative to this plan.

- Particle Accelerators an Overview
- Relativity for Accelerator Physicists
- Building Blocks of Particle Accelerators
- Lie Algebraic Structure of Classical Mechanics and Applications to Particle Accelerators
- Symplectic Maps & Analysis of Maps
- Particle Tracking
- Linear & Circular Machines
- Cyclotrons
- Free Electron Lasers
- Collective effects in linear approximation
- Preview of Particle Accelerator Physics and Modeling II

Literature
Particle Accelerator Physics, H. Wiedemann, ISBN-13 978-3-540-49043-2, Springer

Prerequisites / notice
This lecture is also suited for PhD. students

402-0851-00L QCD: Theory and Experiment W 3 credits 3G G. Dissertori, University lecturers

Abstract
An introduction to the theoretical aspects and experimental tests of QCD, with emphasis on perturbative QCD and related experiments at colliders.

Objective
Knowledge acquired on basics of perturbative QCD, both of theoretical and experimental nature. Ability to perform simple calculations of perturbative QCD, as well as to understand modern publications on theoretical and experimental aspects of perturbative QCD.

Content
QCD Lagrangian and Feynman Rules
QCD running coupling
Parton model
Altarelli-Parisi equations
Basic processes
Experimental tests at lepton and hadron colliders
Measurements of the strong coupling constant

Literature
2) R. K. Ellis, W. J. Stirling, B. R. Webber : "QCD and Collider Physics" (Cambridge Monographs on Particle Physics, Nuclear Physics & Cosmology)

402-0845-66L The BFKL Equation Reloaded and the Multi-Regge Kinematics in QCD and in N=4 SYM W 1 credit 2G V. Del Duca

Abstract
The goal of the course is to help the audience to keep abreast of the strong advances there have been in the study of the high energy limit of scattering amplitudes in the last decade.

Objective
The goal of the course is to help the audience to keep abreast of the strong advances there have been in the study of the high energy limit of scattering amplitudes in the last decade.

Content
- the BFKL Hamiltonian as an integrable model
- the analytic structure of the Mueller-Navelet jet cross sections in QCD
- the analytic properties of N=4 SYM amplitudes in multi-Regge kinematics

Prerequisites / notice
follow-up of the block course "An Introduction to the Perturbative Pomeron and to the BFKL Equation in QCD and in N=4 SYM"

Optional Subjects in Mathematics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
</table>
| 401-3531-00L | Differential Geometry I | W | 10 credits | 4V+1U | U. Lang | This course counts as a core course in the Bachelor's
degree programme in Mathematics. Holders of an ETH Zurich Bachelor's degree in Mathematics who didn't use credits from neither 401-3531-00L Differential Geometry I nor 401-3532-00L Differential Geometry II for their Bachelor's degree still can have recognised this course for the Master's degree. Furthermore, at most one of the three course units 401-3461-00L Functional Analysis I 401-3531-00L Differential Geometry I 401-3601-00L Probability Theory can be recognised for the Master's degree in Mathematics or Applied Mathematics.

Abstract
Curves in $\mathbb{R}^n$, inner geometry of hypersurfaces in $\mathbb{R}^n$, curvature, Theorema Egregium, special classes of surfaces, Theorem of Gauss-Bonnet, Hyperbolic space. Differentiable manifolds, tangent bundle, immersions and embeddings, Sard’s Theorem, mapping degree and intersection number, vector bundles, vector fields and flows, differential forms, Stokes’ Theorem.

Objective
Introduction to elementary differential geometry and differential topology.

Content
- Differential geometry in $\mathbb{R}^n$: theory of curves, submanifolds and immersions, inner geometry of hypersurfaces, Gauss map and curvature, Theorema Egregium, special classes of surfaces, Theorem of Gauss-Bonnet, Poincaré Index Theorem.
- The hyperbolic space.
- Differential topology: differentiable manifolds, tangent bundle, immersions and embeddings in $\mathbb{R}^n$, Sard’s Theorem, transversality, mapping degree and intersection number, vector bundles, vector fields and flows, differential forms, Stokes’ Theorem.

Literature
Differential Geometry in $\mathbb{R}^n$:
- Manfredo P. do Carmo: Differential geometry of curves and surfaces
- Wolfgang Kühnel: Differentialgeometrie. Curves-surfaces-manifolds
- Christian Bär: Elementary differential geometry
- Dennis Barden & Charles Thomas: An Introduction to Differential Manifolds
- Victor Guillemin & Alan Pollack: Differential Topology
- Morris W. Hirsch: Differential Topology

---

### Proseminars and Semester Papers

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0717-MSL</td>
<td>Particle Physics at CERN</td>
<td>W</td>
<td>9</td>
<td>18P</td>
<td>F. Nøssit-Tedaldi, W. Lautermark</td>
</tr>
<tr>
<td>Abstract</td>
<td>During the semester break participating students stay for 4 weeks at CERN and perform experimental work relevant to our particle physics projects. Dates to be agreed upon.</td>
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</tr>
<tr>
<td>Objective</td>
<td>Students learn, by doing, the needed skills to perform a small particle physics experiment: setup, problem solving, data taking, analysis, interpretation and presentation in a written report of publication quality.</td>
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<tr>
<td>Content</td>
<td>Detailed information: <a href="http://www/cmsdoc.cern.ch/~nessif/ETHTeilchenpraktikumCERN.html">http://www/cmsdoc.cern.ch/~nessif/ETHTeilchenpraktikumCERN.html</a></td>
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</tr>
<tr>
<td>Prerequisites / notice</td>
<td>Language of instruction: English or German</td>
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</tbody>
</table>

| 402-0719-MSL | Particle Physics at PSI (Paul Scherrer Institute)                    | W    | 9    | 18P   | C. Grab                    |
| Abstract     | During semester breaks 6-12 students stay for 3 weeks at PSI and participate in a hands-on course on experimental particle physics. A small real experiment is performed in common, including apparatus design, construction, running and data analysis. The course includes some lectures, but the focus lies on the practical aspects of experimenting. |
| Objective    | Students learn all the different steps it takes to perform a complete particle physics experiment in a small team. They acquire skills to do this themselves in the team, including design, construction, data taking and data analysis. |

| 402-0210-96L | Proseminar Theoretical Physics: Solitons and Instantons in Condensed Matter | W    | 9    | 4S    | V. Geshkenbein             |
| Abstract     | A guided self-study of original papers and of advanced textbooks in theoretical physics. Within the general topic, determined each semester, participants give a presentation on a particular subject and deliver a written report. |

| 402-0217-MSL | Theoretical Semester Project in a Group of the Physics Department | W    | 9    | 18A   | Professors                 |
| Abstract     | This course unit is an alternative if no suitable "Proseminar Theoretical Physics" is available if the proseminar is already overbooked. |
| Prerequisites / notice | Die Leistungskontrolle erfolgt aufgrund eines oder mehrerer schriftlicher Berichte bzw. einer schriftlichen Arbeit. Vorträge können ein zusätzlicher Bestandteil der Leistungskontrolle sein. |

| 402-0215-MSL | Experimental Semester Project in a Group of the Physics Department | W    | 9    | 18A   | Professors                 |

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Data: 06.03.2019 12:57 Autumn Semester 2016 Page 795 of 1571
Abstract
The aim of the project is to give the student experience in working in a research environment, carrying out physics experiments, analysing and interpreting the resulting data.

Prerequisites / notice

► GESS Science in Perspective

Recommended GESS Science in Perspective (Type B) for D-PHYS.

see GESS Science in Perspective: Type A: Enhancement of Reflection Capability

see GESS Science in Perspective: Language Courses ETH/UZH

► Master's Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-2000-00L</td>
<td>Scientific Works in Physics</td>
<td>O</td>
<td>0 credits</td>
<td></td>
<td>C. Grab</td>
</tr>
<tr>
<td></td>
<td>Target audience:</td>
<td></td>
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<tr>
<td></td>
<td>Master students who cannot document to have received an adequate training in working scientifically.</td>
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<td></td>
<td>Directive</td>
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</tr>
<tr>
<td>Abstract</td>
<td>Literature Review: ETH-Library, Journals in Physics, Google Scholar; Thesis Structure: The IMRAD Model; Document Processing: LaTeX and BibTeX, Mathematical Writing, AVETH Survival Guide; ETH Guidelines for Integrity; Authorship Guidelines; ETH Citation Etiquettes; Declaration of Originality.</td>
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</tr>
<tr>
<td>Objective</td>
<td>Basic standards for scientific works in physics: How to write a Master Thesis. What to know about research integrity.</td>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>462-0900-00L</td>
<td>Master's Thesis ■</td>
<td>O</td>
<td>30 credits</td>
<td>57D</td>
<td>Supervisors</td>
</tr>
<tr>
<td></td>
<td>Further information:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><a href="http://www.phys.ethz.ch/phys/education/master/msc-theses">www.phys.ethz.ch/phys/education/master/msc-theses</a></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abstract</td>
<td>The Master's thesis is normally conducted in the fourth semester and concludes the degree programme. With the Master's thesis students verify their ability to undertake independent and scientifically structured work in the area of high energy physics.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Prerequisites / notice</td>
<td>The time limit for completing the Master's thesis is six months.</td>
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</tr>
</tbody>
</table>

High-Energy Physics (Joint Master with EP Paris) - Key for Type

| O          | Compulsory      | E-  | Recommended, not eligible for credits |
| W+         | Eligible for credits and recommended | Z   | Courses outside the curriculum |
| W          | Eligible for credits | Dr  | Suitable for doctorate |

Key for Hours

| V          | lecture        | P   | practical/laboratory course |
| G          | lecture with exercise | A   | independent project |
| U          | exercise       | D   | diploma thesis |
| S          | seminar        | R   | revision course / private study |
| K          | colloquium     |     |                           |

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Computer Science (General Courses)

Computer Science for Non-Computer Scientists

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>252-0834-00L</td>
<td>Information Systems for Engineers</td>
<td>Z</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>R. Marti</td>
</tr>
</tbody>
</table>

**Abstract**
Foundations of information systems from a user's viewpoint. The focus is on structured data: relational databases, the data language SQL, designing relational databases. Additional topics: Information Retrieval (searching documents), and estimating their relevance and authority with respect to free-text queries; XML as a format for data exchange; Characteristics and processing of "Big Data".

**Objective**
Following the course should enable students to:

1. answer non-trivial queries on existing relational databases by formulating (entry-level) SQL statements, as well as to add new database content and to update or delete existing content,
2. formalize facts as perceived in the real world in terms of the entity-relationship model, and derive a set of normalized relations (tables) which define the structure of a relational database,
3. explain how a database management system (DBMS) essentially works and what kind of services it provides,
4. understand how a web search engine such as Google basically works,
5. know and apply the core concepts to structure and query XML-documents,
6. list the characteristics of "Big Data" and know the basics of processing "Big Data".

**Content**
Die Lehrveranstaltung vermittelt Grundlagen und Konzepte von Informationssystemen aus der Sicht eines Anwenders. Im Zentrum stehen relationale Datenbanksysteme, die Abfrage- und Datenmanipulationssprache SQL, sowie der Entwurf bzw. die Strukturierung relationaler Datenbanken. Dieser Stoff wird auch in praktischen Übungen vertieft.

Weitere Themen sind der Umgang mit unstrukturierten und semistrukturierten Daten, die Integration von Daten aus verschiedenen autonomen Informationssystemen, sowie eine Übersicht der Architektur von Datenbanksystemen.

**Literature**


**Prerequisites / notice**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>252-0835-00L</td>
<td>Computer Science I</td>
<td>Z</td>
<td>4 credits</td>
<td>2V+2U</td>
<td>F. O. Friedrich</td>
</tr>
</tbody>
</table>

**Abstract**
The course covers the fundamental concepts of computer programming with a focus on systematic algorithmic problem solving. Taught language is C++. No programming experience is required.

**Objective**
Primary educational objective is to learn programming with C++. When successfully attended the course, students have a good command of the mechanisms to construct a program. They know the fundamental control and data structures and understand how an algorithmic problem is mapped to a computer program. They have an idea of what happens "behind the scenes" when a program is translated and executed.

Secondary goals are an algorithmic computational thinking, understanding the possibilities and limits of programming and to impart the way of thinking of a computer scientist.

**Content**
The course covers fundamental data types, expressions and statements, (Limits of) computer arithmetic, control statements, functions, arrays, structural types and pointers. The part on object orientation deals with classes, inheritance and polymorphism, simple dynamic data types are introduced as examples. In general, the concepts provided in the course are motivated and illustrated with algorithms and applications.

**Lecture notes**
A script written in English will be provided during the semester. The script and slides will be made available for download on the course web page.

**Literature**
Bjarne Stroustrup: Einführung in die Programmierung mit C++, Pearson Studium, 2010

**Prerequisites / notice**
From AS 2013, an admission to the exam does not any more formally require an attending of the recitation sessions. Handing in solutions to the weekly exercise sheets is thus not mandatory, but we strongly recommend it.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>252-0839-00L</td>
<td>Informatics</td>
<td>Z</td>
<td>2 credits</td>
<td>2G</td>
<td>L. E. Fässler, M. Dahinden</td>
</tr>
</tbody>
</table>

Data: 06.03.2019 12:57  Autumn Semester 2016  Page 797 of 1571
The course covers the basic concepts of computer programming. All materials for the lecture are available at www.evim.ethz.ch

This lecture is an introduction to programming based on the language C++. We cover fundamental types, control statements, functions,

Students learn to apply selected concepts and tools from computer science for working on interdisciplinary projects. The following topics are covered: modeling and simulations, visualizing multi-dimensional data, managing data with lists and tables and with relational databases, introduction to programming, universal methods for algorithm design.

1. Modeling and simulations
2. Visualizing multidimensional data
3. Data management with lists and tables
4. Data management with a relational database
5. Introduction to macro programming
6. Introduction to programming with Python

Lecture notes
All materials for the lecture are available at www.evim.ethz.ch

This course is based on application-oriented learning. The students spend most of their time working through projects with data from natural science and discussing their results with teaching assistants. To learn the computer science basics there are electronic tutorials available.

Lecture notes in English and Handouts in German will be distributed electronically along with the course.

The following topics are covered: modeling and simulations, introduction to programming, visualizing multi-dimensional data, introduction matrices, managing data with lists and tables and with relational databases, universal methods for algorithm design.

- know universal methods for algorithm design.
- handle the complexity of real-world data,
- process and analyze real-world data from their subject of study,
- control computer and automate processes of problem solving by programming,
- understand the role of computer science in science,
- to control computer and automate processes of problem solving by programming,
The unit "Computer Science in Secondary School Mathematics" addresses key contributions of computer science to general education, the tight relations between the algorithmic and the mathematical way of thinking, and the thoughtful choice of computer science topics for high school mathematics classes.

The general goal of the course consists in presenting ways to teach fundamentals of computer science, which are closely related to contents and methods of mathematics. After attending the course unit, a mathematics teacher is able to teach selected fundamentals of computer science in mathematics classes.

The students understand the fundamental concepts of computer science in the context of a broad and deep knowledge. Through this understanding, they manage to prepare teaching materials for a successful knowledge transfer and to pass their passion for the subject on to their pupils.

The students know various teaching methods as well as their advantages and disadvantages. They can handle inhomogeneous prior knowledge of the learners inside a class. Besides holding classes, the students do care about the individual pupil support.

They encourage the autonomy of the learners, manage to work with diverse target groups and to establish a positive learning environment.

The students are able to express themselves using a comprehensible and refined professional language, both in a spoken and a written way, and they master the basic terminology of computer science. Besides the English terms, they are familiar with the corresponding German expressions. The students are able to produce detailed, matured, linguistically correct and design-wise appealing teaching materials.

The main topics of the course unit "Computer Science in Secondary School Mathematics" represent a scientific and didactic added value for mathematics classes.

The course covers the didactics of logic, of cryptography, of finite state automata, of computability and of the introduction to programming. The students develop the understanding of fundamental scientific concepts such as algorithm, program, complexity, determinism, computation, automata, verification, testing, security of a cryptosystem and secure communication. They reflect on ways to embed them into a scientifically sound and didactically sustainable mathematics course.

In a semester exercise, the students develop and document an adaptive teaching unit for computer science. They learn to employ the didactics methods and techniques that are introduced at the beginning of the semester. Literature will be given. Additional materials and slides will be available.

Lecture notes:

**Generally Accessible Seminars and Colloquia**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>251-0100-00L</td>
<td>Computer Science Colloquium</td>
<td>E-</td>
<td>0 credits</td>
<td>2K</td>
<td>Lecturers</td>
</tr>
<tr>
<td>Abstract</td>
<td>Invited talks, covering the entire scope of computer science. External Listeners are welcome at no charge. A detailed schedule is published at the beginning of each semester.</td>
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<tr>
<td>Objective</td>
<td>Top international computer scientists take the floor at the distinguished computer science colloquium. Our guest speakers present impacting topics across various areas of the discipline. The colloquium series is held every semester and also includes inaugural and farewell lectures of the department's professors. The colloquium is a noteworthy event for all graduate students. Outside attendance is equally welcome.</td>
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<tr>
<td>Content</td>
<td>Eingeladene Vorträge aus dem gesamten Bereich der Informatik, zu denen auch Auswärtige kostenlos eingeladen sind. Zu Semesterbeginn erscheint jeweils ein ausführliches Programm.</td>
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</table>

| 401-5960-00L    | Colloquium on Mathematics, Computer Science, and Education | E-     | 0 credits | N. Hungerbühl, M. Akved, J. Hromkovic, H. Klemenz |
| Objective       | Subject didactics for mathematics and computer science teachers. |
| Content         | Didactics colloquium |

**Computer Science (General Courses) - Key for Type**

<table>
<thead>
<tr>
<th>Type</th>
<th>ECTS</th>
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<tbody>
<tr>
<td>O</td>
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<td>W+</td>
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<tr>
<td>W</td>
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<td>E</td>
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**Key for Hours**

<table>
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<tr>
<th>Type</th>
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<th>Lecturers</th>
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</table>

**ECTS**

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Computer Science Bachelor
► Bachelor Studies (Programme Regulations 2016)
►► First Year Examinations
►►► First Year Examination Block 1

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-0131-00L</td>
<td>Linear Algebra</td>
<td>O</td>
<td>7</td>
<td>4V+2U</td>
<td>O. Imamoglu, O. Sorkine Hornung</td>
</tr>
<tr>
<td>Abstract</td>
<td>Application oriented introduction to linear algebra (vector spaces, linear transformations, matrices), matrix decompositions (LU, QR, eigenvalue, and singular value decomposition). Introduction to the programming environment Matlab.</td>
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<tr>
<td>Objective</td>
<td>Die Lernziele sind:</td>
<td></td>
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<tr>
<td></td>
<td>- die fundamentalen Konzepte der linearen Algebra gut zu verstehen</td>
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<tr>
<td></td>
<td>- in der Lage zu sein, mit Hilfe von MatLab Rechenaufgaben zu lösen</td>
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</tr>
<tr>
<td></td>
<td>- Anwendungen der linearen Algebra in der Informatik kennenzulernen</td>
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</tr>
<tr>
<td>Content</td>
<td>Linear Algebra:</td>
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</tr>
<tr>
<td></td>
<td>Linear systems of equations, vectors and matrices, norms and scalar products, LU decomposition, vector spaces and linear transformations, least squares problems, QR decomposition, determinants, eigenvalues and eigenvectors, singular value decomposition, applications.</td>
<td></td>
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<tr>
<td>Lecture notes</td>
<td>Lecture notes &quot;Linear Algebra&quot; (Gutknecht) in German, with English expressions for all technical terms.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>The relevant high school material is reviewed briefly at the beginning.</td>
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</tbody>
</table>

| 252-0025-00L | Discrete Mathematics        | O    | 7    | 4V+2U  | U. Maurer                         |
| Abstract     | Content: Mathematical reasoning and proofs, abstraction. Sets, relations (e.g. equivalence and order relations), functions, (un-)countability, number theory, algebra (groups, rings, fields, polynomials, subalgebras, morphisms), logic (propositional and predicate logic, proof calculi), number theory, algebra (groups, rings, fields, polynomials, subalgebras, morphisms), logic (propositional and predicate logic, proof calculi). |
| Objective    | The primary goals of this course are (1) to introduce the most important concepts of discrete mathematics, (2) to understand and appreciate the role of abstraction and mathematical proofs, and (3) to discuss a number of applications, e.g. in cryptography, coding theory, and algorithm theory. |
| Content      | See course description.     |      |      |        |                                  |
| Lecture notes| available (in english)      |      |      |        |                                  |

| 252-0026-00L | Algorithms and Data Structures | O   | 7    | 3V+2U+1A | P. Widmayer, M. Püschel |
| Abstract     | This course is about fundamental algorithm design paradigms, classic algorithmic problems, and data structures. The connection between algorithms and data structures is explained for geometric and graph problems. For this purpose, fundamental graph theoretic concepts are introduced. |
| Objective    | An understanding of the design and analysis of fundamental algorithms and data structures. |

| 252-0027-00L | Introduction to Programming | O   | 7    | 4V+2U  | T. Gross                           |
| Abstract     | Introduction to fundamental concepts of modern programming and operational skills for developing high-quality programs, including large programs as in industry. The course introduces software engineering principles with an object-oriented approach based. |
| Objective    | Many people can write programs. The "Introduction to Programming" course goes beyond that basic goal: it teaches the fundamental concepts and skills necessary to perform programming at a professional level. As a result of successfully completing the course, students master the fundamental control structures, data structures, reasoning patterns and programming language mechanisms characterizing modern programming, as well as the fundamental rules of producing high-quality software. They have the necessary programming background for later courses introducing programming skills in specialized application areas. |
| Content      | Basics of object-oriented programming. Objects and classes. Pre- and postconditions, class invariants, Design by Contract. Fundamental control structures. Assignment and References. Basic hardware concepts. Fundamental data structures and algorithms. Recursion. Inheritance and interfaces, introduction to event-driven design and concurrent programming. Basic concepts of Software Engineering such as the software process, specification and documentation, reuse and quality assurance. |
| Lecture notes| The lecture slides are available for download on the course page. |
| Literature   | See the course page for up-to-date information. |
| Prerequisites / notice | There are no special prerequisites. Students are expected to enroll in the other courses offered to first-year students of computer science. |

►►► First Year Examination Block 2

Offered in the spring semester.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-0211-00L</td>
<td>Analysis I</td>
<td>O</td>
<td>7</td>
<td>4V+2U</td>
<td>not available</td>
</tr>
<tr>
<td>Abstract</td>
<td>Does not take place this semester. The course unit will be offered again in the spring semester 2017.</td>
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<tr>
<td>Objective</td>
<td>Real and complex numbers, vectors, functions, limits, sequences, series, power series, differentiation and integration in one variable, introduction to ordinary differential equations.</td>
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<tr>
<td>Content</td>
<td>Real and complex numbers, vectors, functions, limits, sequences, series, power series, differentiation and integration in one variable, introduction to ordinary differential equations.</td>
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<tr>
<td>Lecture notes</td>
<td>Michael Struwe. <em>Analysis für Informatik.</em> ETH Zürich, 2010.</td>
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</tbody>
</table>

► Bachelor Studies (Programme Regulations 2008)
### 3. Semester

#### Compulsory Courses (3. Sem.)

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>252-0057-00L</td>
<td>Theoretical Computer Science</td>
<td>O</td>
<td>8 credits</td>
<td>4V+2U+1A</td>
<td>J. Hromkovic</td>
</tr>
</tbody>
</table>

**Abstract**

Concepts to cope with: a) what can be accomplished in a fully automated fashion (algorithmically solvable) b) How to measure the inherent difficulty of tasks (problems) c) What is randomness and how can it be useful? d) What is nondeterminism and what role does it play in CS? e) How to represent infinite objects by finite automata and grammars?

**Objective**

Learning the basic concepts of computer science along their historical development

**Content**

This lecture gives an introduction to theoretical computer science, presenting the basic concepts and methods of computer science in its historical context. We present computer science as an interdisciplinary science which, on the one hand, investigates the border between the possible and the impossible and the quantitative laws of information processing, and, on the other hand, designs, analyzes, verifies, and implements computer systems.

The main topics of the lecture are:

- alphabets, words, languages, measuring the information content of words, representation of algorithmic tasks
- finite automata, regular and context-free grammars
- Turing machines and computability
- complexity theory and NP-completeness
- design of algorithms for hard problems

**Lecture notes**

The lecture is covered in detail by the textbook "Theoretical Computer Science".

**Literature**

Basic literature:


Further reading:


More exercises and examples in:

6. A. Asteroth, Ch. Baier: Theoretische Informatik

**Prerequisites / notice**

During the semester, two non-obligatory test exams will be offered.

| 252-0061-00L | Systems Programming and Computer Architecture | O | 8 credits | 4V+2U+1A | T. Roscoe |

**Abstract**

Introduction to computer architecture and system programming:

Instruction sets, storage hierarchies, runtime structures with an emphasis on computers as engines for the execution of compiled programs. Interaction between system software and the hardware. Problems that arise from the final representation, performance measurement and tuning, and program portability issues are covered.

**Objective**

The objective is to allow students to understand all aspects of the execution of compiled (C) programs on modern architectures -- the instruction set, the storage resources (registers, stack, memory), input/output, the impact of compiler decisions, and the interaction between the operating system and hardware. Two main themes are correctness issues (esp. those that arise from the finite representation of data) and performance issues (incl. measurement and tuning issues). The interface to the operating system is discussed to prepare for subsequent classes on more advanced systems topics.

The two key goals are:

1) To equip students with a thorough understanding of how to write correct programs that run fast on modern computer, and
2) How to write correct and efficient low-level systems code.

This course does not cover how to design or build a processor or computer.
Content
This course provides an overview of “computers” as a platform for the execution of (compiled) computer programs. This course provides a programmer's view of how computer systems execute programs, store information, and communicate. The course introduces the major computer architecture structures that have direct influence on the execution of programs (processors with registers, caches, other levels of the memory hierarchy, supervisor/kernel mode, and I/O structures) and covers implementation and representation issues only to the extent that they are necessary to understand the structure and operation of a computer system.

The course attempts to expose students to the practical issues that affect performance, portability, security, robustness, and extensibility. This course provides a foundation for subsequent courses on operating systems, networks, compilers and many other courses that require an understanding of the system-level issues. Topics covered include: machine-level code and its generation by optimizing compilers, address translation, input and output, trap/event handlers, performance evaluation and optimization (with a focus on the practical aspects of data collection and analysis).

Literature
The course is based in part on "Computer Systems: A Programmer's Perspective" (2nd Edition) by R. Bryant and D. O'Hallaron, with some additional material.

Prerequisites / notice
252-0024-00L Parallel Programming, 252-0014-00L Digital Circuits

401-0613-00L Probability and Statistics
O 6 credits 3V+2U J. Teichmann

Abstract
Basic concepts from probability and statistics:
- introduction to probability theory
- short introduction to basic concepts and methods from statistics

Objective
a) ability to understand the covered methods from probability theory and to apply them in other contexts
b) probabilistic thinking and stochastic modelling
c) ability to perform basic statistical tests and to interpret the results

Content
Basic concepts from probability and statistics with special emphasis on the topics needed in computer science

The conceptual goals are
- the laws of randomness and probabilistic thinking (thinking in probabilities)
- understanding and intuition for stochastic modelling
- simple and basic methods from statistics

The contents of the course encompasses
- an introduction to probability theory: basic concepts (probability space, probability measure), independence, random variables, discrete and continuous distributions, conditional probability, expectation and variance, limit theorems
- methods from statistics: parameter estimation, maximum likelihood and moment methods, tests, confidence intervals

Lecture notes
Lecture notes for the course (in German) will be made available electronically at the beginning of the course.

401-0663-00L Numerical Methods for CSE
O 7 credits 4V+2U R. Hiptmair

Abstract
The course gives an introduction into fundamental techniques and algorithms of numerical mathematics which play a central role in numerical simulations in science and technology. The course focuses on fundamental ideas and algorithmic aspects of numerical methods. The exercises involve actual implementation of numerical methods in C++.

Objective
* Knowledge of the fundamental algorithms in numerical mathematics
* Knowledge of the essential terms in numerical mathematics and the techniques used for the analysis of numerical algorithms
* Ability to choose the appropriate numerical method for concrete problems
* Ability to interpret numerical results
* Ability to implement numerical algorithms efficiently

Content
1. Direct Methods for linear systems of equations
2. Least Squares Techniques
3. Data Interpolation and Fitting
4. Filtering Algorithms
8. Approximation of Functions
9. Numerical Quadrature
10. Iterative Methods for non-linear systems of equations
11. Single Step Methods for ODEs
12. Stiff Integrators

Lecture notes
Lecture materials (PDF documents and codes) will be made available to participants:

Lecture Git repository: https://gitlab.math.ethz.ch/NumCSE/NumCSE
Tablet classroom notes: http://www.sam.math.ethz.ch/~grsam/HS16/NumCSE/NCSE16_Notes/
Lecture recording: http://www.video.ethz.ch/lectures/d-math/2016/autumn/401-0663-00L.html
Homework problems: https://people.math.ethz.ch/~grsam/HS16/NumCSE/NCSEProblems.pdf
We present the characteristics and concepts of distributed systems, and discuss distributed control algorithms (flooding, mutual exclusion, REST, SOAP), infrastructure for ad hoc networking (JINI), cloud computing, and mechanisms for security and safety. Having a distributed system may permit getting away with failures and malfunctions of parts of the system. We discuss fault-tolerance issues (models, consensus), replication (primary copy, 2PC, 3PC, Paxos, quorum systems), shared memory (spin locks, concurrency).

### Literature


Prerequisites / notice: The course will be accompanied by programming exercises in C++ relying on the template library EIGEN. Familiarity with C++, object oriented and generic programming is an advantage. Participants of the course are expected to learn C++ by themselves.

### Compensatory Courses

#### Compulsory Major Courses

#### Major

#### Compulsory Major Courses

#### Major in Computer and Software Engineering

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>252-0210-00L</td>
<td>Compiler Design</td>
<td>O</td>
<td>8 credits</td>
<td>4V+3U</td>
<td>T. Gross</td>
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<tr>
<td></td>
<td>Does not take place this semester.</td>
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<td>The course unit will be offered again in the spring semester 2017.</td>
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<tr>
<td></td>
<td>Abstract</td>
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<td></td>
<td>This course uses compilers as example to expose modern software development techniques.</td>
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<td></td>
<td>Compiler organization.</td>
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<td></td>
<td>Lexical analysis.</td>
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<td>Top-down parsing via recursive descent, table-driven parsers, bottom-up parsing.</td>
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<td></td>
<td>Symboltables, semantic</td>
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<td>Code generation for a simple RISC machine: conditionals, loops, procedure calls, simple register allocation techniques.</td>
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<td>Objective</td>
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<td></td>
<td>Learn principles of compiler design, gain practical experience designing and implementing a medium-scale software system.</td>
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<td>Content</td>
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<td></td>
<td>This course uses compilers as example to expose modern software development techniques. The course introduces the students to the fundamentals of compiler construction. Students will implement a simple yet complete compiler for an object-oriented programming language for a realistic target machine. Students will learn the use of appropriate tools (tokenizer, parser generators); the implementation language is Java. Throughout the course, students learn to apply their knowledge of theory (automata, grammars, stack machines, program transformation) and well-known programming techniques (module definitions, design patterns, frameworks, software reuse) in a software project.</td>
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<td></td>
<td>Specific topics: Compiler organization. Lexical analysis. Top-down parsing via recursive descent, table-driven parsers, bottom-up parsing.</td>
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<td>Code generation for a simple RISC machine: expression evaluation, straight line code, conditionals, loops, procedure calls, simple register allocation techniques. Storage allocation on the stack, parameter passing, runtime storage management, heaps. Special topics as time permits: introduction to global dataflow and its application to register allocation, instruction scheduling.</td>
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<td></td>
<td>Literature</td>
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<td>Prerequisites / notice</td>
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<td></td>
<td>Prerequisites:</td>
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<td>Prior exposure to modern techniques for program construction, knowledge of at least one process architecture at the assembly language level.</td>
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<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>252-0213-00L</td>
<td>Distributed Systems</td>
<td>O</td>
<td>8 credits</td>
<td>6G+1A</td>
<td>F. Mattern, R. Wattenhofer</td>
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<td></td>
<td>Distributed control algorithms (mutual exclusion, logical clocks), communication models (RPC, synchronous/asynchronous communication, broadcast, events, tuple spaces), middleware, service- and resource-oriented architectures (SOAP, REST), security, fault-tolerance (failure models, consensus), replication (primary copy, 2PC, 3PC, Paxos, quorum systems), shared memory (spin locks, concurrency).</td>
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<td>Objective</td>
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<td></td>
<td>Become acquainted with pertinent technologies and architectures of distributed systems.</td>
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<td></td>
<td>Content</td>
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<td></td>
<td>We present the characteristics and concepts of distributed systems, and discuss distributed control algorithms (flooding, mutual exclusion, logical clocks), communications models (remote procedure call, client-server models, synchronous and asynchronous communication), abstract communication principles (broadcast, events, tuple spaces), name services, communication middleware for open systems (e.g., REST, SOAP), infrastructure for ad hoc networking (JINI), cloud computing, and mechanisms for security and safety. Having a distributed system may permit getting away with failures and malfunctions of parts of the system. We discuss fault-tolerance issues (models, consensus, agreement) as well as replication issues (primary copy, 2PC, 3PC, Paxos, quorum systems, distributed storage) and problems with asynchronous multiprocessing (shared memory, spin locks, concurrency). To get familiar with message passing communication, some of the exercises will be devoted to a practical lab where participants will develop software for a mobile platform (smartphones).</td>
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<tr>
<td></td>
<td>Literature</td>
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</table>

### Major in Computational Science

The lecture 151-0107-20L High Performance Computing for Science and Engineering I in the autumn semester can only together with the lecture 401-0686-10L High Performance Computing for Science and Engineering II in the spring semester be accredited as compulsory course.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
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<tbody>
<tr>
<td>252-0206-00L</td>
<td>Visual Computing</td>
<td>O</td>
<td>8 credits</td>
<td>4V+3U</td>
<td>M. Gross, O. Hilliges</td>
</tr>
<tr>
<td></td>
<td>This course acquaints students with core knowledge in computer graphics, image processing, multimedia and computer vision. Topics include: Graphics pipeline, perception and camera models, transformation, shading, global illumination, texturing, sampling, filtering, image representations, image and video compression, edge detection and optical flow.</td>
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<td>Objective</td>
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<td>This course provides an in-depth introduction to the core concepts of computer graphics, image processing, multimedia and computer vision. The course forms a basis for the specialization track Visual Computing of the CS master program at ETH.</td>
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<td></td>
<td>Content</td>
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<td>Course topics will include: Graphics pipeline, perception and color models, camera models, transformations and projection, projections, lighting, shading, global illumination, texturing, sampling theorem, Fourier transforms, image representations, convolution, linear filtering, diffusion, nonlinear filtering, edge detection, optical flow, image and video compression.</td>
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<td></td>
<td>Lecture notes</td>
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<td></td>
<td>A script will be handed out for a part of the course. Copies of the slides will be available for download. We will also provide a detailed list of references and textbooks.</td>
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<tr>
<td></td>
<td>Literature</td>
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</table>

151-0107-20L High Performance Computing for Science and Engineering (HPCE) I: W 4 credits 4G M. Troyer, P. Chatzidoukas
Abstract
This course gives an introduction into algorithms and numerical methods for parallel computing for multi and many-core architectures and for applications from problems in science and engineering.

Objective
Introduction to HPC for scientists and engineers
Fundamental of:
1. Parallel Computing Architectures
2. MultiCores
3. ManyCores

Content
Programming models and languages:
1. C++ threading (2 weeks)
2. OpenMP (4 weeks)
3. MPI (5 weeks)
Computers and methods:
1. Hardware and architectures
2. Libraries
3. Particles: N-body solvers
4. Fields: PDEs
5. Stochastics: Monte Carlo

Lecture notes
http://www.cse-lab.ethz.ch/index.php/teaching/42-teaching/classes/615-hpcse1
Class notes, handouts

>>> Major in Theoretical Computer Science

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>252-0209-00L</td>
<td>Algorithms, Probability, and Computing</td>
<td>O</td>
<td>8</td>
<td>4V+2U+1A</td>
<td>E. Welzl, M. Ghaifari, A. Steger, P. Widmayer</td>
</tr>
<tr>
<td>Abstract</td>
<td>Advanced design and analysis methods for algorithms and data structures: Randomized Search Trees, Point Location, Minimum Cut, Linear Programming, Randomized Algebraic Algorithms (matchings), Probabilistically Checkable Proofs (introduction).</td>
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<tr>
<td>Objective</td>
<td>Studying and understanding of fundamental advanced concepts in algorithms, data structures and complexity theory.</td>
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<tr>
<td>Lecture notes</td>
<td>Will be handed out.</td>
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</table>

>>> Electives

Compulsory major courses may also qualify as electives. Students may also choose courses from the Master's program in Computer Science. It is their responsibility to make sure that they meet the requirements and conditions for these courses.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>252-3110-00L</td>
<td>Human Computer Interaction</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>O. Hilliges, M. Norrie</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course provides an introduction to the field of human-computer interaction, emphasising the central role of the user in system design. Through detailed case studies, students will be introduced to different methods used to analyse the user experience and shown how these can inform the design of new interfaces, systems and technologies.</td>
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<tr>
<td>Objective</td>
<td>The goal of the course is that students should understand the principles of user-centred design and be able to apply these in practice.</td>
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<tr>
<td>Content</td>
<td>The course will introduce students to various methods of analysing the user experience, showing how these can be used at different stages of system development from requirements analysis through to usability testing. Students will get experience of designing and carrying out user studies as well as analysing results. The course will also cover the basic principles of interaction design. Practical exercises related to touch and gesture-based interaction will be used to reinforce the concepts introduced in the lecture. To get students to further think beyond traditional system design, we will discuss issues related to ambient information and awareness.</td>
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<tr>
<td>151-0107-20L</td>
<td>High Performance Computing for Science and Engineering (HPCSE) I</td>
<td>W</td>
<td>4</td>
<td>4G</td>
<td>M. Troyer, P. Chatzidoukas</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course gives an introduction into algorithms and numerical methods for parallel computing for multi and many-core architectures and for applications from problems in science and engineering.</td>
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<tr>
<td>Objective</td>
<td>Introduction to HPC for scientists and engineers</td>
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<tr>
<td>Content</td>
<td>Programming models and languages:</td>
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<td></td>
<td>1. C++ threading (2 weeks)</td>
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<td>2. OpenMP (4 weeks)</td>
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<td>3. MPI (5 weeks)</td>
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<td>Computers and methods:</td>
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<td></td>
<td>1. Hardware and architectures</td>
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<td></td>
<td>2. Libraries</td>
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<td>3. Particles: N-body solvers</td>
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<td>4. Fields: PDEs</td>
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<td>5. Stochastics: Monte Carlo</td>
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<tr>
<td>Lecture notes</td>
<td><a href="http://www.cse-lab.ethz.ch/index.php/teaching/42-teaching/classes/615-hpcse1">http://www.cse-lab.ethz.ch/index.php/teaching/42-teaching/classes/615-hpcse1</a></td>
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<tbody>
<tr>
<td>227-0627-00L</td>
<td>Applied Computer Architecture</td>
<td>W</td>
<td>6</td>
<td>4G</td>
<td>A. Gunzinger</td>
</tr>
<tr>
<td>Abstract</td>
<td>This lecture gives an overview of the requirements and the architecture of parallel computer systems, performance, reliability and costs.</td>
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<tr>
<td>Objective</td>
<td>Understand the function, the design and the performance modeling of parallel computer systems.</td>
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</tbody>
</table>
The lecture "Applied Computer Architecture" gives technical and corporate insights in the innovative Computer Systems/Architectures (CPU, GPU, FPGA, special processors) and their real implementations and applications. Often the designs have to deal with technical limits.

Which computer architecture allows the control of the over 1000 magnets at the Swiss Light Source (SLS)?
Which architecture is behind the alarm center of the Swiss Railway (SBB)?
Which computer architectures are applied for driver assistance systems?
Which computer architecture is hidden behind a professional digital audio mixing desk?
How can data streams of about 30 TBytes, produced by a proton accelerator, be processed in real time?
Can the weather forecast also be processed with GPUs?
How can a good computer architecture be found?
Which are the driving factors in successful computer architecture design?

Script and exercises sheets.

The lecture "Einführung in die Programmierung" gives technical and corporate insights in the innovative Computer Systems/Architectures.

Lecture notes
Prerequisites / notice
Basics of computer architecture.

227-0945-00L Cell and Molecular Biology for Engineers I
This course is part I of a two-semester course.

W 3 credits 3G C. Frei

Abstract
The course gives an introduction into cellular and molecular biology, specifically for students with a background in engineering. The focus will be on the basic organization of eukaryotic cells, molecular mechanisms and cellular functions. Textbook knowledge will be combined with results from recent research and technological innovations in biology.

Objective
After completing this course, engineering students will be able to apply their previous training in the quantitative and physical sciences to modern biology. Students will also learn the principles how biological models are established, and how these models can be tested.

Content
Lectures will include the following topics: DNA, chromosomes, RNA, protein, genetics, gene expression, membrane structure and function, vesicular traffic, cellular communication, energy conversion, cytoskeleton, cell cycle, cellular growth, apoptosis, autophagy, cancer, development and stem cells.

In addition, three journal clubs will be held, where one/two publication will be discussed (part I: 1 Journal club, part II: 2 Journal Clubs). For each journal club, students (alone or in groups of up to three students) have to write a summary and discussion of the publication. These written documents will be graded and count as 25% for the final grade.

Lecture notes
Scripts of all lectures will be available.

Literature

227-1037-00L Introduction to Neuroinformatics

W 6 credits 2V+1U K. A. Martin, M. Cook, V. Mante, M. Pfeiffer

Abstract
The course provides an introduction to the functional properties of neurons. Particularly the description of membrane electrical properties (action potentials, channels), neuronal anatomy, synaptic structures, and neuronal networks. Simple models of computation, learning, and behavior will be explained. Some artificial systems (robot, chip) are presented.

Objective
Understanding computation by neurons and neuronal circuits is one of the great challenges of science. Many different disciplines can contribute their tools and concepts to solving mysteries of neuronal computation. The goal of this introductory course is to introduce the monocultures of physics, maths, computer science, engineering, biology, psychology, and even philosophy and history, to discover the enchantments and challenges that we all face in taking on this major 21st century problem and how each discipline can contribute to discovering solutions.

Content
This course considers the structure and function of biological neural networks at different levels. The function of neural networks lies fundamentally in their wiring and in the electro-chemical properties of nerve cell membranes. Thus, the biological structure of the nerve cell needs to be understood if biologically-realistic models are to be constructed. These simple models are used to estimate the electrical current flow through dendritic cables and explore how a more complex geometry of neurons influences this current flow. The active properties of nerves are studied to understand both sensory transduction and the generation and transmission of nerve impulses along axons. The concept of local neuronal circuits arises in the context of the rules governing the formation of nerve connections and topographic projections within the nervous system. Communication between neurons in the network can be thought of as information flow across synapses, which can be modified by experience. We need an understanding of the action of inhibitory and excitatory neurotransmitters and neuromodulators, so that the dynamics and logic of synapses can be interpreted. Finally, the neural architectures of feedforward and recurrent networks will be discussed in the context of co-ordination, control, and integration of sensory and motor information in neural networks.

252-4101-00L ACM-Lab
Does not take place this semester.

W 4 credits 3P A. Steger

Abstract
Solve programming problems from previous ACM Programming Contests (see http://acm.uva.es/problemset/); learn and use efficient programming methods and algorithms.

Objective
The objective of this course is to learn how to solve algorithmic problems given as descriptions in natural language, similar to those posed in ACM Programming Contests. This includes appropriate problem modeling, choice of suitable (combinatorial) algorithms, and their efficient implementation using C/C++ and the STL.

252-2600-05L Software Engineering Seminar
Number of participants limited to 22.

W 2 credits 2S M. Vechev

Abstract
The course is an introduction to research in software engineering, based on reading and presenting high quality research papers in the field. The instructor may choose a variety of topics or one topic that is explored through several papers.

Objective
The main goals of this seminar are 1) learning how to read and understand a recent research paper in computer science; and 2) learning how to present a technical topic in computer science to an audience of peers.

Content
The technical content of this course falls into the general area of software engineering but will vary from semester to semester.

252-2610-00L Foundations of Eiffel-Programming
Nur geeignet für Repetenten der Basprüfung nach Studienreglement 2008

Z 0 credits 2G H. Lehner

Objective
- The Students
  - know Eiffel-specific language concepts and terminology
  - understand the basic concepts of object-oriented programming using Eiffel
  - are able to apply this knowledge to solve algorithmic tasks on their own
  - can write software specifications using Eiffel contracts

Content
Complementary service for the lecture "Einführung in die Programmierung" of the fall semester 2015 for students in the bachelor regulations 08.

Lecture notes
Students can enroll in this course for optional preparation for the exam of the mentioned lecture.

All material and information of this course is available on the webpage http://tec.inf.ethz.ch/gep/ (in german).
- Have been enrolled in "Einführung in die Programmierung" in fall semester 2015
- are studying in the bachelor regulations 08

GESS Science in Perspective

Recommended Science in Perspective (Type B) for D-INFK.

see Science in Perspective: Type A: Enhancement of Reflection Capability

Language Courses

see Science in Perspective: Language Courses ETH/UZH

Bachelor's Thesis

The Bachelor thesis is the final requirement of the BSc program and is supervised by one of the D-INFK professors. The thesis encourages students to show and produce a scientifically structured work.

Objective

In their BSc thesis students should demonstrate their ability to carry out independent, structured scientific work.

Prerequisites / notice

The supervisor of the thesis defines the task, start and end date.

A written report will be prepared on the scientific studies carried out, followed by a final presentation.

The thesis must be handed in within 6 months.

Computer Science Bachelor - Key for Type

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>252-0500-00L</td>
<td>Bachelor's Thesis</td>
<td>O</td>
<td>10 credits</td>
<td>21D</td>
<td>Professors</td>
</tr>
</tbody>
</table>

Key for Hours

- V: lecture
- G: lecture with exercise
- U: exercise
- S: seminar
- K: colloquium
- P: practical/laboratory course
- A: independent project
- D: diploma thesis
- R: revision course / private study

ECTS: European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
At the end of the seminar, participants will be in a position to further educate themselves in the field of research into teaching and learning.

Abstract
This course looks into scientific theories and also empirical studies on human learning and relates them to the school.

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

Content
Thematic Schwerpunkte:

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

Lernformen:
Theory and methodological constructs are combined with selected experimental studies in performance measurement and educational diagnostics and study them on the basis of different current issues.

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

Content
The concrete contents of the seminars are elaborated on the basis of the preferences of the participants and from the discussed work. The framework is given in such a manner that aspects of tests and seminars are included in the framework of the start of the semesters. The goals of the tests will be given in such a manner that they can be applied in the practical work in the future. The content is given in such a manner that the work is the key issue.
In this class, students will learn concepts and skills for coping with psychosocial demands of teaching.

**851-0242-05L**  
**Cognitively Activating Instructions in MINT Subjects**  
**W**  
2 credits  
2S  
R. Schumacher

This course unit can only be enrolled after successful participation in, or during enrollment in the course "Human Learning (EW 1)".

### Abstract

This seminar focuses on teaching units in chemistry, physics and mathematics that have been developed at the MINT Learning Center of the ETH Zurich. In the first meeting, the mission of the MINT Learning Center will be communicated. Furthermore, in groups of two, the students will intensively work on, refine and optimize a teaching unit following a goal set in advance.

### Objective

- Get to know cognitively activating instructions in MINT subjects
- Get information about recent literature on learning and instruction

### Prerequisites / notice

Für eine reibungslose Semesterplanung wird um frühe Anmeldung und persönliches Erscheinen zum ersten Lehrveranstaltungstermin ersucht.

**851-0242-07L**  
**Human Intelligence**  
**Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).**  
**W**  
1 credit  
1S  
E. Stern, P. Edelsbrunner, B. Rütsche

This course unit can only be enrolled after successful participation in, or during enrollment in the course "Human Learning (EW 1)".

### Abstract

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

### Objective

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

**851-0242-08L**  
**Research Methods in Educational Science**  
**Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).**  
**W**  
1 credit  
1S  
P. Edelsbrunner, B. Rütsche, E. Stern, E. Ziegler

This course unit can only be enrolled after successful participation in, or during enrollment in the course "Human Learning (EW 1)".

### Abstract

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

### Objective

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

### Subject Didactics and Professional Training

**Number**  
272-0101-00L  
**Subject Didactics of Computer Science I**  
Simultaneous enrolment in Introductory Practical in Computer Science - course 272-0201-00L is compulsory.

### Abstract

The unit "Subject Didactics of Computer Science I" addresses key contributions of computer science to general education. The course deals with the thoughtful choice of educational contents for computer science classes, which takes into account its comprehensibility for different age groups as well as didactic approaches suitable for a successful knowledge transfer.

### Objective

The general objective of the course consists in highlighting the tight connection between the mathematical and algorithmic way of thinking and the approaches adopted by engineering disciplines, and in reflecting on teaching approaches for sustainable computer science teaching activities.

The students understand the fundamental concepts of computer science in the context of a broad and deep knowledge. Through this understanding, they manage to prepare teaching materials for a successful knowledge transfer and to pass their passion for the subject on to their pupils.

The students know various teaching methods as well as their advantages and disadvantages. They can handle inhomogeneous prior knowledge of the learners inside a class. Besides holding classes, the students do care about the individual pupil support.

They encourage the autonomy of the learners, manage to work with diverse target groups and to establish a positive learning environment.

The students are able to express themselves using a comprehensible and refined professional language, both in a spoken and a written way, and they master the basic terminology of computer science. Besides the English terms, they are familiar with the corresponding German expressions. The students are able to produce detailed, matured, linguistically correct and design-wise appealing teaching materials.
The course "Subject Didactics of Computer Science I" addresses key contributions of computer science to general education. The chosen topics support the young learners in developing a unique and indispensable way of thinking, in enhancing their understanding of our world as well as in achieving university education entrance qualifications.

The main topics of the course unit "Subject Didactics of Computer Science I" are the didactics of finite state automata, of formal languages and of the introduction to programming. The unit focuses on contents of computer science that contribute to general education. This involves the understanding of fundamental scientific concepts such as algorithm, complexity, determinism, computation, automata, verification, testing and programming language as well as the way to embed them into a scientifically sound and didactically sustainable computer science course.

In a semester exercise, the students develop and document an adaptive teaching unit for computer science. They learn to employ the didactics methods and techniques that are introduced at the beginning of the semester.

- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist-subject didactics and pedagogical angle and potentially from a social angle too.
- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

The course "Subject Didactics of Computer Science I" addresses key contributions of computer science to general education. The chosen topics support the young learners in developing a unique and indispensable way of thinking, in enhancing their understanding of our world as well as in achieving university education entrance qualifications.

The main topics of the course unit "Subject Didactics of Computer Science I" are the didactics of finite state automata, of formal languages and of the introduction to programming. The unit focuses on contents of computer science that contribute to general education. This involves the understanding of fundamental scientific concepts such as algorithm, complexity, determinism, computation, automata, verification, testing and programming language as well as the way to embed them into a scientifically sound and didactically sustainable computer science course.

In a semester exercise, the students develop and document an adaptive teaching unit for computer science. They learn to employ the didactics methods and techniques that are introduced at the beginning of the semester.

Lecture notes

Prerequisites / notice

Dokument: schriftliche Vorbereitung für Prüfungslektionen.

Wird von der Praktikumslehrperson bestimmt.


Lecturer: J. Hromkovic

**271-0102-00L Teaching Internship Including Examination Lessons in Computer Science**

- Teaching Internship Computer Science for TC and Teaching Diploma Computer Science as Minor Subject.
- Repetition of the Teaching Internship is excluded even if Examination Lessons are to be repeated.

**Abstract**

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

**Objective**

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

**Content**

The students are guided by the Auseinandersetzung with the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.

- The main topics of the course unit "Subject Didactics of Computer Science I" are the didactics of finite state automata, of formal languages and of the introduction to programming. The unit focuses on contents of computer science that contribute to general education. This involves the understanding of fundamental scientific concepts such as algorithm, complexity, determinism, computation, automata, verification, testing and programming language as well as the way to embed them into a scientifically sound and didactically sustainable computer science course.

- In a semester exercise, the students develop and document an adaptive teaching unit for computer science. They learn to employ the didactics methods and techniques that are introduced at the beginning of the semester.

**Lecture notes**

- Underlagen und Folien werden zur Verfügung gestellt.

**Literature**


**Prerequisites / notice**

- Lehrdiplom-Studenten müssen diese Lerneinheit zusammen mit dem Einführungspraktikum Informatik - 272-0201-00L - belegen.

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**272-0103-00L Mentored Work Subject Didactics Computer Science**

- Mentored Work Subject Didactics in Computer Science for TC, Teaching Diploma and Teaching Diploma Computer Science as Minor Subject.

**Abstract**

In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and teach 20 lessons independently. Two of them are as assessed as Examination Lessons. The unit focuses on contents of computer science that contribute to general education. This involves the understanding of fundamental scientific concepts such as algorithm, complexity, determinism, computation, automata, verification, testing and programming language as well as the way to embed them into a scientifically sound and didactically sustainable computer science course.

- In a semester exercise, the students develop and document an adaptive teaching unit for computer science. They learn to employ the didactics methods and techniques that are introduced at the beginning of the semester.

**Objective**

- The students are guided by the Auseinandersetzung with the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.
- The main topics of the course unit "Subject Didactics of Computer Science I" are the didactics of finite state automata, of formal languages and of the introduction to programming. The unit focuses on contents of computer science that contribute to general education. This involves the understanding of fundamental scientific concepts such as algorithm, complexity, determinism, computation, automata, verification, testing and programming language as well as the way to embed them into a scientifically sound and didactically sustainable computer science course.

- In a semester exercise, the students develop and document an adaptive teaching unit for computer science. They learn to employ the didactics methods and techniques that are introduced at the beginning of the semester.

**Content**

Die Studierenden sammeln Erfahrungen in der Unterrichtsführung, der Auseinandersetzung mit Lernenden, der Klassenbetreuung und der Lernformen.

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

- The main topics of the course unit "Subject Didactics of Computer Science I" are the didactics of finite state automata, of formal languages and of the introduction to programming. The unit focuses on contents of computer science that contribute to general education. This involves the understanding of fundamental scientific concepts such as algorithm, complexity, determinism, computation, automata, verification, testing and programming language as well as the way to embed them into a scientifically sound and didactically sustainable computer science course.

- In a semester exercise, the students develop and document an adaptive teaching unit for computer science. They learn to employ the didactics methods and techniques that are introduced at the beginning of the semester.

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**Specialized Courses in Respective Subject with Educational Focus**

**271-0102-00L Teaching Internship Including Examination Lessons in Computer Science**

**272-0103-00L Mentored Work Subject Didactics Computer Science**

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Data: 06.03.2019 12:57

Autumn Semester 2016

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<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>252-0535-00L</td>
<td>Machine Learning</td>
<td>W</td>
<td>8 credits</td>
<td>3V+2U+2A</td>
<td>J. M. Buhmann</td>
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<td></td>
<td><strong>Objective</strong></td>
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<td></td>
<td>Students will be familiarized with the most important concepts and algorithms for supervised and unsupervised learning; reinforce the statistics knowledge which is indispensable to solve modeling problems under uncertainty. Key concepts are the generalization ability of algorithms and systematic approaches to modeling and regularization. A machine learning project will provide an opportunity to test the machine learning algorithms on real world data.</td>
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<tr>
<td></td>
<td><strong>Content</strong></td>
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<tr>
<td></td>
<td>The theory of fundamental machine learning concepts is presented in the lecture, and illustrated with relevant applications. Students can deepen their understanding by solving both pen-and-paper and programming exercises, where they implement and apply famous algorithms to real-world data.</td>
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<tr>
<td></td>
<td><strong>Lecture notes</strong></td>
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<tr>
<td></td>
<td>No lecture notes, but slides will be made available on the course webpage.</td>
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<td></td>
<td><strong>Literature</strong></td>
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</table>

The course requires solid basic knowledge in analysis, statistics and numerical methods for CSE as well as practical programming experience for solving assignments. Students should at least have followed one previous course offered by the Machine Learning Institute (e.g., CIL or LIS) or an equivalent course offered by another institution.
The Internet is a typical example of a large-scale distributed computer system without central control, with users that are typically only interested in their own good. For instance, they are interested in getting high bandwidth for themselves, but don't care about others, and the same is true for computational load or download rates. Game theory provides a particularly well-suited model for the behavior and interaction of such selfish users and programs. Classic game theory dates back to the 1930s and typically does not consider algorithmic aspects at all. Only a few years back, algorithms and game theory have been considered together, in an attempt to reconcile selfish behavior of independent agents with the common good.

This course discusses algorithmic aspects of game-theoretic models, with a focus on recent algorithmic and mathematical developments. Rather than giving an overview of such developments, the course aims to study selected important topics in depth.

Outline:
- Introduction to classic game-theoretic concepts.
- Existence of stable solutions (equilibria), algorithms for computing equilibria, computational complexity.
- Speed of convergence of natural game playing dynamics such as best-response dynamics or regret minimization.
- Techniques for bounding the quality-loss due to selfish behavior versus optimal outcomes under central control (a.k.a. the 'Price of Anarchy').
- Design and analysis of mechanisms that induce truthful behavior or near-optimal outcomes at equilibrium.

Several copies of both books are available in the Computer Science library.

Prerequisites / notice
Audience: Although this is a Computer Science course, we encourage the participation from all students who are interested in this topic.

Requirements: You should enjoy precise mathematical reasoning. You need to have passed a course on algorithms and complexity. No knowledge of game theory is required.

Randomized Algorithms and Probabilistic Methods

Las Vegas & Monte Carlo algorithms; inequalities of Markov, Chebyshev, Chernoff; negative correlation; Markov chains: convergence, rapidly mixing; generating functions; Examples include: min cut, median, balls and bins, routing in hypercubes, 3SAT, card shuffling, random walks

Objective
After this course students will know fundamental techniques from probabilistic combinatorics for designing randomized algorithms and will be able to apply them to solve typical problems in these areas.

Content
Randomized Algorithms are algorithms that "flip coins" to take certain decisions. This concept extends the classical model of deterministic algorithms and has become very popular and useful within the last twenty years. In many cases, randomized algorithms are faster, simpler or just more elegant than deterministic ones. In the course, we will discuss basic principles and techniques and derive from them a number of randomized methods for problems in different areas.

Computer Science TC - Key for Type

O Compulsory
W+ Eligible for credits and recommended
W Eligible for credits

Key for Hours
V lecture
G lecture with exercise
U exercise
S seminar
K colloquium

ECTS European Credit Transfer and Accumulation System
Special students and auditors need special permission from the lecturers.
Computer Science Teaching Diploma

More informations at: https://www.ethz.ch/de/studium/didaktische-ausbildung/studienangebot-zulassung/lehrdiplom-fuer-maturitaetsschulen.html

► Computer Science as First Subject

►► Educational Science

Course offerings in the category Educational Science are listed under “Programme: Educational Science for Teaching Diploma and TC”.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
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<tbody>
<tr>
<td>851-0242-06L</td>
<td>Cognitively Activating Instructions in MINT Subjects</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>R. Schumacher</td>
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<tr>
<td></td>
<td>Enrolment only possible with matriculation in Teaching Diploma</td>
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<td></td>
<td>or Teaching Certificate (excluding Teaching Diploma Sport).</td>
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<td></td>
<td>This course unit can only be enrolled after successful</td>
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<td></td>
<td>participation in, or during enrollment in the course “Human Learning”</td>
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<td>(EW 1)”.</td>
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<tr>
<td>Abstract</td>
<td>This seminar focuses on teaching units in chemistry, physics</td>
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<td></td>
<td>and mathematics that have been developed at the MINT Learning Center</td>
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<td>of the ETH Zurich. In the first meeting, the mission of the MINT</td>
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<td>Learning Center will be communicated. Furthermore, in groups of two,</td>
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<td></td>
<td>the students will intensively work on, refine and optimize a</td>
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<td></td>
<td>teaching unit following a goal set in advance.</td>
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<tr>
<td>Objective</td>
<td>- Get to know cognitively activating instructions in MINT subjects</td>
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<td></td>
<td>- Get information about recent literature on learning and instruction</td>
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<tr>
<td>Prerequisites</td>
<td>Für eine reibungslose Semesterplanung wird um frühe Anmeldung und</td>
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<td>notice</td>
<td>persönliches Erscheinen zum ersten Lehrveranstaltungstermin</td>
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<tr>
<td>851-0242-07L</td>
<td>Human Intelligence</td>
<td>W</td>
<td>1</td>
<td>1S</td>
<td>E. Stern, P. Edelsbrunner,</td>
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<td></td>
<td>Enrolment only possible with matriculation in Teaching Diploma</td>
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<td>B. Rütsche</td>
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<td>or Teaching Certificate (excluding Teaching Diploma Sport).</td>
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<td></td>
<td>Number of participants limited to 30.</td>
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<td>This course unit can only be enrolled after successful</td>
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<td></td>
<td>participation in, or during enrollment in the course “Human Learning”</td>
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<td></td>
<td>(EW 1)”.</td>
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<tr>
<td>Abstract</td>
<td>This focus will be on the book “Intelligenz: Grosse Unterschiede und</td>
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<td></td>
<td>ihre Folgen” by Stern and Neubauer. Participation at the first</td>
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<td></td>
<td>meeting is obligatory. It is required that all participants read</td>
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<td>the complete book. Furthermore, in two meetings of 90 minutes,</td>
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<td>concept papers developed in small groups (5 - 10 students) will be</td>
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<td></td>
<td>discussed.</td>
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<tr>
<td>Objective</td>
<td>- Understanding research methods used in the empirical human sciences</td>
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<td>- Getting to know intelligence tests</td>
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<td></td>
<td>- Understanding findings relevant for education</td>
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<tr>
<td>851-0242-08L</td>
<td>Research Methods in Educational Science</td>
<td>W</td>
<td>1</td>
<td>1S</td>
<td>P. Edelsbrunner, B. Rütsche,</td>
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<td></td>
<td>Enrolment only possible with matriculation in Teaching Diploma</td>
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<td>E. Stern, E. Ziegler</td>
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<td>or Teaching Certificate (excluding Teaching Diploma Sport).</td>
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<td>Number of participants limited to 30.</td>
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<td>This course unit can only be enrolled after successful</td>
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<td>participation in, or during enrollment in the course “Human Learning”</td>
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<td>(EW 1)”.</td>
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<tr>
<td>Abstract</td>
<td>Literature from the learning sciences is critically discussed with a</td>
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<td></td>
<td>focus on research methods.</td>
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<td></td>
<td>At the first meeting, working groups will be assembled and</td>
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<td>meetings with those will be set up.</td>
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<td></td>
<td>In the small groups students will write critical essays about the</td>
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<td></td>
<td>read literature. At the third meeting, we will discuss the essays</td>
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<td></td>
<td>and develop research questions in group work.</td>
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<tr>
<td>Objective</td>
<td>- Understand research methods used in the empirical educational</td>
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<td>sciences</td>
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<td></td>
<td>- Understand and critically examine information from scientific</td>
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<td>journals and media</td>
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<td>- Understand pedagogically relevant findings from the empirical</td>
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<td></td>
<td>educational sciences</td>
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<tr>
<td>851-0242-09L</td>
<td>Student Research Projects: Practical Research on Learning and</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>A. Deiglmayr, P. Edelsbrunner,</td>
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<td></td>
<td>Instruction</td>
<td></td>
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<td>S. Hoffer, B. Rütsche,</td>
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<td></td>
<td>Number of participants limited to 20.</td>
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<td></td>
<td></td>
<td>L. Schalk, E. Stern, E.</td>
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<tr>
<td></td>
<td>The successful completion of both course no. 851-0240-00L</td>
<td></td>
<td></td>
<td></td>
<td>Ziegler</td>
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<tr>
<td></td>
<td>“Menschliches Lernen (EW 1)” and course no. 851-0239-01L</td>
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<td></td>
<td>“Unterstützung und Diagnose von Wissenserwerbsprozessen (EW 3)” is a</td>
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<td></td>
<td>necessary prerequisite for this course.</td>
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<tr>
<td>Abstract</td>
<td>In teams of two, participants in this seminar conduct their own</td>
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<tr>
<td></td>
<td>research project. Each team is advised by one of the researchers</td>
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<td></td>
<td>serving as lecturers in this course. Basic conceptual and</td>
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<td></td>
<td>methodological issues are the topic of a series of plenary</td>
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<td>meetings; however, the major part of the work is done in</td>
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<td>small-group meetings with the advising researcher, and in</td>
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<td>self-directed research projects.</td>
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<tr>
<td>Objective</td>
<td>The course is targeted at advanced students who have taken an</td>
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<td></td>
<td>interest in gathering practical research experience in the field of</td>
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<td>Learning &amp; Instruction. In teams of two, students conduct their own</td>
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<td></td>
<td>research projects (planning, conducting, analyzing, interpreting,</td>
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<td></td>
<td>and presenting research); thus, the course requires a high amount</td>
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<td>of self-directed working. Students are personally advised, and</td>
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<td></td>
<td>supported in their research project, by one of the researchers</td>
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<td>serving as lecturers in this course. During the first half the</td>
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<td></td>
<td>semester, relevant methodological knowledge and skills are</td>
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<td>practiced during plenary meetings and in students’ independent</td>
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<td>reading (e.g. generating and testing research questions, designing</td>
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<td>experiments, and analyzing data in the field of Learning and</td>
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<td></td>
<td>Instruction)</td>
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<tr>
<td>Learning goals</td>
<td>- Participants can illustrate and explain basic methods and concepts</td>
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<td>for research in the fields of Learning and Instruction, e.g. with</td>
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<td>the help of practical examples.</td>
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<td>- Participants can generate testable research questions for a topic</td>
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<td>relevant in the fields of Learning and Instruction.</td>
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<td>- Participants can design and conduct a study that is relevant for</td>
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<td>answering their research question.</td>
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<td>- Participants can summarize and evaluate the main results from a</td>
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<td>study in the field of learning and Instruction, with regard to the</td>
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<td>research question being asked.</td>
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see Educational Science Teaching Diploma

►► Subject Didactics in Computer Science

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>272-0101-00L</td>
<td>Subject Didactics in Computer Science</td>
<td>O</td>
<td>4</td>
<td>3G</td>
<td>G. Serafini, J. Hromkovic</td>
</tr>
<tr>
<td></td>
<td>Simultaneous enrolment in Introductory Practical in</td>
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Data: 06.03.2019 12:57  Autumn Semester 2016  Page 812 of 1571
Abstract
The unit "Subject Didactics of Computer Science I" addresses key contributions of computer science to general education. The course deals with the thoughtful choice of educational contents for computer science classes, which takes into account its comprehensibility for different age groups as well as didactic approaches suitable for a successful knowledge transfer.

Objective
The general objective of the course consists in highlighting the tight connection between the mathematical and algorithmic way of thinking and the approaches adopted by engineering disciplines, and in reflecting on teaching approaches for sustainable computer science teaching activities.

The students understand the fundamental concepts of computer science in the context of a broad and deep knowledge. Through this understanding, they manage to prepare teaching materials for a successful knowledge transfer and to pass their passion for the subject on to their pupils.

The students know various teaching methods as well as their advantages and disadvantages. They can handle inhomogeneous prior knowledge of the learners inside a class. Besides holding classes, the students do care about the individual pupil support.

They encourage the autonomy of the learners, manage to work with diverse target groups and to establish a positive learning environment.

The students are able to express themselves using a comprehensible and refined professional language, both in a spoken and a written way, and they master the basic terminology of computer science. Besides the English terms, they are familiar with the corresponding German expressions. The students are able to produce detailed, matured, linguistically correct and design-wise appealing teaching materials.

Content
The course "Subject Didactics of Computer Science I" addresses key contributions of computer science to general education. The chosen topics support the young learners in developing a unique and indispensable way of thinking, in enhancing their understanding of our world as well as in achieving university education entrance qualifications.

The main topics of the course unit "Subject Didactics of Computer Science I" are the didactics of finite state automata, of formal languages and of the introduction to programming. The unit focuses on contents of computer science that contribute to general education. This involves the understanding of fundamental scientific concepts such as algorithm, complexity, determinism, computation, automata, verification, testing and programming language as well as the way to embed them into a scientifically sound and didactically sustainable computer science course.

In a semester exercise, the students develop and document an adaptive teaching unit for computer science. They learn to employ the didactics methods and techniques that are introduced at the beginning of the semester.

Lecture notes
Unterlagen und Folien werden zur Verfügung gestellt.

Literature
Die Literatur ist themenspezifisch. Die Studierenden beschaffen sie sich in der Regel selber (siehe Lernziele). In besonderen Fällen wird Lehramts- oder Lehre Diplom-Studierende müssen diese Lerneinheit zusammen mit dem Einführungspraktikum Informatik - 272-0201-00L - belegen.

Prerequisites / notice

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Type</th>
<th>Lecturer</th>
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</thead>
<tbody>
<tr>
<td>272-0103-00L</td>
<td>Mentored Work Subject Didactics Computer Science</td>
<td>2</td>
<td>O</td>
<td>J. Hromkovic, G. Serafini</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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<th>Type</th>
<th>Lecturer</th>
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<tbody>
<tr>
<td>272-0104-00L</td>
<td>Mentored Work Subject Didactics Computer Science</td>
<td>2</td>
<td>O</td>
<td>J. Hromkovic, G. Serafini</td>
</tr>
</tbody>
</table>

Prerequisites / notice
Die Arbeit sollte vor Beginn des Praktikums abgeschlossen werden.
The objective is for the students:
- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.
- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

Thematic Schwerpunkte
Die Gegenstände der mentorierten Arbeit in Fachdidaktik stammen in der Regel aus dem gymnasialen Unterricht.

Lernformen

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

Professional Training

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Lecturers</th>
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<tr>
<td>272-0201-00L</td>
<td>Introductory Practical in Computer Science I - course 272-0101-00L</td>
<td>O</td>
<td>3</td>
<td>6P</td>
<td>J. Hromkovic, G. Serafini</td>
</tr>
<tr>
<td>272-0202-00L</td>
<td>Professional Exercises</td>
<td>O</td>
<td>2</td>
<td>4U</td>
<td>J. Hromkovic, G. Serafini</td>
</tr>
<tr>
<td>272-0203-00L</td>
<td>Teaching Internship Computer Science I</td>
<td>O</td>
<td>8</td>
<td>17P</td>
<td>J. Hromkovic, G. Serafini</td>
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<tr>
<td>272-0204-00L</td>
<td>Teaching Internship for students upgrading TC to Teaching Diploma</td>
<td>W</td>
<td>4</td>
<td>9P</td>
<td>J. Hromkovic, G. Serafini</td>
</tr>
</tbody>
</table>

Data: 06.03.2019 12:57  Autumn Semester 2016  Page 814 of 1571
Die Studierenden erfahren das Lektionsthema in der Regel eine Woche vor dem Prüfungstermin. Von der zuständigen Lehrperson erhalten

In the context of an examination lesson conducted and graded at a high school, the candidates provide evidence of the subject-matter-based and didactic skills they have acquired in the course of their training.

On the basis of a specified topic, the candidate shows that they are in a position to develop and conduct teaching that is conducive to learning at high school level, substantiating it in terms of the subject-matter and from the didactic angle.

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

2 credits
Examination Lesson I in Computer Science

Simultaneous enrolment in "Examination Lesson II in Computer Science" (272-0205-01L) is compulsory.

In the context of an examination lesson conducted and graded at a high school, the candidates provide evidence of the subject-matter-based and didactic skills they have acquired in the course of their training.

On the basis of a specified topic, the candidate shows that they are in a position to develop and conduct teaching that is conducive to learning at high school level, substantiating it in terms of the subject-matter and from the didactic angle.

Die gehaltene Lektion wird kriteriernbasiert beurteilt. Die Beurteilung umfasst auch die schriftliche Vorbereitung und ein mündliche Reflexion des Kandidaten/ der Kandidatin über die gehaltene Lektion im Rahmen eines kurzen Kolloquiums.

Dokument: Schriftliche Vorbereitung für Prüfungsektionen.

Nach Abschluss der übrigen Ausbildung.

Teaching Diploma in 2 Subjects in One-Step Procedure: no courses from this category have to be completed.

Number Title Type ECTS Hours Lecturers
272-0400-00L Mentored Work Specialised Courses in the Respective Subject with Educational Focus Computer Sc A
2 credits 4A J. Hromkovic, G. Serafini

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

The aim is for the students to familiarise themselves with a new topic by obtaining material and studying the sources, so that they can selectively extend their specialist competence in this way.

Themenatische Schwerpunkte:

Lernformen:

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

Die Arbeit sollte vor Beginn des Praktikums abgeschlossen werden.

272-0401-00L Mentored Work Specialised Courses in the Respective Subject with Educational Focus Computer Sc B
2 credits 4A J. Hromkovic, G. Serafini

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

The aim is for the students to familiarise themselves with a new topic by obtaining material and studying the sources, so that they can selectively extend their specialist competence in this way.

- To try out different options for specialist further training in their profession.

2 credits
Examination Lesson II in Computer Science

Simultaneous enrolment in "Examination Lesson I in Computer Science" (272-0205-00L) is compulsory.

In the context of an examination lesson conducted and graded at a high school, the candidates provide evidence of the subject-matter-based and didactic skills they have acquired in the course of their training.

On the basis of a specified topic, the candidate shows that they are in a position to develop and conduct teaching that is conducive to learning at high school level, substantiating it in terms of the subject-matter and from the didactic angle.

Die gehaltene Lektion wird kriteriernbasiert beurteilt. Die Beurteilung umfasst auch die schriftliche Vorbereitung und ein mündliche Reflexion des Kandidaten/ der Kandidatin über die gehaltene Lektion im Rahmen eines kurzen Kolloquiums.

Dokument: Schriftliche Vorbereitung für Prüfungsektionen.

Nach Abschluss der übrigen Ausbildung.
Content
Thematic objectives:
The course aims to introduce students to the fundamental concepts and algorithms of machine learning, focusing on supervised and unsupervised learning.

Learning outcomes:
Students will be able to:
- Understand and apply the key concepts and algorithms of machine learning.
- Solve problems using machine learning algorithms.
- Design and implement machine learning solutions.

Literature

Prerequisites
Students should have a basic understanding of probability, statistics, and linear algebra. Familiarity with a programming language (e.g., Python or R) is also recommended.

Content
- Introduction to machine learning
- Supervised learning: classification
- Supervised learning: regression
- Unsupervised learning: clustering
- Unsupervised learning: dimensionality reduction
- Ensemble methods
- Time series analysis

Objective
Students will be able to:
- Understand and apply the fundamental concepts of machine learning.
- Design and implement machine learning solutions.
- Evaluate the performance of machine learning algorithms.

Course structure
The course is divided into four main parts:
- Introduction to machine learning
- Supervised learning
- Unsupervised learning
- Advanced topics in machine learning

Assessment
- Midterm exam (30%)
- Final exam (40%)
- Project (30%)

Grading
Grades will be assigned based on the following criteria:
- Participation in class discussions
- Quality and completeness of assignments
- Performance on exams and projects
The Internet is a typical example of a large-scale distributed computer system without central control, with users that are typically only interested in their own good. For instance, they are interested in getting high bandwidth for themselves, but don't care about others, and the same is true for computational load or download rates. Game theory provides a particularly well-suited model for the behavior and interaction of such selfish users and programs. Classic game theory dates back to the 1930s and typically does not consider algorithmic aspects at all. Only a few years back, algorithms and game theory have been considered together, in an attempt to reconcile selfish behavior of independent agents with the common good.

This course discusses algorithmic aspects of game-theoretic models, with a focus on recent algorithmic and mathematical developments. Rather than giving an overview of such developments, the course aims to study selected important topics in depth.

Outline:
- Introduction to classic game-theoretic concepts.
- Existence of stable solutions (equilibria), algorithms for computing equilibria, computational complexity.
- Speed of convergence of natural game playing dynamics such as best-response dynamics or regret minimization.
- Techniques for bounding the quality-loss due to selfish behavior versus optimal outcomes under central control (a.k.a. the 'Price of Anarchy').
- Design and analysis of mechanisms that induce truthful behavior or near-optimal outcomes at equilibrium.
- Selected current research topics, such as Google's Sponsored Search Auction, the U.S. FCC Spectrum Auction, Kidney Exchange.

Several copies of both books are available in the Computer Science library.

Audience: Although this is a Computer Science course, we encourage the participation from all students who are interested in this topic.

Requirements: You should enjoy precise mathematical reasoning. You need to have passed a course on algorithms and complexity. No knowledge of game theory is required.

Compulsory Elective Courses

Further course offerings from the category Educational Science are listed under "Programme: Educational Science for Teaching Diploma and TC".

see Compulsory Elective Courses Teaching Diploma

Additional Requirements (ETH-Masterstudents in PHYS/MATH/CSE)

Part 1

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>252-0057-00L</td>
<td>Theoretical Computer Science</td>
<td>O</td>
<td>8</td>
<td>4V+2U+1A</td>
<td>J. Hromkovic</td>
</tr>
</tbody>
</table>

Abstract

Concepts to cope with: a) what can be accomplished in a fully automated fashion (algorithmically solvable) b) How to measure the inherent difficulty of tasks (problems) c) What is randomness and how can it be useful? d) What is nondeterminism and what role does it play in CS? e) How to represent infinite objects by finite automata and grammars?

Objective

Learning the basic concepts of computer science along their historical development

Content

This lecture gives an introduction to theoretical computer science, presenting the basic concepts and methods of computer science in its historical context. We present computer science as an interdisciplinary science which, on the one hand, investigates the border between the possible and the impossible and the quantitative laws of information processing, and, on the other hand, designs, analyzes, verifies, and implements computer systems.

The main topics of the lecture are:

- alphabets, words, languages, measuring the information content of words, representation of algorithmic tasks
- finite automata, regular and context-free grammars
- Turing machines and computability
- complexity theory and NP-completeness
- design of algorithms for hard problems

The lecture is covered in detail by the textbook "Theoretical Computer Science".

Basic literature:


Further reading:


More exercises and examples in:

6. A. Aseroth, Ch. Baier: Theoretische Informatik

During the semester, two non-obligatory test exams will be offered.
This course is about fundamental algorithm design paradigms, classic algorithmic problems, and data structures. The connection between the operating system and hardware. Two main themes are correctness issues (esp. those that arise from the finite representation of data) and performance issues (incl. measurement and tuning issues). The interface to the operating system is discussed to prepare for subsequent classes on more advanced systems topics.

The two key goals are:

1) To equip students with a thorough understanding of how to write correct programs that run fast on modern computer, and
2) How to write correct and efficient low-level systems code.

This course does not cover how to design or build a processor or computer.

This course provides an overview of "computers" as a platform for the execution of (compiled) computer programs. This course provides a programmer's view of how computer systems execute programs, store information, and communicate. The course introduces the major computer architecture structures that have direct influence on the execution of programs (processors with registers, caches, other levels of the memory hierarchy, supervisor/kernel mode, and I/O structures) and covers implementation and representation issues only to the extent that they are necessary to understand the structure and operation of a computer system.

The course attempts to expose students to the practical issues that affect performance, portability, security, robustness, and extensibility. This course provides a foundation for subsequent courses on operating systems, networks, compilers and many other courses that require an understanding of the system-level issues. Topics covered include: machine-level code and its generation by optimizing compilers, address translation, input and output, trap/event handlers, performance evaluation and optimization (with a focus on the practical aspects of data collection and analysis).

### Literature

- The course is based in part on "Computer Systems: A Programmer's Perspective" (2nd Edition) by R. Bryant and D. O'Hallaron, with some additional material.
- Randomized Algorithms by R. Motwani und P. Raghavan;
- Linear Programming, Randomized Algebraic Algorithms (matchings), Probabilistically Checkable Proofs (introduction).

### Prerequisites

252-0024-00L Parallel Programming, 252-0014-00L Digital Circuits

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### Part 2

#### Number

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>252-0209-00L</td>
<td>Algorithms, Probability, and Computing</td>
<td>W</td>
<td>8</td>
<td>4V+2U+1A</td>
<td>E. Welzl, M. Ghaflari, A. Steger, P. Widmayer</td>
</tr>
</tbody>
</table>

#### Abstract

This course is about fundamental algorithm design paradigms, classic algorithmic problems, and data structures. The connection between algorithms and data structures is explained for geometric and graph problems. For this purpose, fundamental graph theoretic concepts are introduced.

#### Objective

An understanding of the design and analysis of fundamental algorithms and data structures.

#### Content


#### Literature


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### Computer Science as Second Subject

**Important:** You can only enrol in the courses of subject didactics and professional training as a subsidiary subject if you have not more than 12 CP left for additional requirements.

#### Subject Didactics in Computer Science

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>272-0101-00L</td>
<td>Subject Didactics of Computer Science I</td>
<td>O</td>
<td>4</td>
<td>3G</td>
<td>G. Serafini, J. Hromkovic</td>
</tr>
</tbody>
</table>

Simultaneous enrolment in Introductory Practical in
Computer Science - course 272-0201-00L - is compulsory.

**Abstract**
The unit "Subject Didactics of Computer Science I" addresses key contributions of computer science to general education. The course deals with the thoughtful choice of educational contents for computer science classes, which takes into account its comprehensibility for different age groups as well as didactic approaches suitable for a successful knowledge transfer.

**Objective**
The general objective of the course consists in highlighting the tight connection between the mathematical and algorithmic way of thinking and the approaches adopted by engineering disciplines, and in reflecting on teaching approaches for sustainable computer science teaching activities.

The students understand the fundamental concepts of computer science in the context of a broad and deep knowledge. Through this understanding, they manage to prepare teaching materials for a successful knowledge transfer and to pass their passion for the subject on to their pupils.

The students know various teaching methods as well as their advantages and disadvantages. They can handle inhomogeneous prior knowledge of the learners inside a class. Besides holding classes, the students do care about the individual pupil support.

They encourage the autonomy of the learners, manage to work with diverse target groups and to establish a positive learning environment.

The students are able to express themselves using a comprehensible and refined professional language, both in a spoken and a written way, and they master the basic terminology of computer science. Besides the English terms, they are familiar with the corresponding German expressions. The students are able to produce detailed, matured, linguistically correct and design-wise appealing teaching materials.

**Content**
The course "Subject Didactics of Computer Science I" addresses key contributions of computer science to general education. The chosen topics support the young learners in developing a unique and indispensable way of thinking, in enhancing their understanding of our world as well as in achieving university education entrance qualifications.

The main topics of the course unit "Subject Didactics of Computer Science I" are the didactics of finite state automata, of formal languages and of the introduction to programming. The unit focuses on contents of computer science that contribute to general education. This involves the understanding of fundamental scientific concepts such as algorithm, complexity, determinism, computation, automata, verification, testing and programming language as well as the way to embed them into a scientifically sound and didactically sustainable computer science course.

In a semester exercise, the students develop and document an adaptive teaching unit for computer science. They learn to employ the didactics methods and techniques that are introduced at the beginning of the semester.

**Lecture notes**
Unterlagen und Folien werden zur Verfügung gestellt.

**Literature**

**Prerequisites**
Lehrdiplom-Studierende müssen diese Lernheit zusammen mit dem Einführungspraktikum Informatik - 272-0201-00L - belegen.

### 272-0103-00L Mentored Work Subject Didactics Computer Science

**Abstract**
In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.

**Objective**
The objective is for the students:
- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.
- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

**Content**
Thematic Schwerpunkte
Die Gegenstände der mentorierten Arbeit in Fachdidaktik stammen in der Regel aus dem gymnasialen Unterricht.

**Lernformen**

**Literature**
Die Literatur ist themenspezifisch. Die Studierenden beschaffen sie sich in der Regel selber (siehe Lernziele). In besonderen Fällen wird sie vom Betreuer zur Verfügung gestellt.

**Prerequisites**
Die Arbeit sollte vor Beginn des Praktikums abgeschlossen werden.

### 272-0104-00L Mentored Work Subject Didactics Computer Science

**Abstract**
In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.

**Prerequisites**
Lehrdiplom-Studierende müssen diese Lernheit zusammen mit dem Einführungspraktikum Informatik - 272-0201-00L - belegen.
Objective
The objective is for the students:
- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.
- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

Content
Thematische Schwerpunkte
Die Gegenstände der mentorierten Arbeit in Fachdidaktik stammen in der Regel aus dem gymnasialen Unterricht.

Lernformen

Literatur
Die Literatur ist themenspezifisch. Die Studierenden beschaffen sie sich in der Regel selber (siehe Lernziele). In besonderen Fällen wird sie vom Betreuer zur Verfügung gestellt.

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

Professional Training in Computer Science

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>271-0102-00L</td>
<td>Teaching Internship Including Examination Lessons in Computer Science</td>
<td>O</td>
<td>4</td>
<td>9 P</td>
<td>J. Hromkovic, G. Serafini</td>
</tr>
<tr>
<td></td>
<td>Teaching Internship Computer Science for TC and Teaching Diploma Computer Science as Minor Subject</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Repetition of the Teaching Internship is excluded even if Examination Lessons are to be repeated</td>
<td></td>
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<td></td>
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</tr>
</tbody>
</table>

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

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

Content

Lecture notes
Dokument: schriftliche Vorbereitung für Prüfungslektionen.

Literature
Wird von der Praktikumslehrperson bestimmt.

Computer Science Teaching Diploma - Key for Type

<table>
<thead>
<tr>
<th></th>
<th>Compulsory</th>
<th>E-</th>
<th>Recommended, not eligible for credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
</tbody>
</table>

Key for Hours

<table>
<thead>
<tr>
<th></th>
<th>lecture</th>
<th>P</th>
<th>practical/laboratory course</th>
</tr>
</thead>
<tbody>
<tr>
<td>G</td>
<td>lecture with exercise</td>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
<td>R</td>
<td>revision course / private study</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
<td></td>
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</tr>
</tbody>
</table>

ECTS
European Credit Transfer and Accumulation System
- Special students and auditors need special permission from the lecturers.

Objective
The objective of this course is to learn how to solve algorithmic problems given by a textual description. This includes appropriate problem modeling, choice of suitable (combinatorial) algorithms, and implementing them (using C/C++, STL, CGAL, and BGL).

Literature

263-0007-00L
Advanced Systems Lab

Objective
The goal of this course is to teach students how to evaluate the performance of complex computer and software systems. Accordingly, the methodology to carry out experiments and measurements is studied. Furthermore, the modelling of systems with the help of queueing network systems is explained.

Literature

263-0006-00L
Algorithms Lab

Objective
Students learn how to solve algorithmic problems given by a textual description (understanding problem setting, finding appropriate modeling, choosing suitable algorithms, and implementing them). Knowledge of basic algorithms and data structures is assumed; more advanced material and usage of standard libraries for combinatorial algorithms are introduced in tutorials.

Literature
A. Steger, E. Welzl, P. Widmayer

Machine Learning

Abstract
Machine learning algorithms provide analytical methods to search data sets for characteristic patterns. Typical tasks include the classification of data, function fitting and clustering, with applications in image and speech analysis, bioinformatics and exploratory data analysis. This course is accompanied by practical machine learning projects.

Objective
Students will be familiarized with the most important concepts and algorithms for supervised and unsupervised learning; reinforce the statistics knowledge which is indispensable to solve modeling problems under uncertainty. Key concepts are the generalization ability of algorithms and systematic approaches to modeling and regularization. A machine learning project will provide an opportunity to test the machine learning algorithms on real world data.

Content
Topics covered in the lecture include:
- Bayesian theory of optimal decisions
- Maximum likelihood and Bayesian parameter inference
- Classification with discriminant functions: Perceptrons, Fisher’s LDA and support vector machines (SVM)
- Ensemble methods: Bagging and Boosting
- Regression: least squares, ridge and LASSO penalization, non-linear regression and the bias-variance trade-off
- Non parametric density estimation: Parzen windows, nearest neighbour
- Dimension reduction: principal component analysis (PCA) and beyond

Lecture notes
No lecture notes, but slides will be made available on the course webpage.

Literature

Prerequisites
The course requires solid basic knowledge in analysis, statistics and numerical methods for CSE as well as practical programming experience for solving assignments. Students should at least have followed one previous course offered by the Machine Learning Institute (e.g., CIL or LIS) or an equivalent course offered by another institution.

Computer Science Master

Focus Courses

Focus Courses in Computational Science

Focus Core Courses Computational Science

Computational Systems Biology

Abstract
Study of fundamental concepts, models and computational methods for the analysis of complex biological networks. Topics: Systems approaches in biology, biology and reaction network fundamentals, modeling and simulation approaches (topological, probabilistic, stoichiometric, qualitative, linear / nonlinear ODEs, stochastic), and systems analysis (complexity reduction, stability, identification).

Objective
The aim of this course is to provide an introductory overview of mathematical and computational methods for the modeling, simulation and analysis of biological networks.

Content
Biology has witnessed an unprecedented increase in experimental data and, correspondingly, an increased need for computational methods to analyze this data. The explosion of sequenced genomes, and subsequently, of bioinformatics methods for the storage, analysis and comparison of genetic sequences provides a prominent example. Recently, however, an additional area of research, captured by the label "Systems Biology," focuses on how networks, which are more than the mere sum of their parts' properties, establish biological functions. This is essentially a task of reverse engineering. The aim of this course is to provide an introductory overview of corresponding computational methods for the modeling, simulation and analysis of biological networks.

We will start with an introduction into the basic units, functions and design principles that are relevant for biology at the level of individual cells. Making extensive use of example systems, the course will then focus on methods and algorithms that allow for the investigation of biological networks with increasing detail. These include (i) graph theoretical approaches for revealing large-scale network organization, (ii) probabilistic (Bayesian) network representations, (iii) structural network analysis based on reaction stoichiometries, (iv) qualitative methods for dynamic modeling and simulation (Boolean and piece-wise linear approaches), (v) mechanistic modeling using ordinary differential equations (ODEs) and finally (vi) stochastic simulation methods.
### Focus Elective Courses Computational Science

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>LECTurers</th>
</tr>
</thead>
</table>

#### Abstract
This course covers some of the fundamental concepts of computer graphics, namely 3D object representations and generation of photorealistic images from digital representations of 3D scenes.

#### Objective
At the end of the course the students will be able to build a rendering system. The students will study the basic principles of rendering and image synthesis. In addition, the course is intended to stimulate the students' curiosity to explore the field of computer graphics in subsequent courses or on their own.

#### Content
This course covers fundamental concepts of modern computer graphics. Students will learn about 3D object representations and the details of how to generate photorealistic images from digital representations of 3D scenes. Starting with an introduction to 3D shape modeling and representation, texture mapping and ray-tracing, we will move on to acceleration structures, the physics of light transport, appearance modeling and global illumination principles and algorithms. We will end with an overview of modern image-based image synthesis techniques, covering topics such as lightfields and depth-image based rendering.

#### Lecture notes
no

#### Prerequisites / notice
Prerequisites:
Fundamentals of calculus and linear algebra, basic concepts of algorithms and data structures, programming skills in C++, Visual Computing course recommended.

The programming assignments will be in C++. This will not be taught in the class.

<table>
<thead>
<tr>
<th>Number</th>
<th>Introduction to Finite Elements and Sparse Linear System Solving</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>LECTurers</th>
</tr>
</thead>
<tbody>
<tr>
<td>263-5001-00L</td>
<td>Introduction to Finite Elements and Sparse Linear System Solving</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>P. Arbenz</td>
</tr>
</tbody>
</table>

#### Abstract
The finite element (FE) method is the method of choice for (approximately) solving partial differential equations on complicated domains. In the first third of the lecture, we give an introduction to the method. The rest of the lecture will be devoted to methods for solving the large sparse linear systems of equation that a typical for the FE method. We will consider direct and iterative methods.

#### Objective
Students will know the most important direct and iterative solvers for sparse linear systems. They will be able to determine which solver to choose in particular situations.

#### Content
I. THE FINITE ELEMENT METHOD

1. Introduction. model problems.
2. 1D problems. Piecewise polynomials in 1D.
3. 2D problems. Triangulations. Piecewise polynomials in 2D.
5. Implementation aspects.

II. DIRECT SOLUTION METHODS

6. LU and Cholesky decomposition.
7. Sparse matrices.

III. ITERATIVE SOLUTION METHODS

9. Stationary iterative methods, preconditioning.
11. Incomplete factorization preconditioning.
12. Multigrid preconditioning.
13. Nonsymmetric problems (GMRES, BiCGstab).

#### Literature

#### Prerequisites / notice
Prerequisites: Linear Algebra, Analysis, Computational Science.
The exercises are made with Matlab.

<table>
<thead>
<tr>
<th>Number</th>
<th>Computational Biology</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>LECTurers</th>
</tr>
</thead>
<tbody>
<tr>
<td>636-0017-00L</td>
<td>Computational Biology</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>T. Stadler, C. Magnus</td>
</tr>
</tbody>
</table>

The aim of the course is to provide up-to-date knowledge on how we can study biological processes using genetic sequencing data. Computational algorithms extracting biological information from genetic sequence data are discussed, and statistical tools to understand this information in detail are introduced.
Objective
Attendees will learn which information is contained in genetic sequencing data and how to extract information from them using computational tools. The main concepts introduced are:
- stochastic models in molecular evolution
- phylogenetic & phylodynamic inference
- maximum likelihood and Bayesian statistics

Content
The course consists of four parts. We first introduce modern genetic sequencing technology, and algorithms to obtain sequence alignments from the output of the sequencers. We then present methods to directly analyze this alignment (such as BLAST algorithm, GWAS approaches). Second, we introduce methods and concepts of molecular evolution, i.e. we discuss how genetic sequences change over time. Third, we employ evolutionary concepts to infer ancestral relationships between organisms based on their genetic sequences, i.e. we discuss methods to infer genealogies and phylogenies. Finally, we introduce the field of phylogeography. Throughout the class, the models and methods are illustrated on different datasets giving insight into the epidemiology and evolution of a range of infectious diseases (HIV, HCV, influenza, Ebola). Applications of the methods to the field of macroevolution provide insight into the evolution and ecology of different species clades. Students will be trained in the algorithms and their application both on paper and in silico as part of the exercises.

Lecture notes
Slides of the lecture will be available online.
https://www.bsse.ethz.ch/cb/materials.html

Literature
The course is not based on any of the textbooks below, but they are excellent choices as accompanying material:
- Drummond, A. & Bouckaert, R. 2015. Bayesian evolutionary analysis with BEAST

Prerequisites / notice
Basic knowledge in linear algebra, analysis, and statistics will be helpful. Some programming experience will be useful for the exercises, but is not required. Programming skills will not be tested in the examination.

151-0104-00L Uncertainty Quantification for Engineering & Life Sciences
Does not take place this semester.

Number of participants limited to 60.

Abstract
Quantification of uncertainties in computational models pertaining to applications in engineering and life sciences. Exploitation of massively available data to develop computational models with quantifiable predictive capabilities. Applications of Uncertainty Quantification and Propagation to problems in mechanics, control, systems and cell biology.

Objective
The course will teach fundamental concept of Uncertainty Quantification and Propagation (UQ+P) for computational models of systems in Engineering and Life Sciences. Emphasis will be placed on practical and computational aspects of UQ+P including the implementation of relevant algorithms in multicore architectures.

Content
Topics that will be covered include: Uncertainty quantification under parametric and non-parametric modeling uncertainty, Bayesian inference with model class assessment, Markov Chain Monte Carlo simulation, prior and posterior reliability analysis.

Lecture notes
The class will be largely based on the book: Data Analysis: A Bayesian Tutorial by Devinderjit Sivia as well as on class notes and related literature that will be distributed in class.

Literature
1. Data Analysis: A Bayesian Tutorial by Devinderjit Sivia
2. Probability Theory: The Logic of Science by E. T. Jaynes
3. Class Notes

Prerequisites / notice
Fundamentals of Probability, Fundamentals of Computational Modeling

Seminar Computational Science

Number Title Type ECTS Hours Lecturers
252-5701-00L Advanced Topics in Computer Graphics and Vision W 2 credits 2S M. Gross, O. Sorkine Hornung

Number of participants limited to 24.

Abstract
This seminar covers advanced topics in computer graphics, such as modeling, rendering, animation, real-time graphics, physical simulation, and computational photography. Each time the course is offered, a collection of research papers is selected and each student presents one paper to the class and leads a discussion about the paper and related topics.

Objective
The goal is to get an in-depth understanding of actual problems and research topics in the field of computer graphics as well as improve presentations and critical analysis skills.

Content
This seminar covers advanced topics in computer graphics, including both seminal research papers as well as the latest research results. Each time the course is offered, a collection of research papers are selected covering topics such as modeling, rendering, animation, real-time graphics, physical simulation, and computational photography. Each student presents one paper to the class and leads a discussion about the paper and related topics. All students read the papers and participate in the discussion.

Lecture notes
No script

Literature
Individual research papers are selected each term. See http://graphics.ethz.ch/ for the current list.

Prerequisites / notice
Prerequisites:
The courses "Computer Graphics I and II" (GDV I & II) are recommended, but not mandatory.

Focus Courses in Distributed Systems

Focus Core Courses Distributed Systems

Number Title Type ECTS Hours Lecturers
253-3800-00L Advanced Operating Systems W 6 credits 2V+2U+1A T. Roscoe

Abstract
This course is intended to give students a thorough understanding of design and implementation issues for modern operating systems, with a particular emphasis on the challenges of modern hardware features. We will cover key design issues in implementing an operating system, such as memory management, scheduling, protection, inter-process communication, device drivers, and file systems.
The goals of the course are, firstly, to give students a broader perspective on OS design than that provided by knowledge of Unix or Windows, building on the material in a standard undergraduate operating systems class, and secondly, to provide them with practical experience in dealing directly with the concurrency, resource management, and abstraction problems confronting OS designers and implementers.

This course is intended to give students a thorough understanding of design and implementation issues for modern operating systems, with a particular emphasis on the challenges of modern hardware features. We will cover key design issues in implementing an operating system, such as memory management, scheduling, protection, inter-process communication, device drivers, and file systems.

The course is based around a milestone-oriented project, where students work in small groups to implement major components of a microkernel-based operating system. The final assessment will be a combination grades awarded for milestones during the course of the project, a final written report on the work, and a set of test cases on the final code.

### Focus Elective Courses Distributed Systems

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>252-0437-00L</td>
<td>Distributed Algorithms</td>
<td>W</td>
<td>4</td>
<td>V</td>
<td>F. Mattern</td>
</tr>
<tr>
<td></td>
<td>Models of distributed computations, time space diagrams, virtual time, logical clocks and causality, wave algorithms, parallel and distributed graph traversal, consistent snapshots, mutual exclusion, election and symmetry breaking, distributed termination detection, garbage collection in distributed systems, monitoring distributed systems, global predicates.</td>
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<tr>
<td></td>
<td>Verteilte Algorithmen sind Verfahren, die dadurch charakterisiert sind, dass mehrere autonome Prozesse gleichzeitig Teile eines gemeinsamen Problems in kooperativer Weise bearbeiten und der dabei erforderliche Informationsaustausch ausschliesslich über Nachrichten erfolgt. Derartige Algorithmen kommen im Rahmen verteilter Systeme zum Einsatz, bei denen kein gemeinsamer Speicher existiert und die Übertragungszeit von Nachrichten i.a. nicht vernachlässigt werden kann. Da dabei kein Prozess eine aktuell konsistente Sicht des globalen Zustands besitzt, führt dies zu interessanten Problemen. Im einzelnen werden u.a. folgende Themen behandelt: Modelle verteilter Berechnungen; Raum-Zeit Diagramme; Virtuelle Zeit; Logische Uhren und Kausalität; Wellenalgorithmen; Verteilte und parallele Graphtraversierung; Berechnung konsistenter Schnappschüsse; Wechselseitiger Ausschluss; Elektion und Symmetriebrechung; Verteilte Terminierung; Garbage-Collection in verteilen Systemen; Beobachten verteilter Systeme; Berechnung globaler Prädikate.</td>
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</tbody>
</table>

- F. Mattern: Verteilte Basisalgorithmen, Springer-Verlag
- G. Tel: Topics in Distributed Algorithms, Cambridge University Press
- G. Tel: Introduction to Distributed Algorithms, Cambridge University Press, 2nd edition
- N. Lynch: Distributed Algorithms, Morgan Kaufmann Publ

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<tbody>
<tr>
<td>263-3900-00L</td>
<td>Communication Networks Seminar</td>
<td>W</td>
<td>2</td>
<td>S</td>
<td>T. Roscoe, A. Singla</td>
</tr>
<tr>
<td></td>
<td>Number of participants limited to 24.</td>
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<td></td>
<td>We will study recent advances in computer networking by reading and presenting research papers from recent iterations of the top conferences in the area, including NSDI, SIGCOMM, and CoNEXT.</td>
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<td></td>
<td>The objectives are (a) to understand the state-of-the-art in the field; (b) to learn to read, present and critique papers; and (c) to identify opportunities for new research.</td>
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<td>Students are expected to attend the entire seminar, choose a topic for presentation from a given list, and make a presentation on that topic. Students are evaluated on the knowledge gained, the presentation made, and the report they present at the end of the semester.</td>
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</thead>
<tbody>
<tr>
<td>263-3504-00L</td>
<td>Hardware Acceleration for Data Processing</td>
<td>W</td>
<td>2</td>
<td>S</td>
<td>G. Alonso, T. Hoefler, O. Mutlu</td>
</tr>
<tr>
<td></td>
<td>The seminar will cover topics related to data processing using new hardware in general and hardware accelerators (GPU, FPGA, specialized processors) in particular.</td>
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### Seminar Distributed Systems

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<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>252-0817-00L</td>
<td>Distributed Systems Laboratory</td>
<td>W</td>
<td>10</td>
<td>P</td>
<td>G. Alonso, F. Mattern, T. Roscoe, R. Wattenhofer</td>
</tr>
</tbody>
</table>

In the Master Programme max. 10 credits can be accounted by Labs on top of the IFocus Courses. These Labs will only count towards the Master Programme. Additional Labs will be listed on the Addendum.

This course involves the participation in a substantial development and/or evaluation project involving distributed systems technology. There are projects available in a wide range of areas: from web services to ubiquitous computing including wireless networks, ad-hoc networks, RFID, and distributed applications on smartphones.

The course involves the participation in a substantial development and/or evaluation project involving distributed systems technology. There are projects available in a wide range of areas: from web services to ubiquitous computing including wireless networks, ad-hoc networks, and distributed applications on smartphones. The goal of the project is for the students to gain hands-on-experience with real products and the latest technology in distributed systems. For information of the course or projects available, please contact Prof. Mattern, Prof. Wattenhofer, Prof. Roscoe or Prof. G. Alonso.

<table>
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</tbody>
</table>
Objective
The seminar will cover topics related to data processing using new hardware in general and hardware accelerators (GPU, FPGA, specialized processors) in particular.

Content
The general application areas are big data and machine learning. The systems covered will include systems from computer architecture, high performance computing, data appliances, and data centers.

Prerequisites / notice
Students taking this seminar should have the necessary background in systems and low level programming.

<table>
<thead>
<tr>
<th>227-0559-00L</th>
<th>Seminar in Distributed Computing</th>
<th>W</th>
<th>2 credits</th>
<th>2S</th>
<th>R. Wattenhofer</th>
</tr>
</thead>
</table>

Abstract
In this seminar participating students present and discuss recent research papers in the area of distributed computing. The seminar consists of algorithmic as well as systems papers in distributed computing theory, peer-to-peer computing, ad hoc and sensor networking, or multi-core computing.

Objective
In the last two decades, we have experienced an unprecedented growth in the area of distributed systems and networks; distributed computing now encompasses many of the activities occurring in today's computer and communications world. This course introduces the basics of distributed computing, highlighting common themes and techniques. We study the fundamental issues underlying the design of distributed systems: communication, coordination, synchronization, uncertainty. We explore essential algorithmic ideas and lower bound techniques.

In this seminar, students present the latest work in this domain.

Seminar language: English

Different each year. For details see: www.disco.ethz.ch/courses.html

Slides of presentations will be made available.

The actual paper selection can be found on www.disco.ethz.ch/courses.html.

##### Focus Courses in Information Security

##### Focus Core Courses Information Security

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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</thead>
<tbody>
<tr>
<td>252-0463-00L</td>
<td>Security Engineering</td>
<td>W</td>
<td>5</td>
<td>2V+2U</td>
<td>D. Basin</td>
</tr>
</tbody>
</table>

Abstract
Subject of the class are engineering techniques for developing secure systems. We examine concepts, methods and tools, applied within the different activities of the SW development process to improve security of the system. Topics: security requirements & risk analysis, system modeling & model-based development methods, implementation-level security, and evaluation criteria for secure systems.

Objective
Security engineering is an evolving discipline that unifies two important areas: software engineering and security. Software Engineering addresses the development and application of methods for systematically developing, operating, and maintaining, complex, high-quality software.

Security, on the other hand, is concerned with assuring and verifying properties of a system that relate to confidentiality, integrity, and availability of data.

The goal of this class is to survey engineering techniques for developing secure systems. We will examine concepts, methods, and tools that can be applied within the different activities of the software development process, in order to improve the security of the resulting systems.

Topics covered include

- security requirements & risk analysis,
- system modeling and model-based development methods,
- implementation-level security, and
- evaluation criteria for the development of secure systems
Security engineering is an evolving discipline that unifies two important areas: software engineering and security. Software Engineering addresses the development and application of methods for systematically developing, operating, and maintaining, complex, high-quality software.

Security, on the other hand, is concerned with assuring and verifying properties of a system that relate to confidentiality, integrity, and availability of data.

The goal of this class is to survey engineering techniques for developing secure systems. We will examine concepts, methods, and tools that can be applied within the different activities of the software development process, in order to improve the security of the resulting systems.

Topics covered include

* security requirements & risk analysis,
* system modeling and model-based development methods,
* implementation-level security, and
* evaluation criteria for the development of secure systems

Modules taught:

1. Introduction
   - Introduction of Infsec group and speakers
   - Security meets SW engineering: an introduction
   - The activities of SW engineering, and where security fits in
   - Overview of this class
2. Requirements Engineering: Security Requirements and some Analysis
   - overview: functional and non-functional requirements
   - use cases, misuse cases, sequence diagrams
   - safety and security
   - FMEA, FTA, attack trees
3. Modeling in the design activities
   - structure, behavior, and data flow
   - class diagrams, statecharts
4. Model-driven security for access control (design)
   - SecureUML as a language for access control
   - Combining Design Modeling Languages with SecureUML
   - Semantics, i.e., what does it all mean,
   - Generation
   - Examples and experience
5. Model-driven security (Part II)
   - Continuation of above topics
6. Security patterns (design and implementation)
7. Implementation-level security
   - Buffer overflows
   - Input checking
   - Injection attacks
8. Testing
   - overview
   - model-based testing
   - testing security properties
9. Risk analysis and management 1 (project management)
   - "risk": assets, threats, vulnerabilities, risk
   - risk assessment: quantitative and qualitative
   - safeguards
   - generic risk analysis procedure
   - The OCTAVE approach
10. Risk analysis: IT baseline protection
    - Overview
    - Example
11. Evaluation criteria
    - CMM
    - systems security engineering CMM
    - common criteria
12. Guest lecture
    - TBA

Literature

- Further relevant books and journal/conference articles will be announced in the lecture.

Prerequisites / notice

Prerequisite: Class on Information Security
Content
The first part of the lecture covers individual system's aspects starting with tamperproof or tamperresistant hardware in general over operating system related security mechanisms to application software systems such as host based intrusion detection systems. The main topics covered are: tamper resistant hardware, CPU support for security, protection mechanisms in the kernel, file system security (permissions / ACLs / network filesystem issues), IPC Security, mechanisms in more modern OS, such as Capabilities and Zones, Libraries and Software tools for security assurance, etc.

In the second part, the focus is on system design and methodologies for building secure systems. Topics include: patch management, common software faults (buffer overflows, etc.), writing secure software (design, architecture, QA, testing), compiler-supported security, language-supported security, logging and auditing (BSM audit, dtrace, ...), cryptographic support, and trustworthy computing (TGG, SGX).

Along the lectures, model cases will be elaborated and evaluated in the exercises.

263-4640-00L Network Security W 6 credits 2V+1U+2A A. Perrig, T. P. Dübendorfer, S. Frei
Abstract
This lecture discusses fundamental concepts and technologies in the area of network security. Several case studies illustrate the dark side of the Internet and explain how to protect against such threats. A hands-on computer lab that accompanies the lecture gives a deep dive on firewalls, penetration testing and intrusion detection.

Objective
Students are aware of current threats that Internet services and networked devices face and can explain appropriate countermeasures. Students can identify and assess known vulnerabilities in a software system that is connected to the Internet. Students know fundamental network security concepts. Students have an in-depth understanding of important security technologies. Students know how to configure a real firewall and know some penetration testing tools from their own experience.

Content
Risk management and the vulnerability lifecycle of software and networked services are discussed. Threats like denial of service, spam, worms, and viruses are studied in-depth. Fundamental security related concepts like identity, availability, authentication and secure channels are introduced. State of the art technologies like secure shell, network and transport layer security, intrusion detection and prevention systems, cross-site scripting, secure implementation techniques and more for securing the Internet and web applications are presented. Several case studies illustrate the dark side of the Internet and explain how to protect against current threats. A hands-on computer lab that accompanies the lecture gives a deep dive on firewalls, penetration testing and intrusion detection.

This lecture is intended for students with an interest in securing Internet services and networked devices. Students are assumed to have knowledge in networking as taught in the Communication Networks lecture.

Prerequisites / notice
Knowledge in computer networking and Internet protocols (e.g. course Communication Networks (D-ITET)) or Operating Systems and Networks (D-INFK).

Due to recent changes in the Swiss law, ETH requires each student of this course to sign a written declaration that he/she will not use the information given in this for illegal purposes. This declaration will have to be signed and submitted no later than at the beginning of the second lesson.

Focus Elective Courses Information Security

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>252-0811-00L</td>
<td>Applied Security Laboratory</td>
<td>W</td>
<td>8</td>
<td>7P</td>
<td>D. Basin</td>
</tr>
</tbody>
</table>

Abstract
In the Master Programme max. 10 credits can be accounted by Labs on top of the Interfocus Courses. Additional Labs will be listed on the Addendum.

Objective
The Applied Security Laboratory addresses four major topics: operating system security (hardening, vulnerability scanning, access control, logging), application security with an emphasis on web applications (web server setup, common web exploits, authentication, session handling, code security), computer forensics, and risk analysis and risk management.

Content
This course emphasizes applied aspects of Information Security. The students will study a number of topics in a hands-on fashion and carry out experiments in order to better understand the need for secure implementation and configuration of IT systems and to assess the effectiveness and impact of security measures. This part is based on a book and virtual machines that include example applications, questions, and answers.

The students will also complete an independent project: based on a set of functional requirements, they will design and implement a prototypical IT system. In addition, they will conduct a thorough security analysis and devise appropriate security measures for their systems. Finally, they will carry out a technical and conceptual review of another system. All project work will be performed in teams and must be properly documented.

Lecture notes

Literature
Recommended reading includes:
* Various: CWASP Guide to Building Secure Web Applications, available online
* Huseby: Innocent Code – A Security Wake-Up Call for Web Programmers, John Wiley & Sons. (permissions / ACLs / network filesystem issues), IPC Security, mechanisms in more modern OS, such as Capabilities and Zones, Libraries and Software tools for security assurance, etc.

Prerequisites / notice
* The lab allows flexible working since there are only few mandatory meetings during the semester.
* The lab covers a variety of different techniques. Thus, participating students should have a solid foundation in the following areas: information security, operating system administration (especially Unix/Linux), and networking. Students are also expected to have a basic understanding of HTML, PHP, JavaScript, and MySQL because several examples are implemented in these languages.
* Students must be prepared to spend more than three hours per week to complete the lab assignments and the project. This applies particularly to students who do not meet the recommended requirements given above. Successful participation of the course receive 8 credits as compensation for their effort.
* All participants must sign the lab's charter and usage policy during the introduction lecture.

252-1411-00L Security of Wireless Networks W 5 credits 2V+1U+1A S. Capkun
Abstract
Core Elements: Wireless communication channel, Wireless network architectures and protocols, Attacks on wireless networks, Protection techniques.

Objective
After this course, the students should be able to: describe and classify security goals and attacks in wireless networks; describe security architectures of the following wireless systems and networks: 802.11, GSM/UMTS, RFID, ad hoc/sensor networks; reason about security protocols for wireless network; implement mechanisms to secure 802.11 networks.
Security engineering is an evolving discipline that unifies two important areas: software engineering and security. The main goals of the seminar are the independent study of scientific literature and assessment of its contributions as well as learning and practicing presentation techniques. The seminar covers various topics in information security, including network security, cryptography and security protocols. The participants are expected to read a scientific paper and present it in a 35-40 min talk. At the beginning of the semester a short introduction to presentation techniques will be given.

### Selected Topics
- security protocols: models, specification & verification
- trust management, access control and non-interference
- side-channel attacks
- identity-based cryptography
- host-based attack detection
- anomaly detection in backbone networks
- key-management for sensor networks

### Literature
The reading list will be published on the course web site.

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<tr>
<td>252-0463-00L</td>
<td>Security Engineering</td>
<td>W</td>
<td>5 credits</td>
<td>2V+2U</td>
<td>D. Basin</td>
</tr>
</tbody>
</table>

The objective of the course is to bring the students up to a level where they should be able to read academic papers on state-of-the-art research areas and present them in an appropriate way. The goal of this class is to survey engineering techniques for developing secure systems. We will examine concepts, methods, and tools that can be applied within the different activities of the software development process, in order to improve the security of the resulting systems.

Topics covered include:
- security requirements & risk analysis,
- system modeling and model-based development methods,
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- evaluation criteria for the development of secure systems.
Security engineering is an evolving discipline that unifies two important areas: software engineering and security. Software Engineering addresses the development and application of methods for systematically developing, operating, and maintaining, complex, high-quality software.

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11. Evaluation criteria
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    - systems security engineering CMM
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12. Guest lecture
    - TBA

Literature
- Further relevant books and journal/conference articles will be announced in the lecture.

Prerequisites / notice
Prerequisite: Class on Information Security

Abstract
Machine learning algorithms provide analytical methods to search data sets for characteristic patterns. Typical tasks include the classification of data, function fitting and clustering, with applications in image and speech analysis, bioinformatics and exploratory data analysis. This course is accompanied by practical machine learning projects.

Objective
Students will be familiarized with the most important concepts and algorithms for supervised and unsupervised learning; reinforce the statistics knowledge which is indispensable to solve modeling problems under uncertainty. Key concepts are the generalization ability of algorithms and systematic approaches to modeling and regularization. A machine learning project will provide an opportunity to test the machine learning algorithms on real world data.

Machine Learning
W 8 credits 3V+2U+2A J. M. Buhmann

Autumn Semester 2016
The theory of fundamental machine learning concepts is presented in the lecture, and illustrated with relevant applications. Students can deepen their understanding by solving both pen-and-paper and programming exercises, where they implement and apply famous algorithms to real-world data.

Topics covered in the lecture include:
- Bayesian theory of optimal decisions
- Maximum likelihood and Bayesian parameter inference
- Classification with discriminant functions: Perceptrons, Fisher's LDA and support vector machines (SVM)
- Ensemble methods: Bagging and Boosting
- Regression: least squares, ridge and LASSO penalization, non-linear regression and the bias-variance trade-off
- Non-parametric density estimation: Parzen windows, nearest neighbour
- Dimension reduction: principal component analysis (PCA) and beyond

Lecture notes
No lecture notes, but slides will be made available on the course webpage.

Literature


Prerequisites / notice
The course requires solid basic knowledge in analysis, statistics and numerical methods for CSE as well as practical programming experience for solving assignments.

Students should at least have followed one previous course offered by the Machine Learning Institute (e.g., CIL or LIS) or an equivalent course offered by another institution.

Focus Elective Courses Information Systems

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<th>Hours</th>
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<tbody>
<tr>
<td>252-0341-01L</td>
<td>Information Retrieval</td>
<td>W</td>
<td>4</td>
<td>2V+U+1</td>
<td>T. Hofmann</td>
</tr>
<tr>
<td>Abstract</td>
<td>Introduction to information retrieval with a focus on text documents and images. Main topics comprise extraction of characteristic features from documents, index structures, retrieval models, search algorithms, benchmarking, and feedback mechanisms. Searching the web, images and XML collections demonstrate recent applications of information retrieval and their implementation.</td>
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</tr>
<tr>
<td>Objective</td>
<td>In depth understanding of managing, indexing, and retrieving documents with text, image and XML content. Knowledge about basic search algorithms on the web, benchmarking of search algorithms, and relevance feedback methods.</td>
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</tbody>
</table>

| 252-0373-00L   | Mobile and Personal Information Systems    | W    | 4    | 2V+U  | M. Norrie          |
| Abstract       | The course examines how traditional information system architectures and technologies have been adapted to support various forms of mobile and personal information systems. Topics to be covered include: databases of mobile objects; context-aware services; opportunistic information sharing; ambient information; pervasive display systems. |      |      |                   |
| Objective      | Students will be introduced to a variety of novel information services and architectures developed for mobile environments in order to gain insight into the requirements and processes involved in designing and developing such systems and learning to think beyond traditional information systems. |      |      |                   |
| Content        | Advances in mobile devices and communication technologies have led to a rapid increase in demands for various forms of mobile information systems where the users, the applications and the databases themselves may be mobile. Based on both lectures and breakout sessions, this course examines the impact of the different forms of mobility and collaboration that systems require nowadays and how these influence the design of systems at the database, the application and the user interface level. For example, traditional data management techniques have to be adapted to meet the requirements of such systems and cope with new connection, access and synchronisation issues. As mobile devices have increasingly become integrated into the users' lives and are expected to support a range of activities in different environments, applications should be context-aware, adapting functionality, information delivery and the user interfaces to the current environment and task. Various forms of software and hardware sensors may be used to determine the current context, raising interesting issues for discussion. Finally, user mobility, and the varying and intermittent connectivity that it implies, gives rise to new forms of dynamic collaboration that require lightweight, but flexible, mechanisms for information synchronization and consistency maintenance. Here, the interplay of mobile, personal and social context will receive special attention. |      |      |                   |

| 263-3010-00L   | Big Data                                   | W    | 6    | 2V+U+1A| G. Fourny         |
| Abstract       | The key challenge of the information society is to turn data into information, information into knowledge, knowledge into value. This has become increasingly complex. Data comes in larger volumes, diverse shapes, from different sources. Data is more heterogeneous and less structured than forty years ago. Nevertheless, it still needs to be processed fast, with support for complex operations. |      |      |                   |
| Objective      | This combination of requirements, together with the technologies that have emerged in order to address them, is typically referred to as "Big Data." This revolution has led to a completely new way to do business, e.g., develop new products and business models, but also to do science -- which is sometimes referred to as data-driven science or the "fourth paradigm". Unfortunately, the quantity of data produced and available -- now in the Zettabyte range (that's 21 zeros) per year -- keeps growing faster than our ability to process it. Hence, new architectures and approaches for processing it were and are still needed. Harnessing them must involve a deep understanding of data not only in the large, but also in the small. The field of databases evolves at a fast pace. In order to be prepared, to the extent possible, to the (r)evolutions that will take place in the next few decades, the emphasis of the lecture will be on the paradigms and core design ideas, while today's technologies will serve as supporting illustrations thereof. After visiting this lecture, you should have gained an overview and understanding of the Big Data landscape, which is the basis on which one can make informed decisions, i.e., pick and orchestrate the relevant technologies together for addressing each business use case efficiently and consistently. |      |      |                   |
This course gives an overview of database technologies and of the most important database design principles that lay the foundations of the Big Data universe. The material is organized along three axes: data in the large, data in the small, data in the very small. A broad range of aspects is covered with a focus on how they fit all together in the big picture of the Big Data ecosystem.

- physical storage (HDFS, S3)
- logical storage (key-value stores, document stores, column stores, key-value stores, data warehouses)
- data formats and syntaxes (XML, JSON, CSV, XBRL)
- data shapes and models (tables, trees, graphs, cubes)
- an overview of programming languages with a focus on their type systems (SQL, XQuery, MDX)
- the most important query paradigms (selection, projection, joining, grouping, ordering, windowing)
- paradigms for parallel processing (MapReduce) and technologies (Hadoop, Spark)
- optimization techniques (functional and declarative paradigms, query plans, rewrites, indexing)
- applications.

We will also host two guest lectures to get insights from the industry: UBS and Google.

Literature
Large scale analytics and machine learning are outside of the scope of this course. Papers from scientific conferences and journals. References will be given as part of the course material during the semester.

263-3210-00L Deep Learning Number of participants limited to 120.

Abstract
Deep learning is an area within machine learning that deals with algorithms and models that automatically induce multi-level data representations.

Objective
In recent years, deep learning and deep networks have significantly improved the state-of-the-art in many application domains such as computer vision, speech recognition, and natural language processing. This class will cover the fundamentals of deep learning and provide a rich set of hands-on tasks and practical projects to familiarize students with this emerging technology.

Prerequisites / notice
The participation in the course is subject to the following conditions:
1) The number of participants is limited to 120 students (MSc and PhDs).
2) Students must have taken the exam in Machine Learning (252-0535-00) or have acquired equivalent knowledge.

263-3200-00L Data Mining: Learning from Large Data Sets

Abstract
Many scientific and commercial applications require insights from massive, high-dimensional data sets. This courses introduces principled, state-of-the-art techniques from statistics, algorithms and discrete and convex optimization for learning from such large data sets. The course both covers theoretical foundations and practical applications.

Objective
Many scientific and commercial applications require us to obtain insights from massive, high-dimensional data sets. In this graduate-level course, we will study principled, state-of-the-art techniques from statistics, algorithms and discrete and convex optimization for learning from such large data sets. The course will both cover theoretical foundations and practical applications.

Content
Topics covered:
- Dealing with large data (Data centers; Map-Reduce/Hadoop; Amazon Mechanical Turk)
- Fast nearest neighbor methods (Shingling, locality sensitive hashing)
- Online learning (Online optimization and regret minimization, online convex programming, applications to large-scale Support Vector Machines)
- Multi-armed bandits (exploration-exploitation tradeoffs, applications to online advertising and relevance feedback)
- Active learning (uncertainty sampling, pool-based methods, label complexity)
- Dimension reduction (random projections, nonlinear methods)
- Data streams (Sketches, coresets, applications to online clustering)
- Recommender systems

Prerequisites / notice
Prerequisites: Solid basic knowledge in statistics, algorithms and programming. Background in machine learning is helpful but not required.

263-5210-00L Probabilistic Artificial Intelligence

Abstract
This course introduces core modeling techniques and algorithms from statistics, optimization, planning, and control and study applications in areas such as sensor networks, robotics, and the Internet.

Objective
How can we build systems that perform well in uncertain environments and unforeseen situations? How can we develop systems that exhibit "intelligent" behavior, without prescribing explicit rules? How can we build systems that learn from experience in order to improve their performance? We will study core modeling techniques and algorithms from statistics, optimization, planning, and control and study applications in areas such as sensor networks, robotics, and the Internet. The course is designed for upper-level undergraduate and graduate students.

Content
Topics covered:
- Search (BFS, DFS, A*), constraint satisfaction and optimization
- Tutorial in logic (propositional, first-order)
- Probability
- Bayesian Networks (models, exact and approximative inference, learning) - Temporal models (Hidden Markov Models, Dynamic Bayesian Networks)
- Probabilistic planning (MDPs, POMDPs)
- Reinforcement learning
- Combining logic and probability

Prerequisites / notice
Solid basic knowledge in statistics, algorithms and programming

Seminar Information Systems

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<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>263-3504-00L</td>
<td>Hardware Acceleration for Data Processing</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>G. Alonso, T. Hoefler, O. Mutlu</td>
</tr>
</tbody>
</table>

Abstract
The seminar will cover topics related to data processing using new hardware in general and hardware accelerators (GPU, FPGA, specialized processors) in particular.

Objective
The seminar will cover topics related to data processing using new hardware in general and hardware accelerators (GPU, FPGA, specialized processors) in particular.

Content
The seminar will cover topics related to data processing using new hardware in general and hardware accelerators (GPU, FPGA, specialized processors) in particular.

Prerequisites / notice
Students taking this seminar should have the necessary background in systems and low level programming.

252-5051-00L Advanced Topics in Machine Learning

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
</table>

W 2 credits 2S J. M. Buhmann, T. Hofmann, A. Krause, G. Rätsch
Abstract
In this seminar, recent papers of the pattern recognition and machine learning literature are presented and discussed. Possible topics cover statistical models in computer vision, graphical models and machine learning.

Objective
The seminar “Advanced Topics in Machine Learning” familiarizes students with recent developments in pattern recognition and machine learning. Original articles have to be presented and critically reviewed. The students will learn how to structure a scientific presentation in English which covers the key ideas of a scientific paper. An important goal of the seminar presentation is to summarize the essential ideas of the paper in sufficient depth while omitting details which are not essential for the understanding of the work. The presentation style will play an important role and should reach the level of professional scientific presentations.

Content
The seminar will cover a number of recent papers which have emerged as important contributions to the pattern recognition and machine learning literature. The topics will vary from year to year but they are centered on methodological issues in machine learning like new learning algorithms, ensemble methods or new statistical models for machine learning applications. Frequently, papers are selected from computer vision or bioinformatics - two fields, which relies more and more on machine learning methodology and statistical models.

Literature
The papers will be presented in the first session of the seminar.

Focus Courses in Software Engineering

Focus Core Courses Software Engineering

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<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
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<tbody>
<tr>
<td>252-0237-00L</td>
<td>Concepts of Object-Oriented Programming</td>
<td>W</td>
<td>6</td>
<td>3V+2U</td>
<td>P. Müller</td>
</tr>
</tbody>
</table>

Abstract
Course that focuses on an in-depth understanding of object-oriented programming and compares designs of object-oriented programming languages. Topics include different flavors of type systems, inheritance models, encapsulation in the presence of aliasing, object and class initialization, program correctness, reflection.

Objective
After this course, students will:
- Have a deep understanding of advanced concepts of object-oriented programming and their support through various language features.
- Be able to understand language concepts on a semantic level and be able to compare and evaluate language designs.
- Be able to learn new languages more rapidly.
- Be aware of many subtle problems of object-oriented programming and know how to avoid them.

Content
The main goal of this course is to convey a deep understanding of the key concepts of sequential object-oriented programming and their support in different programming languages. This is achieved by studying how important challenges are addressed through language features and programming idioms. In particular, the course discusses alternative language designs by contrasting solutions in languages such as C++, C#, Eiffel, Java, Python, and Scala. The course also introduces novel ideas from research languages that may influence the design of future mainstream languages.

- The topics discussed in the course include among others:
  - The pros and cons of different flavors of type systems (for instance, static vs. dynamic typing, nominal vs. structural, syntactic vs. behavioral typing)
  - The key problems of single and multiple inheritance and how different languages address them
  - Generic type systems, in particular, Java generics, C# generics, and C++ templates
  - The situations in which object-oriented programming does not provide encapsulation, and how to avoid them
  - The pitfalls of object initialization, exemplified by a research type system that prevents null pointer dereferencing
  - How to maintain the consistency of data structures

Literature
Will be announced in the lecture.

Prerequisites / notice
Mastering at least one object-oriented programming language (this course will NOT provide an introduction to object-oriented programming); programming experience

Focus Elective Courses Software Engineering

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<tr>
<th>Number</th>
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<th>Hours</th>
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<tbody>
<tr>
<td>263-2800-00L</td>
<td>Design of Parallel and High-Performance Computing</td>
<td>W</td>
<td>7</td>
<td>3V+2U+1A</td>
<td>T. Hoefler, M. Püschel</td>
</tr>
</tbody>
</table>

Abstract
Advanced topics in parallel / concurrent programming.

Objective
Understand concurrency paradigms and models from a higher perspective and acquire skills for designing, structuring and developing possibly large concurrent software systems. Become able to distinguish parallelism in problem space and in machine space. Become familiar with important technical concepts and with concurrency folklore.

System Construction
Main goal is teaching knowledge and skills needed for building custom operating systems and runtime environments. Relevant topics are studied at the example of sufficiently simple systems that have been built at our Institute in the past, ranging from purpose-oriented single processor real-time systems up to generic system kernels on multi-core hardware.

Objective
The lecture’s main goal is teaching of knowledge and skills needed for building custom operating systems and runtime environments.

The lecture intends to supplement more abstract views of software construction, and to contribute to a better understanding of "how it really works" behind the scenes.
After this course students will know fundamental techniques from probabilistic combinatorics for designing randomized algorithms and will be able to apply them to solve typical problems in these areas.

ECTS

Hours

Lecturers

The aim of this seminar is to introduce students to recent research results in the area of programming languages and software engineering. To accomplish that, students will study and present research papers in the area as well as participate in paper discussions. The papers will span topics in both theory and practice, including papers on program verification, program analysis, testing, programming language design, and development tools. A particular focus will be on domain-specific languages.

The publications to be presented will be announced on the seminar home page at least one week before the first session.

The seminar will cover a variety of machine learning models and algorithms (including deep neural networks) and will discuss their applications in a diverse set of domains. Furthermore, the seminar will discuss how domain knowledge is integrated into vanilla ML models. To improve this the seminar will use a case-study format where all students read the same paper each week but fulfill different roles and hence prepare with different viewpoints in mind.

Students are encouraged to choose papers outside of those usually assigned to students in other seminars.

The seminar is organized with each student taking one of the following roles on a rotating basis:

- Student roles/instructions
  - Conference Reviewer (e.g., reviewer of UIST/ICML/PLDI): Complete a full critical review of the paper. Use the original review from and come to a recommendation whether the paper should be accepted or not.
  - Historian: Find out how this paper sits in the context of the related work. Use bibliography tools to find the most influential papers cited by this work and at least one paper influenced by the work (and summarize the two papers).
  - PhD student: Propose a follow-up project for your own research based on this paper - importantly the project should be directly inspired by this work and at least one paper influenced by the work.
  - Hacker: Implement a (simplified) version of the core aspect of the paper. Prepare a demo for the seminar. In case the complexity is too high perform an in-depth analysis of reproducibility of the paper.
  - Detective: Find out background information about the authors. Where did they work when the paper was published; what was their role; who else have they published with; which prior work of the authors may have inspired the current paper? Students may contact the authors (but need to adhere to politeness and courteous manners and stay on topic in their conversations).
  - All students (every week): Come up with alternative title; find a missing result that the paper should have included.

Prerequisites / notice

Participation will be limited subject to available topics.

Focus Courses in Theoretical Computer Science

Focus Core Courses Theoretical Computer Science

Objective

After this course students will know fundamental techniques from probabilistic combinatorics for designing randomized algorithms and will be able to apply them to solve typical problems in these areas.
Learning the basic concepts of game theory and mechanism design, acquiring the computational paradigm of self-interested agents, and understanding the classification of data, function fitting and clustering, with applications in image and speech analysis, bioinformatics and exploratory data analysis. This course is accompanied by practical machine learning projects.

Objective

- The theory of fundamental machine learning concepts is presented in the lecture, and illustrated with relevant applications. Students can deepen their understanding by solving both pen-and-paper and programming exercises, where they implement and apply famous algorithms to real-world data.

Topics covered in the lecture include:

- Bayesian theory of optimal decisions
- Maximum likelihood and Bayesian parameter inference
- Classification with discriminant functions: Perceptrons, Fisher’s LDA and support vector machines (SVM)
- Ensemble methods: Bagging and Boosting
- Regression: least squares, ridge and LASSO penalization, non-linear regression and the bias-variance trade-off
- Non parametric density estimation: Parzen windows, nearest neighbour
- Dimension reduction: principal component analysis (PCA) and beyond

Lecture notes

- No lecture notes, but slides will be made available on the course webpage.

Literature


Prerequisites / notice

- The course requires solid basic knowledge in analysis, statistics and numerical methods for CSE as well as practical programming experience for solving assignments.
- Students should at least have followed one previous course offered by the Machine Learning Institute (e.g., CIL or LIS) or an equivalent course offered by another institution.

Focus Elective Courses Theoretical Computer Science

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>252-1407-00L</td>
<td>Algorithmic Game Theory</td>
<td>W</td>
<td>7</td>
<td>3V+2U+1A</td>
<td>P. Widmayer, P. Penna</td>
</tr>
</tbody>
</table>

Abstract

Game theory provides a formal model to study the behavior and interaction of self-interested users and programs in large-scale distributed computer systems without central control. The course discusses algorithmic aspects of game theory.

Objective

- Learning the basic concepts of game theory and mechanism design, acquiring the computational paradigm of self-interested agents, and using these concepts in the computational and algorithmic setting.

Content

- The Internet is a typical example of a large-scale distributed computer system without central control, with users that are typically only interested in their own good. For instance, they are interested in getting high bandwidth for themselves, but don’t care about others, and the same is true for computational load or download rates. Game theory provides a particularly well-suited model for the behavior and interaction of such selfish users and programs. Classic game theory dates back to the 1930s and typically does not consider algorithmic aspects at all. Only a few years back, algorithms and game theory have been considered together, in an attempt to reconcile selfish behavior of independent agents with the common good.
- This course discusses algorithmic aspects of game-theoretic models, with a focus on recent algorithmic and mathematical developments. Rather than giving an overview of such developments, the course aims to study selected important topics in depth.

Outline:

- Introduction to classic game-theoretic concepts.
- Existence of stable solutions (equilibria), algorithms for computing equilibria, computational complexity.
- Speed of convergence of natural game playing dynamics such as best-response dynamics or regret minimization.
- Techniques for bounding the quality-loss due to selfish behavior versus optimal outcomes under central control (a.k.a. the ‘Price of Anarchy’).
- Design and analysis of mechanisms that induce truthful behavior or near-optimal outcomes at equilibrium.
- Selected current research topics, such as Google’s Sponsored Search Auction, the U.S. FCC Spectrum Auction, Kidney Exchange.

Lecture notes

- "Game Theory and Strategy", Philip D. Straffin, The Mathematical Association of America, 5th printing, 2004

Prerequisites / notice

- Several copies of both books are available in the Computer Science library.
- Audience: Although this is a Computer Science course, we encourage the participation from all students who are interested in this topic.
- Requirements: You should enjoy precise mathematical reasoning. You need to have passed a course on algorithms and complexity. No knowledge of game theory is required.
B. Sudakov

Develop an understanding of selected topics in the area of molecular algorithms, and the practice of science.

The goal is to make students familiar with fundamental concepts, techniques and results in combinatorial and computational geometry, so as to enable them to model, analyze, and solve theoretical and practical problems in the area and in various application domains.

Prerequisites:

- Bachelor Studies at ETH.

Outlook: In the following spring semester there is a seminar "Geometry: Combinatorics and Algorithms" that builds on this course. There are ample possibilities for Semester-, Bachelor- and Master Thesis projects in the area.


Prerequisites / notice

There are no formal mathematical pre-requisites, but students should have "mathematical maturity", which entails dealing with abstract concepts and being comfortable with doing mathematical proofs. Some previous exposure to linear algebra, abstract algebra, and cryptography would be useful.

Program

Lecture notes

yes

Literature


Prerequisites / notice

There are no formal mathematical pre-requisites, but students should have "mathematical maturity", which entails dealing with abstract concepts and being comfortable with doing mathematical proofs. Some previous exposure to linear algebra, abstract algebra, and cryptography would be useful.

263-4655-00L Lattice Cryptography

W 4 credits 2V+1U V. Lyubashevsky

Abstract

The course will introduce lattice-based cryptography, which is one of the main candidates for quantum-resistant cryptography.

Content

In this course, we will study lattice-based cryptography. We will cover the basic algorithms associated with integer lattices such as Gram-Schmidt orthogonalization, algorithms for finding short and near lattice vectors, as well as the critical algorithm for sampling lattice points according to a discrete Gaussian distribution. We will then proceed to build up a toolbox of lattice-based cryptographic primitives beginning from collision-resistant hash functions, then moving on to digital signatures, encryption, identity-based encryption, and fully-homomorphic encryption. Particular emphasis will be placed on concrete parameters and practical instantiations. For this purpose, we will also study cryptographic constructions based on the hardness of ideal lattices, which are ideals of polynomial rings.

Prerequisites / notice

See above.

401-3901-00L Mathematical Optimization

W 11 credits 4V+2U R. Weismantel

Abstract

Mathematical treatment of diverse optimization techniques.

Content

1. Linear optimization: The geometry of linear programming, the simplex method for solving linear programming problems, Farkas’ Lemma and infeasibility certificates, duality theory of linear programming.


3. Integer optimization: Ties between linear and integer optimization, total unimodularity, complexity theory, cutting plane theory.

4. Combinatorial optimization: Network flow problems, structural results and algorithms for matroids, matchings and, more generally, independence systems.

Seminar Theoretical Computer Science

Number Title Type ECTS Hours Lecturers

252-4202-00L Seminar in Theoretical Computer Science W 2 credits 2S E. Welzl, B. Gärtner, M. Hoffmann, J. Lengler, A. Steger, B. Sudakov

Abstract

Presentation of recent publications in theoretical computer science, including results by diploma, masters and doctoral candidates.

Objective

The goal is to introduce students to current research, and to enable them to read, understand, and present scientific papers.

263-4311-00L Seminar on Molecular Algorithms Limited number of participants

W 2 credits 2S P. Widmayer

Abstract

Develop an understanding of selected topics in the area of molecular algorithms, and the practice of science.

Objective

Study and understanding of selected topics of interest in molecular algorithms such as: Computational Power of Molecular Algorithms, Molecular Algorithms for Solving Fundamental Tasks (Majority, Leader Election, Counting), Complexity Lower Bounds, Implementations of Algorithms in DNA.

Content

This seminar will familiarize the students with current research on molecular algorithms, with a focus on algorithms executable in DNA. We will have an introductory lecture covering the basics of molecular computational models, and the underlying bio-chemical phenomena. Subsequently, we will read and present selected research papers, focusing on their algorithmic content.

No prior knowledge of biology or chemistry will be required.

Literature

Selected research articles.

Prerequisites / notice

The course will require a good understanding of Randomized Algorithms. Hence, you must have passed our "Randomized Algorithms" class (or have acquired equivalent knowledge, in exceptional cases). No prior knowledge of biology or chemistry will be assumed. The basics will be presented in an introductory lecture.

Focus Courses in Visual Computing
### Focus Core Courses Visual Computing

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
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<tbody>
<tr>
<td>252-0535-00L</td>
<td>Machine Learning</td>
<td>W</td>
<td>8 credits</td>
<td>3V+2U+2A</td>
<td>J. M. Buhmann</td>
</tr>
</tbody>
</table>

**Abstract**

Machine learning algorithms provide analytical methods to search data sets for characteristic patterns. Typical tasks include the classification of data, function fitting and clustering, with applications in image and speech analysis, bioinformatics and exploratory data analysis. This course is accompanied by practical machine learning projects.

**Objective**

Students will be familiarized with the most important concepts and algorithms for supervised and unsupervised learning; reinforce the statistics knowledge which is indispensable to solve modeling problems under uncertainty. Key concepts are the generalization ability of algorithms and systematic approaches to modeling and regularization. A machine learning project will provide an opportunity to test the machine learning algorithms on real world data.

**Content**

The theory of fundamental machine learning concepts is presented in the lecture, and illustrated with relevant applications. Students can deepen their understanding by solving both pen-and-paper and programming exercises, where they implement and apply famous algorithms to real-world data.

**Topics covered in the lecture include:**

- Bayesian theory of optimal decisions
- Maximum likelihood and Bayesian parameter inference
- Classification with discriminant functions: Perceptrons, Fisher’s LDA and support vector machines (SVM)
- Ensemble methods: Bagging and Boosting
- Regression: least squares, ridge and LASSO penalization, non-linear regression and the bias-variance trade-off
- Non parametric density estimation: Parzen windows, nearest neighbour
- Dimension reduction: principal component analysis (PCA) and beyond

**Lecture notes**

No lecture notes, but slides will be made available on the course webpage.

**Literature**


**Prerequisites / notice**

The course requires solid basic knowledge in analysis, statistics and numerical methods for CSE as well as practical programming experience for solving assignments.

Students should at least have followed one previous course offered by the Machine Learning Institute (e.g., CIL or LIS) or an equivalent course offered by another institution.

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### Focus Elective Courses Visual Computing

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<th>Number</th>
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<th>Hours</th>
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**Abstract**

This course covers some of the fundamental concepts of computer graphics, namely 3D object representations and generation of photorealistic images from digital representations of 3D scenes.

**Objective**

At the end of the course the students will be able to build a rendering system. The students will study the basic principles of rendering and image synthesis. In addition, the course is intended to stimulate the students’ curiosity to explore the field of computer graphics in subsequent courses or on their own.

**Content**

This course covers fundamental concepts of modern computer graphics. Students will learn about 3D object representations and the details of how to generate photorealistic images from digital representations of 3D scenes. Starting with an introduction to 3D shape modeling and representation, texture mapping and ray-tracing, we will move on to acceleration structures, the physics of light transport, appearance modeling and global illumination principles and algorithms. We will end with an overview of modern image-based image synthesis techniques, covering topics such as lightfields and depth-image based rendering.

**Lecture notes**

No lecture notes.

**Prerequisites / notice**

Prerequisites: Fundamentals of calculus and linear algebra, basic concepts of algorithms and data structures, programming skills in C++, Virtual Computing course recommended.

The programming assignments will be in C++. This will not be taught in the class.

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<th>Number</th>
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</thead>
<tbody>
<tr>
<td>252-0546-00L</td>
<td>Physically-Based Simulation in Computer Graphics</td>
<td>W</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>B. Solenthaler, B. Thomaszewski</td>
</tr>
</tbody>
</table>

**Abstract**

This lecture provides an introduction to physically-based animation in computer graphics and gives an overview of fundamental methods and algorithms. The practical exercises include three assignments which are to be solved in small groups. In an additional course project, topics from the lecture will be implemented into a 3D game or a comparable application.

**Objective**

This lecture provides an introduction to physically-based animation in computer graphics and gives an overview of fundamental methods and algorithms. The practical exercises include three assignments which are to be solved in small groups. In an additional course project, topics from the lecture will be implemented into a 3D game or a comparable application.

**Content**

The lecture covers topics in physically-based modeling, such as particle systems, mass-spring models, finite difference and finite element methods. These approaches are used to represent and simulate deformable objects or fluids with applications in animated movies, 3D games and medical systems. Furthermore, the lecture covers topics such as rigid body dynamics, collision detection, and character animation.
In this seminar, recent papers of the pattern recognition and machine learning literature are presented and discussed. Possible topics cover the advanced aspects of machine learning, such as model selection, optimization, and computational efficiency. The seminar is oriented toward the understanding of machine learning and statistical models in computer vision, graphics, and robotics.

The seminar "Advanced Topics in Machine Learning" familiarizes students with recent developments in pattern recognition and machine learning. The emphasis is on hands-on computational experience and on producing state-of-the-art research projects. During the semester, students will start with intuition, learn the fundamental mathematical concepts and develop state of the art computer algorithms for real-world problems. Our goal is to build "bridges" connecting, symmetry, symmetry group theory, general and specific regularities and real-world applications.

The papers will be presented in the first session of the seminar.

Prerequisites / notice

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<th>Seminar Visual Computing</th>
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<tbody>
<tr>
<td><strong>Number</strong></td>
</tr>
<tr>
<td>252-5051-00L</td>
</tr>
<tr>
<td>252-5701-00L</td>
</tr>
</tbody>
</table>

The papers will be presented in the first session of the seminar.

Data: 06.03.2019 12:57 Autumn Semester 2016 Page 837 of 1571
Content
This seminar covers advanced topics in computer graphics, including both seminal research papers as well as the latest research results. Each time the course is offered, a collection of research papers are selected covering topics such as modeling, rendering, animation, real-time graphics, physical simulation, and computational photography. Each student presents one paper to the class and leads a discussion about the paper and related topics. All students read the papers and participate in the discussion.

Lecture notes
No script

Literature
Individual research papers are selected each term. See http://graphics.ethz.ch/ for the current list.

Prerequisites / notice
The courses "Computer Graphics I and II" (GDV I & II) are recommended, but not mandatory.

Computer Science Elective Courses
The Elective Computer Science Courses can be selected from all Master level courses offered by D-INFK.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>252-0293-00L</td>
<td>Wireless and Mobile Computing for Entertainment Applications</td>
<td>W</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>S. Mangold</td>
</tr>
<tr>
<td>252-3610-00L</td>
<td>Smart Energy</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>F. Mattern, Tiefenbeck</td>
</tr>
<tr>
<td>263-0600-00L</td>
<td>Research in Computer Science</td>
<td>W</td>
<td>5 credits</td>
<td>11A</td>
<td>Professors</td>
</tr>
<tr>
<td>227-0778-00L</td>
<td>Hardware/Software Codesign</td>
<td>W</td>
<td>6 credits</td>
<td>2V+2U</td>
<td>L. Thiele</td>
</tr>
</tbody>
</table>

Abstract
No script

Literature
1. The course webpage: http://www.lst.inf.ethz.ch/education/wireless.html
2. The Java 802 protocol emulator "JEmula802"

Prerequisites / notice
- The script will be made available from the course webpage.
- Students should have interest in wireless communication, and should be familiar with Java programming.
- The lecture covers the role of ICT for sustainable energy usage. Concepts of the emerging smart grid are outlined and approaches to motivate sustainable consumer choices are explained. The lecture combines technologies from ubiquitous computing and traditional ICT with insights from socio-psychological concepts and illustrates them with examples from actual applications.
- Participants become familiar with the challenges related to sustainable energy usage, understand the principles of a smart grid infrastructure and its applications, know the role of ubiquitous computing technologies, can explain the challenges regarding security and privacy, can reflect the basics cues to induce changes in consumer behavior, and develop a general understanding of the effects of a smart grid infrastructure on energy efficiency, and know how to apply the learning to related design projects.
- The lecture covers the role of ICT for sustainable energy usage. Concepts of the emerging smart grid are outlined and approaches to motivate sustainable consumer choices are explained. The lecture combines technologies from ubiquitous computing and traditional ICT with insights from socio-psychological concepts and illustrates them with examples from actual applications.
- The lecture includes interactive exercises, case studies and practical examples.

Prerequisites / notice
- The courses "Computer Graphics I and II" (GDV I & II) are recommended, but not mandatory.

Prerequisites
- Students should have interest in wireless communication, and should be familiar with Java programming.

Prerequisites / notice
- Only students who fulfill one of the following requirements are allowed to begin a research project:
  a) 1 lab (interfocus course) and 1 focus course
  b) 2 core focus courses
  c) 2 labs (interfocus courses)

Content
- Background on energy generation and consumption; characteristics, potential, and limitations of renewable energy sources
- Introduction to energy economics
- Smart grid and smart metering infrastructures, virtual power plants, security challenges
- Demand management and home automation using ubiquitous computing technologies
- Changing consumer behavior with smart ICT
- Benefits challenges of a smart energy system

Content
- Methods of software design in complex computer systems, in particular embedded systems. Models and methods are discussed that are fundamental for systems that consist of software and hardware components.
- The course covers advanced knowledge in the design of complex computer systems, in particular embedded systems. Models and methods are discussed that are fundamental for systems that consist of software and hardware components.
- The course covers the following subjects: (a) Models for describing hardware and software components (specification), (b) Hardware-Software Interfaces (instruction set, hardware and software components, reconfigurable computing, heterogeneous computer architectures, System-on-Chip), (c) Application specific instruction sets, code generation and retargetable compilation, (d) Performance analysis and estimation techniques, (e) System design (hardware-software partitioning and design space exploration).
Prerequisites / notice
Prerequisites for the course is a basic knowledge in the following areas: computer architecture, digital design, software design, embedded systems.

103-0237-00L GIS III

Abstract
The course deals with advanced topics in GIS: GIS project lifecycle, Managing GIS, Legal issues, GIS assets & constraints; Geospatial Web Services: technical basics, architecture, functions, interoperability, standards, mashups, portals, applications; Geostatistics; Sensor Web Enablement; Human-Computer Interaction; Cognitive Issues in GIS.

Objective
Students will get a detailed overview of advanced GIS topics. They will go through all steps of setting up a Web-GIS application in the labs and perform other practical tasks relating to Sensor Web Enablement, Human-Computer Interaction, Geostatistics, and Web Processing Services.

Lecture notes
Lecture slides will be made available in digital form.

Literature

Elective Courses
Students can individually choose from the entire Master course offerings from ETH Zurich, EPF Lausanne, the University of Zurich and - with the consent of the mentor - from all other Swiss universities.

For further details, refer to Art. 31 of the Regulations 2009 for the Master Program in Computer Science.

Internship

Objective
Wherever possible I illustrate by example and present the material in a way to make it immediately applicable. The goal is to provide the knowledge that enables the participants, whether beginner or experienced presenter, to further improve their presentation skills and hence their impact whenever they step in front of an audience.

Content
This course covers all aspects of delivering strong presentations. I explain common mistakes, what works and what does not, and why. Then I discuss structure and content as well as a set of fundamental principles from graphic design that make slides communicate effectively. These principles also apply to the presentation and visualization of data which is covered in some detail. Finally, I give some useful tips on the use of Powerpoint that simplify the creation of strong presentations.

GESS Science in Perspective
Recommended GESS Science in Perspective (Type B) for D-INFK.
see GESS Science in Perspective: Type A: Enhancement of Reflection Capability
see GESS Science in Perspective: Language Courses ETH/UZH

Master’s Thesis
Only students who fulfill the following criteria are allowed to begin with their master thesis:

a. successful completion of the bachelor programme;
b. fulfilling of any additional requirements necessary to gain admission to the master programme.

Abstract
Independent project work supervised by a Computer Science professor. Duration 6 months.

Objective
Independent project work supervised by a Computer Science professor.

Computer Science Master - Key for Type

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
<tr>
<td>Key for Hours</td>
<td></td>
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<td>--------------</td>
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</tr>
<tr>
<td>V</td>
<td>lecture</td>
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<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

**ECTS**

European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
Lecturers

Structural Design I
This is a general chemistry course aimed at first year undergraduate students in the Department of Mechanical and Process Engineering (D-MAVT). The aims of the course are as follows:
1) To provide a thorough understanding of the basic principles of chemistry and its application.
2) To develop an understanding of the atomic and molecular nature of matter and of the chemical reactions that describe their transformations.
3) To emphasize areas considered most relevant in an engineering context.

Electronic structure of atoms, chemical bonding, molecular shape and bonding theory, gases, thermodynamics, chemical thermodynamics, chemical kinetics, equilibria, solutions and intermolecular forces, redox and electrochemistry.

The course is based on "Chemistry the Central Science" by Brown, LeMay, Bursten, Murphy and Woodward. Pearson, 12th Edition (international edition).

Objective
The objective is to encourage students to develop an intuitive understanding of the relationship between the shape of a structure, the load it needs to carry and the forces in it.

To achieve this, the teaching is based on graphic statics, which allow the visualization of internal and external forces in structural systems, therefore illustrating the relationship between shape (form) and stress (force) in load bearing elements. This understanding is directly applied to the students' design projects, in which issues of statics and design overlap.

Content
After a general introduction of basic concepts, structural systems such as cable and arch structures will be analyzed with the help of graphic statics. The students will learn to understand the flow of forces in a structural system in relation to the system's form. They will be able to modify this force flow and give dimension to the structural components.

Prerequisites / notice
All concepts, approaches and methods will be introduced in the weekly lectures and practiced in subsequent exercises.

Lecture notes
on eQuilibrium
http://www.block.arch.ethz.ch/equilibrium
and
http://www.schwartz.arch.ethz.ch/

Further Lernmaterial:
"Form and Forces: Designing Efficient, Expressive Structures"

Fundamentals of Thermal Sciences in association with Energy Conversion

Abstract
This course is intended for students outside of D-MAVT.

Objective
To become acquainted and familiarized with basic principles of fundamental thermal sciences (Thermodynamics, Heat Transfer, etc.) as well as their linkage to energy conversion technologies.

Content
Thermodynamics (first and second laws), Heat Transfer (conduction/convection/radiation), Technical Applications

Literature
1. Introduction to Thermodynamics and Heat Transfer, 2nd ed. by Cengel, Y. A., McGraw Hill;
2. Fundamentals of Engineering Thermodynamics, 6th ed. by Moran & Shapiro, Wiley

Prerequisites / notice
This course is intended for students outside of D-MAVT.

Mathematics
This course gives an introduction to the following subjects:
linear algebra (systems of linear equations, matrices), calculus, multivariable calculus, differential equations.

Objective
Basic mathematical knowledge for engineers. Mathematics as a tool to solve engineering problems.

Content
This course gives an introduction to the following subjects:
linear algebra (systems of linear equations, matrices), calculus, multivariable calculus, differential equations.

Literature
Tom M. Apostol, Calculus, Volume 1, One-Variable Calculus with an Introduction to Linear Algebra, 2nd Edition, Wiley
Tom M. Apostol, Multi-Variable Calculus and Linear Algebra with Applications, 2nd Edition, Wiley

Design and Building Process MBS
"Design and Building Process MBS" is a brief manual for prospective architects and engineers covering the competencies and the responsibilities of all involved parties through the design and building process. Lectures on twelve compact aspects gaining importance in a increasingly specialised, complex and international surrounding.

Objective
Participants will come to understand how they can best navigate the design and building process, especially in relation to understanding their profession, gaining a thorough knowledge of rules and regulations, as well as understanding how involved parties' minds work. They will also have the opportunity to investigate ways in which they can relate to, understand, and best respond to their clients' wants and needs. Finally, course participants will come to appreciate the various tools and instruments, which are available to them when implementing their projects. The course will guide the participants, bringing the individual pieces of knowledge into a superordinate relationship.
### Core Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>066-0413-00L</td>
<td>Materials and Constructions</td>
<td>O</td>
<td>3</td>
<td>2V+1U</td>
<td>M. Koebel</td>
</tr>
<tr>
<td>Abstract</td>
<td>Sustainable building construction, high performance materials for energy efficient buildings, focus on next generation building materials, sustainable construction, glazing, energy integration, production processes</td>
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</tbody>
</table>
| Objective    | The students will acquire knowledge in the following fields:  
- Fundamentals of heat transport in (porous) materials  
- Super-insulating materials and systems (including insulating nano-materials)  
- Materials for retrofitting of buildings  
- Introduction to durability problems of building facades  
- Glazing, windows and glazed facades  
- Materials for photovoltaic devices and solar thermal collector technology and their integration into buildings  
- Materials for energy storage (thermal, electrical) and for decentralized energy generation  
- Embodied energy of building materials. Introduction to LCA analysis for building materials  
- Integrated building envelope solutions, multi-functional and adaptive facades, smart façade concepts |
| Content      | Principles of heat and mass transport, hygro-thermal performance, durability of the building envelope and interaction with indoor and outdoor climates, applications. |

| 066-0415-00L | Building Physics: Theory and Applications  | O    | 4    | 3V+1U | J. Carmeliet, J. Allegrini, D. Derome         |
| Abstract     | Principles of heat and mass transport, hygro-thermal performance, durability of the building envelope and interaction with indoor and outdoor climates, applications. |
| Objective    | The students will acquire the following fields:  
- Indoor and outdoor climate and driving forces.  
- Hydrothermal properties of building materials.  
- Building envelope solutions and their construction.  
- Hydrothermal performance and durability. |
| Content      | Principles of heat and mass transport, hygro-thermal performance, durability of the building envelope and interaction with indoor and outdoor climates, applications. |

| 529-0193-00L | Renewable Energy Technologies I            | O    | 4    | 3G    | A. Wokaun, A. Steinfeld                       |
| Abstract     | Scenarios for world energy demand and CO2 emissions, implications for climate. Methods for the assessment of energy chains. Potential and technology of renewable energies: Biomass (heat, electricity, biofuels), solar energy (low temp. heat, solar thermal and photovoltaic electricity, solar chemistry). Wind and ocean energy, heat pumps, geothermal energy, energy from waste. CO2 sequestration. |
| Objective    | Scenarios for the development of world primary energy consumption are introduced. Students know the potential and limitations of renewable energies for reducing CO2 emissions, and their contribution towards a future sustainable energy system that respects climate protection goals. |
| Lecture notes| Lecture notes will be distributed electronically during the course. |

| 363-0389-00L | Technology and Innovation Management       | O    | 3    | 2G    | S. Brusoni                                    |
| Abstract     | This course focuses on the analysis of innovation as a pervasive process that cut across organizational and functional boundaries. It looks at the sources of innovation, at the tools and techniques that organizations deploy to routinely innovate, and the strategic implications of technical change. |
| Objective    | This course intends to enable all students to:  
- understand the core concepts necessary to analyze how innovation happens  
- master the most common methods and tools organizations deploy to innovate  
- develop the ability to critically evaluate the innovation process, and act upon the main obstacles to innovation |

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This course looks at technology and innovation management as a process. Continuously, organizations are faced with a fundamental decision: they have to allocate resources between well-known tasks that reliably generate positive results; or explore new ways of doing things, new technologies, products and services. The latter is a high risk choice. Its rewards can be high, but the chances of success are small.

How do firms organize to take these decisions? What kind of management skills are necessary to take them? What kind of tools and methods are deployed to sustain managerial decision-making in highly volatile environments? These are the central questions on which this course focuses, relying on a combination of lectures, case-based discussion, guest speakers, simulations and group work.

Lecture notes
Slides will be available on the TIMGROUP website.

Literature
Readings will be available on the TIMGROUP website.

Prerequisites
No specific background in economics or management is required.

<table>
<thead>
<tr>
<th>363-0503-00L</th>
<th>Principles of Microeconomics</th>
<th>O</th>
<th>3 credits</th>
<th>2G</th>
<th>M. Filippini</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>The course introduces basic principles, problems and approaches of microeconomics.</td>
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<tr>
<td>Objective</td>
<td>The learning objectives of the course are:</td>
<td></td>
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<tr>
<td></td>
<td>(1) Students must be able to discuss basic principles, problems and approaches in microeconomics.</td>
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<td>(2) Students can analyse and explain simple economic principles in a market using supply and demand graphs.</td>
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<td>(3) Students can contrast different market structures and describe firm and consumer behaviour.</td>
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<td>(4) Students can identify market failures such as externalities related to market activities and illustrate how these affect the economy as a whole.</td>
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<td>(5) Students can apply simple mathematical treatment of some basic concepts and can solve utility maximization and cost minimization problems.</td>
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</tbody>
</table>

Lecture notes
Lecture notes, exercises and reference material can be downloaded from Moodle.

Literature

The book can also be used for the course 'Principles of Macroeconomics' (Sturm)

For students taking only the course 'Principles of Microeconomics' there is a shorter version of the same book:


Complementary:

<table>
<thead>
<tr>
<th>066-0423-00L</th>
<th>Application of CFD in Buildings</th>
<th>O</th>
<th>3 credits</th>
<th>3V</th>
<th>D. Lakehal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>Fundamentals, Applications and Project works in the area of CFD in buildings.</td>
<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>Understanding:</td>
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<tr>
<td></td>
<td>- Basic principles of fluid flow &amp; heat transfer</td>
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<tr>
<td></td>
<td>- Basic concepts of CFD</td>
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<td></td>
<td>- Validation and verification, practical guidelines</td>
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<tr>
<td>Content</td>
<td>Application and project works of CFD in buildings including the fields of:</td>
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<td></td>
<td>- Building aerodynamics</td>
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<td></td>
<td>- Steady vs. unsteady wind loads on urban structures</td>
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<td></td>
<td>- Air pollution and contaminant dispersion</td>
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<td></td>
<td>- Indoor ventilation</td>
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<tr>
<td></td>
<td>- CFD for renewable energy in the urban physics: Wind loads on roof-mounted solar photovoltaic arrays, coupled solar-wind energy generation applications, etc.</td>
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</tr>
<tr>
<td>Lecture notes</td>
<td>Material will be sent to the students before the start of the course.</td>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>Urban physics: wind, wind comfort, pollutant dispersion, natural ventilation, driving rain, heat islands, climate change and weather conditions, urban acoustics and energy use in the urban context.</td>
<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>- Basic knowledge of the global climate and the local microclimate around buildings</td>
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</tr>
<tr>
<td></td>
<td>- Impact of urban environment on wind, ventilation, rain, pollutants, acoustics and energy, and their relation to comfort, durability, air quality and energy demand</td>
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<tr>
<td></td>
<td>- Application of urban physics concepts in urban design</td>
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</tbody>
</table>

Lecture notes
Material will be sent to the students before the start of the course.
Content
- Climate Change. The Global Picture: global energy balance, global climate models, the IPCC process. Towards regional climate scenarios: role of spatial resolution, overview of approaches, hydrostatic RCMs, cloud-resolving RCMs
- Urban micro climate and comfort: urban heat island effect, wind flow and radiation in the built environment, convective heat transport modelling, heat balance and ventilation of urban spaces - impact of morphology, outdoor wind comfort, outdoor thermal comfort,
- Urban energy and urban design. Energy performance of building quarters and cities, decentralized urban energy production and storage technologies, district heating networks, optimization of energy consumption at district level, effect of the micro, urban heat islands, and climate change on the energy performance of buildings and building blocks.
- Wind driving rain (WDR): WDR phenomena, WDR experimental and modeling, wind blocking effect, applications and moisture durability
- Pollutant dispersion, pollutant cycle: emission, transport and deposition, air quality
- Urban acoustics, noise propagation through the urban environment, meteorological effects, urban acoustic modeling, noise reduction measures, urban vegetation

Lecture notes
All material is provided via the website of the chair (www.carmeliet.arch.ethz.ch/Education/).

Literature
All material is provided via the website of the chair (www.carmeliet.arch.ethz.ch/Education/).

Prerequisites / notice
No prior knowledge is required.

### Specialised Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0235-00L</td>
<td>Thermodynamics of Novel Energy Conversion Technologies</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>C. S. Sharma, D. Poulikakos, G. Sansavini</td>
</tr>
</tbody>
</table>

**Abstract**
In the framework of this course we will look at a current electronic thermal and energy management strategies and novel energy conversion processes. The course will focus on component level fundamentals of these processes and system level analysis of interactions among various energy conversion components.

**Objective**
This course deals with liquid cooling based thermal management of electronics, reuse of waste heat and novel energy conversion and storage systems such as batteries, fuel cells and micro-fuel cells. The focus of the course is on the physics and basic understanding of those systems as well as their real-world applications. The course will also look at analysis of system level interactions between a range of energy conversion components.

**Content**
Part 1: Fundamentals:
- Overview of energy analysis, single phase liquid cooling and micro-mixing
- Thermodynamics of multi-component-systems (mixtures) and phase equilibrium
- Electrochemistry

Part 2: Applications:
- Basic principles of battery
- Introduction to fuel cells
- Reuse of waste heat from supercomputers
- Hotspot targeted cooling of microprocessors
- Microfluidic fuel cells

Part 3: System-level analysis
- Integration of the components into the system: a case study
- Analysis of the coupled operations, identification of critical states
- Support to system-oriented design

**Lecture notes**
The course slides will be made available. Lecture notes will be available for some topics (in English).

**Prerequisites / notice**
The course will be given in English:
1. Mid-term examination: Mid-term exam grade counts as 20% of the final grade.
2. Final exam: Written exam during the regular examination session. It counts as 80% of the final grade.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0113-00L</td>
<td>Applied Fluid Dynamics</td>
<td>W</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>J.P. Kunsch</td>
</tr>
</tbody>
</table>

**Abstract**
The methods of fluid dynamics play an important role in the description of a chain of events, involving the release, spreading and dilution of dangerous fluids in the environment. Tunnel ventilation systems and strategies are studied, which must meet severe requirements during normal operation and in emergency situations (tunnel fires etc.).

**Objective**
Generally applicable methods in fluid dynamics and gas dynamics are illustrated and practiced using selected current examples. Often experts fall back on the methodology of fluid dynamics when involved in the construction of environmentally friendly processing and incineration facilities, as well as when choosing safe transport and storage options for dangerous materials. As a result of accidents, but also in normal operations, dangerous gases and liquids may escape and be transported further by wind or flowing water. There are many possible forms that the resulting damage may take, including fire and explosion when flammable substances are mixed. The topics covered include: Emissions of liquids and gases from containers and pipelines, evaporation from pools and vaporization of gases kept under pressure, the spread and dilution of waste gas plumes in the wind, deflagration and detonation of inflammable gases, fireballs in gases held under pressure, pollution and exhaust gases in tunnels (tunnel fires etc.).

**Lecture notes**
The course slides will be made available. Lecture notes will be available for some topics (in English).

**Prerequisites / notice**
Requirements: successful attendance at lectures "Fluidodynamik I und II", "Thermodynamik I und II"

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0185-00L</td>
<td>Radiation Heat Transfer</td>
<td>W</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>A. Steinfeld, A. Z'Graggen</td>
</tr>
</tbody>
</table>

**Abstract**
Advanced course in radiation heat transfer

**Objective**
Foundations of radiative heat transfer and its applications. Examples are combustion and solar thermal/thermochemical processes, and other applications in the field of energy conversion and material processing.

**Content**

**Lecture notes**
Copy of the slides presented.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Lectures</th>
<th>Prerequisites / notice</th>
</tr>
</thead>
</table>
| 101-0579-00L| Infrastructure Maintenance Processes | 3 credits | 2G | B. T. Adey

This course provides an introduction to the tools to be used to evaluate infrastructure and the level of service being provided from infrastructure.

- **Objective:**
  - To equip students with tools to be used to evaluate infrastructure and the level of service being provided from infrastructure.

- **Content:**
  - Introduction
  - Levels of service
  - Reliability of infrastructure
  - Availability and maintainability of infrastructure
  - Mechanistic-empirical models
  - Regression analysis
  - Event trees
  - Fault trees
  - Markov chains
  - Neural networks
  - Bayesian networks
  - Conclusion

- **Lecture notes:**
  All necessary materials (e.g., transparencies and hand-outs) will be distributed before class.

- **Literature:**
  Appropriate reading material will be assigned when necessary.

- **Prerequisites / notice:**
  This course is meant for students who did not already attend the course "Mathematical Optimization", which is a more advanced lecture covering similar topics and more.

- **Prerequisites:**
  Analysis I/II, Knowledge of Fluid Dynamics I, thermodynamics of ideal gas

- **Addendum:**
  Does not take place this semester.

101-0579-00L "Infrastructure Maintenance Processes" will be offered from FS17 on with new title 101-0579-00L "Infrastructure Management 2: Evaluation Tools"
The course provides the necessary knowledge to develop models supporting the solution of given planning problems. This is done by a list of the basic literature will be offered on a specific online platform, that could be used by all students attending the lectures.

The following topics give an overview of the themes that are to be worked on during the lecture.

- Overview on the theory and application of current scientific pathways towards sustainable development.
- Case Study 1: Sustainable construction, the role of construction industry (national/international)
- Case Study 2: Cities, forms of settlements
- Case Study 3: Material resources, scenarios, energy, construction materials, urban metabolism
- Case Study 4: Buildings, heating/cooling, consumers, prosumers and other stakeholder, cooperations
- Method 1: Life cycle assessment (planning, construction, operation/use, deconstruction)
- Method 2: Economics for sustainable construction
- Method 3: Construction, flexibility, modularity
- Synthesis 1: Climate Change mitigation and adaptation in cities
- Synthesis 2: Transition to sustainable development

Lecture notes All relevant information will be online available before the lectures. For each lecture slides of the lecture will be provided.

Literature A list of the basic literature will be offered on a specific online platform, that could be used by all students attending the lectures.

101-0417-00L Transport Planning Methods W 6 credits 4G K. W. Axhausen

Abstract The course provides the necessary knowledge to develop models supporting the solution of given planning problems. This is done by dividing the forecasting problem into sub-problems. The course is composed of a lecture part, providing the theoretical knowledge, and a applied part, in which students develop their own models.

Objective

- Knowledge of methods and algorithms commonly used in transport planning
- Ability to independently develop a transport model able to solve / answer the given problem / questions
- Understanding of algorithms and their implementations commonly used in transport planning

Content

The course provides the necessary knowledge to develop models supporting the solution of given planning problems. Examples of such planning problems are the estimation of traffic volumes, prediction of estimated utilization of new public transport lines, and evaluation of effects (e.g. change in emissions of a city) triggered by building new infrastructure and changes to operational regulations.

To cope with the forecasting problem it is first divided into sub-problems. Then, these are solved using various algorithms like iterative proportional fitting, shortest path algorithms and the method of successive averages.

The course is composed of a lecture part, providing the theoretical knowledge, and a applied part, in which students create their own models. This part takes place in form of a tutorial and consists in the development of a computer program. The programming part is closely guided and particularly suitable for students with little programming experience.

Lecture notes The slides of the lecture are provided electronically.


363-0387-00L Corporate Sustainability W 3 credits 2G V. Hoffmann

Abstract The lectures addresses the assessment of corporate sustainability and its links to strategy, technology, and finance. Students learn why sustainability matters for managers and how businesses can act towards it. E-modules allow students to train critical thinking skills. In the 2nd half of the semester, sustainability challenges on water, energy, mobility, and food are explored in group projects.

Objective Understand the limits and the potential of corporate sustainability for sustainable development

Content Develop critical thinking skills (argumentation, communication, evaluative judgment) that are useful in the context of corporate sustainability using an innovative writing and peer review method.

- Be able to recognize and realize opportunities for corporate sustainability in a business environment
- Business implications of sustainable development, in particular for the assessment of sustainability performance, strategic change towards sustainability, technological innovations and sustainability, and finance and corporate sustainability.
- Critical thinking skills for corporate sustainability.
- In-depth case studies of corporate sustainability challenges in the track phase: How to deal with environmental pressure groups? How to use the strengths of business to solve pressing sustainability problems? How to catalyze technological innovations for sustainability? How to invest money in a sustainable way?

Lecture notes Presentation slides will be made available on moodle prior to lectures.

Data: 06.03.2019 12:57 Autumn Semester 2016 Page 846 of 1571
<table>
<thead>
<tr>
<th>Literature</th>
<th>Literature recommendations will be distributed during the lecture</th>
</tr>
</thead>
</table>
| 402-0809-01L | Introduction to Computational Physics (for Civil Engineers)  
W 4 credits  
2V+1U  
H. J. Herrmann |
| Abstract | This course offers an introduction to computer simulation methods for physics problems and their implementation on PCs and super computers: classical equations of motion, partial differential equations (wave equation, diffusion equation, Maxwell's equation), Monte Carlo simulations, percolation, phase transitions |
| Prerequisites / notice | Lecture and exercise lessons in english |

| 402-0809-00L | Introduction to Computational Physics  
W 8 credits  
2V+2U  
H. J. Herrmann |
| Abstract | This course offers an introduction to computer simulation methods for physics problems and their implementation on PCs and super computers: classical equations of motion, partial differential equations (wave equation, diffusion equation, Maxwell's equation), Monte Carlo simulations, percolation, phase transitions |
| Prerequisites / notice | Lecture and exercise lessons in english, exams in German or in English |

| 101-0187-00L | Structural Reliability and Risk Analysis  
W 3 credits  
2G  
B. Sudret |
| Abstract | Structural reliability aims at quantifying the probability of failure of systems due to uncertainties in their design, manufacturing and environmental conditions. Risk analysis combines this information with the consequences of failure in view of optimal decision making. The course presents the underlying probabilistic modelling and computational methods for reliability and risk assessment. |
| Objective | The goal of this course is to provide the students with a thorough understanding of the key concepts behind structural reliability and risk analysis. After this course the students will have refreshed their knowledge of probability theory and statistics to model uncertainties in view of engineering applications. They will be able to analyze the reliability of a structure under uncertainty conditions. They will be aware of the state-of-the-art computational methods and software in this field. |
| Content | Engineers are confronted every day to decision making under limited amount of information and uncertain conditions. When designing new structures and systems, the design codes such as SIA or Euro-codes usually provide a framework that guarantees safety and reliability. However the level of safety is not quantified explicitly, which does not allow the analyst to properly choose between design variants and evaluate a total cost in case of failure. In contrast, the framework of risk analysis allows one to incorporate the uncertainty in decision making. |
| The first part of the course is a reminder on probability theory that is used as a main tool for reliability and risk analysis. Classical concepts such as random variables and vectors, dependence and correlation are recalled. Basic statistical inference methods used for building a probabilistic model from the available data, e.g. the maximum likelihood method, are presented. |
| The second part is related to structural reliability analysis, i.e. methods that allow one to compute probabilities of failure of a given system with respect to prescribed criteria. The framework of reliability analysis is first set up. Reliability indices are introduced together with the first order-second moment method (FOSM) and the first order reliability method (FORM). Methods based on Monte Carlo simulation are then reviewed and illustrated through various examples. By-products of reliability analysis such as sensitivity measures and partial safety coefficients are derived and their links to structural design codes is shown. The reliability of structural systems is also introduced as well as the methods used to reassess existing structures based on new information. |
| The third part of the course addresses risk assessment methods. Techniques for the identification of hazard scenarios and their representation by fault trees and event trees are described. Risk is defined with respect to the concept of expected utility in the framework of decision making. Elements of Bayesian decision making, i.e. pre-, post and pre-post risk assessment methods are presented. |
| Lecture notes | The course also includes a tutorial using the UQLab software dedicated to real world structural reliability analysis. Slides of the lectures are available online every week. A printed version of the full set of slides is proposed to the students at the beginning of the semester. |
S. Marelli, R. Schöbi, B. Sudret, UQLab user manual - Structural reliability (rare events estimation), Report UQLab-v0.92-107. |
| Prerequisites / notice | Basic course on probability theory and statistics |

| 701-1346-00L | Carbon Mitigation  
W 3 credits  
2G  
N. Gruber |
| Abstract | Future climate change can only kept within reasonable bounds when CO2 emissions are drastically reduced. In this course, we will discuss a portfolio of options involving the alteration of natural carbon sinks and carbon sequestration. The course includes introductory lectures, presentations from guest speakers from industry and the public sector, and final presentations by the students. |
| Objective | The goal of this course is to investigate, as a group, a particular set of carbon mitigation/sequestration options and to evaluate their potential, their cost, and their consequences. |
| Content | From the large number of carbon sequestration/mitigation options, a few options will be selected and then investigated in detail by the students. The results of this research will then be presented to the other students, the involved faculty, and discussed in detail by the whole group. |
| Lecture notes | None  
Will be identified based on the chosen topic. |
| Literature | Exam: No final exam. Pass/No-Pass is assigned based on the quality of the presentation and ensuing discussion. |

| 051-0723-16L | Information Architecture and Future Cities: Smart Cities  
W 2 credits  
1V  
G. Schmitt |
| Abstract | What are SMART CITIES and how do they emerge? What is the role of architects and urban designers in this process? How do data turn into information as a building material for the future city? The course covers concepts, methods and techniques in design, simulation and communication of cities. The goal is to learn principles and preconditions for the design of sustainable and smart cities. |
Objective

Students gain insight into the next generation of design processes for architects and urban designers, and into concepts of the Information Architecture of SMART CITIES, including the influence of Big Data. They learn about the expanded roles of information and of architecture: information and simulation in architecture as means to make the invisible visible, and architecture as a metaphor and ordering system to structure the immense amounts of data of the Information Society. The seminar is highly interactive and discusses visionary case studies in Europe and Asia and new techniques in Big Data informed smart urban design. Apart from learning about and experiencing Information Architecture and SMART CITIES, the course also introduces research and management skills that will distinguish the future ETH architect. An iBook and the edX Massive Open Online Course (MOOC) Future Cities support the course.

Content

SMART CITIES - What will happen when cities change from static configurations into responsive and dynamic structures? What does it mean for buildings that undergo the same changes? What is the impact on architectural and urban design education? How can citizens influence this development? The SMART CITIES course will answer these questions and supply you with the necessary skills and knowledge to understand and design such dynamic structures. The intelligent use of data and information are at the core of this course. Data and information are new building materials of future cities. Citizens produce increasing amounts of data in their daily life, with stationary sensors and mobile smartphones. Using these data, citizens begin to influence the design of future cities and the re-design of existing ones. The course will be a first step towards the emerging citizen design science and cognitive design computing. Those will be the next generation of participatory design and design computing.

Lecture notes

iBook INFORMATION CITIES

Literature

The necessary texts will be found on the Chair's website at: http://www.ia.arch.ethz.ch. We specifically recommend the consultation of the Future Cities Website at: http://www.futurecities.ethz.ch during the entire course. The iBook INFORMATION CITIES is available in the iBooks Store for free.

Prerequisites / notice

Interactive seminar including 3 exercises

051-0725-16L

063-1357-16L

Project courses

Abstract

Digital Urban Visualization: People as Flows

We examine patterns of crowd-flows in an extraordinary urbanisation phenomena: festivals.

Objective

The course participants will learn how to program simulations using Processing/Java. Previous programming knowledge is not necessary. Furthermore they will gain insights into other analysis methods and learn about their significance, strengths and weaknesses.

Content

We will look at those patterns from two sides. One being the view of a planer asking to find bottle necks or the ideal place for amenities such as bookshops, toilets etc. Another being the view of visitors. We will program different behaviours that should compete against each other in order to compare their different strategies. As a case study we will use the Caliente Festival in Zurich.

For deepening the learnt in a semester thesis we offer to optimise the created simulations to make them available in interactive planning workshops. Additionally they could be converted into interactive web apps. http://www.ia.arch.ethz.ch

Digital Urban Simulation

In this teaching unit architectural and urban design are analyzed by current computational methods. Based on these analyses the effects of planning can be simulated and understood. An important focus of this course is the interpretation of the analysis and simulation results and the application of these correspondent methods in early planning phases.

The students learn how the design and planning of cities can be evidence based by using scientific methods. The teaching unit conveys knowledge in state-of-the-art and emerging spatial analysis and simulation methods and equip students with skills in modern software systems. The course consists of lectures, associated exercises and workshops, as well as of one integral project work.

In a series of theory lectures we explore how the design and planning of cities can be evidence based by using scientific methods. By various exercises the students are equipped with skills in modern software systems. In an integral project work knowledge in state-of-the-art and emerging spatial analysis and simulation methods is deepened. Based on the imparted methods the effects of planning and design interventions can be simulated and understood. An important focus of this course is the interpretation of the analysis and simulation results and the application of the correspondent computational methods in early planning phases.

Literature

A literature list will be distributed at the beginning of the course.

Prerequisites / notice

No programming skills are required.

Semester Project

Abstract

You can choose the mentoring professor of your semester project MBS:

Jan CARMEJET
Stefano BRUSCONI
Mario FONTANA
Guillaume HABERT
John LYGEROS
Marco MAZZOTTI
Arno SCHLÜTER
Roy SMITH

The semester project focuses in solving specific research questions in the field of integrated building systems.
Objective
The semester project is designed to train students in solving specific research questions in the field of integrated building systems. The goal is to apply acquired knowledge which is gained throughout the first year of the master's program. The semester project is advised by a professor who is affiliated with one of the partner departments of the Master program "Integrated building systems".

Content
The semester project is designed to train students in solving specific research questions in the field of integrated building systems. The goal is to apply acquired knowledge which is gained throughout the first year of the master's program. The semester project is advised by a professor who is affiliated with one of the partner departments of the Master program "Integrated building systems".

GESS Science in Perspective
Recommended GESS Science in Perspective (Type B) for D-ARCH.
see GESS Science in Perspective: Type A: Enhancement of Reflection Capability
see GESS Science in Perspective: Language Courses ETH/UZH

Master's Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>066-0434-00L</td>
<td>Master's Thesis</td>
<td>O</td>
<td>30 credits</td>
<td>40D</td>
<td>Professors</td>
</tr>
</tbody>
</table>

Abstract
A 6-months Master thesis completes the Master's program of Integrated Building Systems. With the thesis project students are expected to demonstrate their ability to independent and structured scientific thinking.

Objective
A 6-months Master thesis completes the Master's program of Integrated Building Systems. With the thesis project students are expected to demonstrate their ability to independent and structured scientific thinking.

Content
A 6-months Master thesis completes the Master's program of Integrated Building Systems. With the thesis project students are expected to demonstrate their ability to independent and structured scientific thinking. The thesis can be performed either at ETH Zurich, an industrial enterprise, or in a research institution, but has to be advised by one or more professors affiliated with the Master program "Integrated building systems".

The responsible supervisor defines the topic in consultation with the student, together with the scope of work, criteria of assessment, and dates of beginning and delivery of the work.

Course Units for Additional Admission Requirements
The courses below are only available for MSC students with additional admission requirements.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>151-1633-AAL</td>
<td>Energy Conversion</td>
<td>E-</td>
<td>4 credits</td>
<td>9R</td>
<td>H. G. Park</td>
</tr>
</tbody>
</table>

Abstract
Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Objective
Fundamentals of Thermal Sciences in association with Energy Conversion

Content
Thermodynamics (first and second laws), Heat Transfer (conduction/convection/radiation), Technical Applications

Literature
1. Introduction to Thermodynamics and Heat Transfer, 2nd ed. by Cengel, Y. A., McGraw Hill;
2. Fundamentals of Engineering Thermodynamics, 6th ed. by Moran & Shapiro, Wiley

Prerequisites / notice
This course is intended for students outside of D-MAVT.

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0414-AAL</td>
<td>Transport Planning (Transportation I)</td>
<td>W</td>
<td>3 credits</td>
<td>2R</td>
<td>K. W. Axhausen</td>
</tr>
</tbody>
</table>

Abstract
Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Objective
The course introduces the basic theories and methods of transport planning.

Content
Basic theoretical links between transport, space and economic development; basic terminology; measurement and observation of travel behaviour; methods of the four stage approach; cost-benefit analysis.

Literature

Integrated Building Systems Master - Key for Type

- O: Compulsory
- W+: Eligible for credits and recommended
- W: Eligible for credits
- E-: Recommended, not eligible for credits
- Z: Courses outside the curriculum
- Dr: Suitable for doctorate

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<table>
<thead>
<tr>
<th>Key for Hours</th>
<th>Description</th>
<th>ECTS</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
<td></td>
<td>European Credit Transfer and Accumulation System</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
<td></td>
<td>Special students and auditors need special permission from the lecturers.</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
<td></td>
<td></td>
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<tr>
<td>S</td>
<td>seminar</td>
<td></td>
<td></td>
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<tr>
<td>K</td>
<td>colloquium</td>
<td></td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<td></td>
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<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
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</table>
## Interdisciplinary Sciences Bachelor

### Physical-Chemical Direction

#### 1. Semester (Physical-Chemical Direction)

### Compulsory Subjects First Year Examinations

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>401-1261-07L</td>
<td>Analysis I</td>
<td>O</td>
<td>10</td>
<td>6V+3U</td>
<td>M. Einsiedler</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<tr>
<td></td>
<td>Introduction to the differential and integral calculus in one real variable: fundamentals of mathematical thinking, numbers, sequences, basic point set topology, continuity, differentiable functions, ordinary differential equations, Riemann integration.</td>
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<tr>
<td></td>
<td><strong>Objective</strong></td>
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<tr>
<td></td>
<td>The ability to work with the basics of calculus in a mathematically rigorous way.</td>
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<tr>
<td></td>
<td><strong>Literature</strong></td>
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</tr>
<tr>
<td></td>
<td>K. Koenigsberger: Analysis I, Springer-Verlag</td>
<td></td>
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<tr>
<td></td>
<td>R. Courant: Vorlesungen ueber Differential- und Integralerechnung, Springer Verlag</td>
<td></td>
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<tr>
<td></td>
<td>V. Zorich: Analysis I, Springer Verlag 2006</td>
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</tr>
<tr>
<td></td>
<td>Chr. Blatter: Analysis, <a href="https://people.math.ethz.ch/%7eblatter/">https://people.math.ethz.ch/%7eblatter/</a></td>
<td></td>
<td></td>
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</tbody>
</table>

| 401-1151-00L | Linear Algebra I                   | O    | 7     | 4V+2U | M. Akvedel |
|              | **Abstract**                       |      |       |       |            |
|              | **Objective**                      |      |       |       |            |
|              | Mastering basic concepts of Linear Algebra |
|              | Introduction to mathematical methods |
|              | **Content**                        |      |       |       |            |
|              | Basics |
|              | Vectorspaces and linear maps |
|              | Systems of linear equations and matrices |
|              | Determinants |
|              | Endomorphisms and eigenvalues |
|              | **Literature**                     |      |       |       |            |

| 402-1701-00L | Physics I                          | O    | 7     | 4V+2U | A. Wallraff |
|              | **Abstract**                       |      |       |       |            |
|              | This course gives a first introduction to Physics. The emphasis is on classical mechanics, together with an introduction to thermodynamics. |
|              | **Objective**                      |      |       |       |            |
|              | Acquire knowledge of the basic principles regarding the physics of classical mechanics and thermodynamics. Skills in solving physics problems. |

| 529-0011-01L | General Chemistry (Physical Chemistry) I | O    | 3     | 2V+1U | F. Merkt |
|              | **Abstract**                       |      |       |       |            |
|              | Atomic structure and structure of matter; Atomic orbitals and energy levels; Quantum mechanical atom model; Chemical bonding; Equations of state. |
|              | **Objective**                      |      |       |       |            |
|              | Introduction to Physical Chemistry |
|              | **Content**                        |      |       |       |            |
|              | Atomic structure and structure of matter: atomic theory, elementary particles, atomic nuclei, radioactivity, nuclear reactions. Atomic orbitals and energy levels: ionisation energies, atomic spectroscopy, term values and symbols. Quantum mechanical atom model: wave-particle duality, the uncertainty principle, Schrödinger's equation, the hydrogen atom, construction of the periodic table of the elements. Chemical bonding: ionic bonding, covalent bonding, molecular orbitals. Equations of state: ideal gases |
|              | **Lecture notes**                  |      |       |       |            |
|              | See homepage of the lecture. |
|              | **Literature**                     |      |       |       |            |
|              | See homepage of the lecture. |
|              | **Prerequisites / notice**         |      |       |       |            |
|              | Voraussetzungen: Maturastoff. Insbesondere Integral- und Differentialrechnung. |

### Additional First Year Compulsory Subjects

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0011-04L</td>
<td>Practical Course General Chemistry ■</td>
<td>O</td>
<td>8</td>
<td>12P</td>
<td>H. V. Schönberg, E. C. Meister</td>
</tr>
</tbody>
</table>

*Information about the practical course will be given on the first day.*
Abstract
Qualitative analysis (determination of cations and anions), acid-base-equilibria (pH-values, titrations, buffer), precipitation equilibria (gravimetry, potentiometry, conductivity), redox reactions (syntheses, redox-titrations, galvanic elements), metal complexes (syntheses, complexometric titration)

Analysis of measured values, states of aggregation (vapour pressure, conductivity, calorimetry)

Objective
Qualitative analysis (simple cation and anion separation process, determination of cations and anions), acid-base-equilibria (strengths of acids and bases, pH- and pKₐ-values, titrations, buffer systems, Kieldehl determination), precipitation equilibria (gravimetry, potentiometry, conductivity), oxidation state and redox behaviour (syntheses), redox-titrations, galvanic elements, metal complexes (syntheses of complexes, ligand exchange reactions, complexometric titration)

Analysis of measured values (measuring error, average value, error analysis), states of aggregation (vapour pressure), characteristics of electrolytes (conductivity measurements), thermodynamics (calorimetry)

Content
The general aim for the students of the practical course in general chemistry is an introduction in the scientific work and to get familiar with simple experimental procedures in a chemical laboratory. In general, first experiences with the principal reaction behaviour of a variety of different substances will be made. The chemical characteristics of these will be elucidated by a series of quantitative experiments alongside with the corresponding qualitative analyses. In order to get an overview of classes of substances as well as some general phenomena in chemistry suitable experiments have been chosen. In the second part of the practical course, i.e. physical chemistry, the behaviour of substances in their states of aggregation as well as changes of selected physical values will be recorded and discussed.

Lecture notes
http://www.gruetzmacher.ethz.ch/education/labcourses

Prerequisites / notice
Compulsory: online enrolment latest one week prior start of the semester

Introduction to Chemical Reaction Kinetics

Objective
Understanding and describing ionic equilibria from both a qualitative and a quantitative perspective

Content
Chemical equilibrium and equilibrium constants, mono- and polyprotic acids and bases in aqueous solution, calculation of equilibrium concentrations, acidity functions, Lewis acids, acids in non-aqueous solvents, redox reactions and equilibria, Galvanic cells, electrode potentials, Nernst equation, coordination chemistry, stepwise formation of metal complexes, solubility

Lecture notes
Copies of the course slides as well as other documents will be provided as pdf files via the moodle platform.

Literature

Introduction to Organic Chemistry

Objective
Introduction to the structures of organic compounds as well as the structural and energetic basis of organic chemistry.

Content

Lecture notes
Unterlagen werden als PDF über die ILIAS-Plattform zur Verfügung gestellt

Literature
### Content
- Evidence for Quantum Mechanics: atoms, photons, photo-electric effect, Rutherford scattering, Compton scattering, de-Broglie waves.
- Quantum mechanics: wavefunctions, operators, Schrodinger's equation, infinite and finite square well potentials, harmonic oscillator, hydrogen atoms, spin.
- Atomic structure: perturbation to basic structure, including Zeeman effect, spin-orbit coupling, many-electron atoms. X-ray spectra, optical selection rules, emission and absorption of radiation, including lasers.
- Optics: Fermat's principle, lenses, imaging systems, diffraction, interference, relation between geometrical and wave descriptions, interferometers, spectrometers.
- Statistical mechanics: probability distributions, micro and macrostates, Boltzmann distribution, ensembles, equipartition theorem, blackbody spectrum, including Planck distribution.
- Lecture notes: Lecture notes will be provided electronically during the course.
- Statistical mechanics: "Statistical Physics", F. Mandl 0-471-91532-7

### Electives
- For the Bachelor in Interdisciplinary Sciences students can in principle choose from all subjects taught at the Bachelor level at ETH Zurich.
- At the beginning of the 2. year an individual study program is established for every student in discussion with the Director of Studies in interdisciplinary sciences. For details see Programme Regulations 2010.

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<th>Number</th>
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<tr>
<td>252-0027-00L</td>
<td>Introduction to Programming</td>
<td>W</td>
<td>7 credits</td>
<td>4V+2U</td>
<td>T. Gross</td>
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<tr>
<td>Abstract</td>
<td>Introduction to fundamental concepts of modern programming and operational skills for developing high-quality programs, including large programs as in industry. The course introduces software engineering principles with an object-oriented approach based.</td>
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<td>Objective</td>
<td>Many people can write programs. The &quot;Introduction to Programming&quot; course goes beyond that basic goal: it teaches the fundamental concepts and skills necessary to perform programming at a professional level. As a result of successfully completing the course, students</td>
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<tr>
<td>Content</td>
<td>master the fundamental control structures, data structures, reasoning patterns and programming language mechanisms characterizing modern programming, as well as the fundamental rules of producing high-quality software. They have the necessary programming background for later courses introducing programming skills in specialized application areas.</td>
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<tr>
<td>Literature</td>
<td>The lecture slides are available for download on the course page.</td>
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<tr>
<td>Prerequisites</td>
<td>There are no special prerequisites. Students are expected to enroll in the other courses offered to first-year students of computer science.</td>
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<tr>
<td>252-0847-00L</td>
<td>Computer Science</td>
<td>W</td>
<td>5 credits</td>
<td>2V+2U</td>
<td>B. Gärtner</td>
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<tr>
<td>Abstract</td>
<td>This lecture is an introduction to programming based on the language C++. We cover fundamental types, control statements, functions, arrays, and classes. The concepts will be motivated and illustrated through algorithms and applications.</td>
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<tr>
<td>Objective</td>
<td>The goal of this lecture is an algorithmically oriented introduction to programming.</td>
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<td>Lecture notes in English and Handouts in German will be distributed electronically along with the course.</td>
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<td>327-0103-00L</td>
<td>Introduction to Materials Science</td>
<td>W</td>
<td>3 credits</td>
<td>3G</td>
<td>M. Niederberger, N. Spencer, P. Uggowitzer</td>
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<tr>
<td>Abstract</td>
<td>Fundamental knowledge and understanding of the atomistic and macroscopic concepts of material science.</td>
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<td>Objective</td>
<td>Basic concepts in materials science.</td>
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<td>Content</td>
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<td>Introduction to Materials Science for Engineers</td>
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<tr>
<td>327-0301-00L</td>
<td>Materials Science I</td>
<td>W</td>
<td>3 credits</td>
<td>3G</td>
<td>J. F. Löffler, A. R. Studart, P. Uggowitzer</td>
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<tr>
<td>Abstract</td>
<td>Basic concepts of metal physics, ceramics, polymers and their technology.</td>
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For metals see:
http://www.metphys.mat.ethz.ch/education/lectures/materialwissenschaft-i.html

For ceramics see:
http://www.complex.mat.ethz.ch/education/lectures.html

Literature

Metals:
D. A. Porter, K. E. Easterling
Phase Transformations in Metals and Alloys - Second Edition
ISBN : 0-7487-5741-4
Nelson Thornes

Ceramics:
- Mruz; D.; Fett; T: Ceramics, Mechanical Properties, Failure Behaviour, Materials Selection,
- diverse CEN ISO Standards given in the slides
- Barsoum MW: Fundamentals of Ceramics:

- "Brevieral Ceramics" published by the "Verband der Keramischen Industrie e.V.", ISBN 3-924158-77-0, partly its contents may be found in the internet @ http://www.keramverband.de/brevier_engl/brevier.htm or on our homepage
- Silicon-Based Structural Ceramics (Ceramic Transactions), Stephen C. Danforth (Editor), Brian W. Sheldon, American Ceramic Society, 2003,
- Silicon Nitride-1, Shigeyuki Somiya (Editor), M. Mitomo (Editor), M. Yoshimura (Editor), Kluwer Academic Publishers, 1990 3. Zirconia
- Phase relationships in the zirconia-yttria system, HGM Scott - Journal of Materials Science, 1975, Springer
- "Formation of beta -Si sub 3 N sub 4 solid solutions in the system Si, Al, O, N by reaction sintering--sintering of an Si sub 3 N sub 4 , AlN,
- In the first part of the lecture the bases are obtained for metals. In the second part the basics of cermics will be presented.
- One part of the lecture will be taught in English, but most of it in German.

Prerequisites / notice

401-2300-00L Complex Analysis W 6 credits 3V+2U R. Pandharipande

Abstract
Complex functions of one variable, Cauchy-Riemann equations, Cauchy theorem and integral formula, singularities, residue theorem, index of
closed curves, analytic continuation, special functions, conformal mappings, Riemann mapping theorem.

Objective
Working Knowledge with functions of one complex variables; in particular applications of the residue theorem

Literature
Th. Gamelin: Complex Analysis, Springer 2001
D. Salamon: "Funktionentheorie". Birkhauser, 2011. (In German)
L. Ahlfors: "Complex analysis. An introduction to the theory of analytic functions of one complex variable." International Series in Pure and
B. Palka: "An introduction to complex function theory."
R. Remmert: Theory of Complex Functions. Springer Verlag

401-2333-00L Methods of Mathematical Physics I W 6 credits 3V+2U C. A. Keller

Abstract
Fourier series. Linear partial differential equations of mathematical physics. Fourier transform. Special functions and eigenfunction
expansions. Distributions. Selected problems from quantum mechanics.

Objective
Die Einschreibung in die Übungsgruppen erfolgt online. Melden Sie sich im Laufe der ersten Semesterwoche unter echo.ethz.ch mit Ihrem
ETH Account an. Der Übungsbetrieb beginnt in der zweiten Semesterwoche.

Literature
http://www.complex.mat.ethz.ch/education/lectures.html

Autumn Semester 2016
402-0255-00L  Introduction to Solid State Physics  W  10 credits  3V+2U  K. Ensslin

Objective  
Introduction to Solid State Physics.

Content  
The course provides an introduction to solid state physics, covering several topics that are later discussed in more detail in other more specialized lectures. The central topics are: solids and their lattice structures; interatomic bindings; lattice dynamics, electronic properties of insulators, metals, semiconductors, transport properties, magnetism, superconductivity.

Lecture notes  
A Manuscript is distributed.

Literature  
Ashcroft & Mermin, Festkörperphysik
W. Känzig, Kondensierte Materie

Prerequisites / notice  
Voraussetzungen: Physik I, II, III wünschenswert

402-0263-00L  Astrophysics I  W  10 credits  3V+2U  A. Refregier

Objective  
The course provides an overview of fundamental concepts and physical processes in astrophysics with the dual goals of: i) illustrating physical principles through a variety of astrophysical applications; and ii) providing an overview of research topics in astrophysics.

402-0595-00L  Semiconductor Nanostructures  W  6 credits  2V+1U  T. M. Ihn

Abstract  
The course covers the foundations of semiconductor nanostructures, e.g., materials, band structures, bandgap engineering and doping, field-effect transistors. The physics of the quantum Hall effect and of common nanostructures based on two-dimensional electron gases will be discussed, i.e., quantum point contacts, Aharonov-Bohm rings and quantum dots.

Objective  
At the end of the lecture the student should understand four key phenomena of electron transport in semiconductor nanostructures:
1. The integer quantum Hall effect
2. Conductance quantization in quantum point contacts
3. the Aharonov-Bohm effect
4. Coulomb blockade in quantum dots

Content  
1. Introduction and overview
2. Semiconductor crystals: Fabrication and band structures
3. k-p-theory, effective mass
4. Envelope functions and effective mass approximation, heterostructures and band engineering
5. Fabrication of semiconductor nanostructures
6. Electrostatics and quantum mechanics of semiconductor nanostructures
7. Heterostructures and two-dimensional electron gases
8. Drude Transport
9. Electron transport in quantum point contacts; Landauer-Büttiker description
10. Ballistic transport experiments
11. Interference effects in Aharonov-Bohm rings
12. Electron in a magnetic field, Shubnikov-de Haas effect
13. Integer quantum Hall effect
14. Coulomb blockade and quantum dots

Lecture notes  

Literature  

Prerequisites / notice  
The lecture is suitable for all physics students beyond the bachelor of science degree. Basic knowledge of solid state physics is recommended. Very ambitioned students in the third year may be able to follow. The lecture can be chosen as part of the PhD-program. The course is taught in English.

402-2203-01L  Classical Mechanics  W  7 credits  4V+2U  G. M. Graf

Abstract  
A conceptual introduction to theoretical physics: Newtonian mechanics, central force problem, oscillations, Lagrangian mechanics, symmetries and conservation laws, spinning top, relativistic space-time structure, particles in an electromagnetic field, Hamiltonian mechanics, canonical transformations, integrable systems, Hamilton–Jacobi equation.

451-0015-00L  Biology I  W  2 credits  2V  R. Glockshuber, E. Hafen

Abstract  
The lecture Biology I, together with the lecture Biology II in the following summer semester, is a basic, introductory course into Biology for Students of Materials Sciences and other students with biology as subsidiary subject.

Objective  
The goal of this course is to give the students a basic understanding of the molecules that build a cell and make it function, and the basic principles of metabolism and molecular genetics.
Die folgenden Kapitelnummern beziehen sich auf das der Vorlesung zugrundeliegende Lehrbuch "Biology" (Campbell & Rees, 10th edition, 2015)
Kapitel 1-4 des Lehrbuchs werden als Grundwissen vorausgesetzt

1. Aufbau der Zelle

Kapitel 5: Struktur und Funktion biologischer Makromoleküle
Kapitel 6: Eine Tour durch die Zelle
Kapitel 7: Membranstruktur und -funktion
Kapitel 8: Einführung in den Stoffwechsel
Kapitel 9: Zelluläre Atmung und Speicherung chemischer Energie
Kapitel 10: Photosynthese
Kapitel 12: Der Zellzyklus
Kapitel 17: Vom Vorn zum Protein

2. Allgemeine Genetik

Kapitel 13: Meiose und Reproduktionszyklen
Kapitel 14: Mendel'sche Genetik
Kapitel 15: Die chromosomale Basis der Vererbung
Kapitel 16: Die molekulare Grundlage der Vererbung
Kapitel 18: Genetik von Bakterien und Viren
Kapitel 46: Tierische Reproduktion

Grundlagen des Stoffwechsels und eines Überblicks über molekulare Genetik

Der Vorlesungsstoff ist sehr nahe am Lehrbuch gehalten, Skripte werden ggf. durch die Dozenten zur Verfügung gestellt.

Das folgende Lehrbuch ist für die Vorlesungen Biologie I und II:


Lecture notes
Zur Vorlesung Biologie I gibt es während der Prüfungsphasen eine einstündige, schriftliche Prüfung. Die Vorlesung Biologie II wird separat geprüft.

Prerequisites / notice

529-0051-00L Analytical Chemistry I

Objective
Knowledge about the necessary theoretical background of spectroscopical methods and their practical applications

Content
Application oriented basics of organic and inorganic instrumental analysis and of the empirical employment of structure elucidation methods:
- Mass spectrometry: Ionization methods, mass separation, isotope signals, rules of fragmentation, rearrangements
- NMR spectroscopy: Experimental basics, chemical shift, spin-spin coupling
- IR spectroscopy: Revisiting topics like harmonic oscillators, normal vibrations, coupled oscillating systems (in accordance to the basics of the related lecture in physical chemistry); sample preparation, acquisition techniques, law of Lambert and Beer, interpretation of IR spectra
- Raman spectroscopy

Literature
- M. Hesse, H. Meier, B. Zeeh, Spektroskopische Methoden in der organischen Chemie, 5. überarbeitete Auflage, Thieme, Stuttgart, 1995

Prerequisites / notice
- Certain sections of the text-book must be studied by self-instruction.

551-0105-00L Fundamentals of Biology IA

Objective
The course provides an introduction to the basics of molecular- and cell biology and genetics.

Abstract
The course is divided into several chapters:
1. Basic principles of Evolution
2. Chemistry of Life: Water; Carbon and molecular diversity; biomolecules
3. The cell: structure; membrane structure and function, cell cycle
4. Metabolism: Respiration; Photosynthesis; Fermentation
5. Inheritance: meiosis and sexual reproduction; Mendelian genetics, chromosomal basis of inheritance, molecular basis of inheritance, from gene to protein, regulation of gene expression; genomes and their evolution

Literature
The text-book "Biology" (Campbell, Reece) (10th edition) is the basis of the course.

The structure of the course is largely identical with that of the text-book.

Prerequisites / notice
Certain sections of the text-book must be studied by self-instruction.

529-0121-00L Inorganic Chemistry I

Objective
Introduction to the binding theory in complexes of the transition metals. Interpretation of structure, bonding, and spectroscopic properties.

Abstract

Lecture notes
Can be bought at the HCI-shop

Literature

529-0221-00L Organic Chemistry I

Objective
Introduction into the most important spectroscopical methods and their applications to gain structural information.

Content
- NMR spectroscopy: Experimental basics, chemical shift, spin-spin coupling.
- IR spectroscopy: Revisiting topics like harmonic oscillator, normal vibrations, coupled oscillating systems (in accordance to the basics of the related lecture in physical chemistry); sample preparation, acquisition techniques, law of Lambert and Beer, interpretation of IR spectra.
- Raman spectroscopy.
- UV/VIS spectroscopy: Basics, interpretation of electron spectra. Circular dichroism (CD) and optical rotation dispersion (ORD).

Literature
Script will be for the production price
This course introduces important questions about the evolutionary processes involved in the generation and maintenance of biological diversity across all domains of life and how evolutionary science investigates these questions. The topics covered range from different forms of selection, phylogenetic analysis, population genetics, life history theory, the evolution of sex, social evolution to human evolution. These topics are important for the understanding of a number of evolutionary problems in the basic and applied sciences.

**Prerequisites / notice**

The exam is based on lecture and textbook.

**Lecture notes / literature**

In addition to the suggested literature handouts are distributed. Suggested literature:


The case studies and the analysis of the questions and problems are integral part of the course.

**Content**

Qualitative and quantitative understanding of the physical processes that control the terrestrial water cycle. Energy and mass exchange, mixing and transport processes are described and the coupling of the hydrosphere with the atmosphere and the solid Earth are discussed.

**Literature**

Suggested literature:

- 1. Water as resource, 2. Water and climate

**Prerequisites / notice**

The case studies and the analysis of the questions and problems are integral part of the course.

**Abstract**

Chemical reactivity and classes of compounds. Eliminations, fragmentations, chemistry of aldehydes and ketones (hydrates, acetals, imines, enamines, nucleophilic addition of organometallic compounds, reactions with phosphorus and sulfur ylides; reactions of enolates as nucleophiles) and of carboxylic acid derivatives. Aldol reactions.

**Objective**

Acquisition of a basic repertoire of synthetic methods including important reactions of aldehydes, ketones, carboxylic acids and carboxylic acid derivatives, as well as eliminations and fragmentations. Particular emphasis is placed on the understanding of reaction mechanisms and the correlation between structure and reactivity. A deeper understanding of the concepts presented during the lecture is reached by solving the problems handed out each time and discussed one week later in the exercise class.

**Content**

Chemical reactivity and classes of compounds. Eliminations, fragmentations, chemistry of aldehydes and ketones (hydrates, acetals, imines, enamines, nucleophilic addition of organometallic compounds, reactions with phosphorus and sulfur ylides; reactions of enolates as nucleophiles) and of carboxylic acid derivatives. Aldol reactions.

**Lecture notes / literature**

No set textbooks. Optional literature will be proposed at the beginning of the class and in the lecture notes.

**701-0223-00L**

**Introduction to Evolutionary Biology**

Abstract

This course introduces important questions about the evolutionary processes involved in the generation and maintenance of biological diversity across all domains of life and how evolutionary science investigates these questions. The topics covered range from different forms of selection, phylogenetic analysis, population genetics, life history theory, the evolution of sex, social evolution to human evolution. These topics are important for the understanding of a number of evolutionary problems in the basic and applied sciences.

**Objective**

This course introduces important questions about the evolutionary processes involved in the generation and maintenance of biological diversity across all domains of life and how evolutionary science investigates these questions. The topics covered range from different forms of selection, phylogenetic analysis, population genetics, life history theory, the evolution of sex, social evolution to human evolution. These topics are important for the understanding of a number of evolutionary problems in the basic and applied sciences.

**Content**

Topics likely to be covered in this course include research methods in evolutionary biology, adaptation, evolution of sex, evolutionary transitions, human evolution, infectious disease evolution, human history evolution, macroevolution, mechanisms of evolution, phylogenetic analysis, population dynamics, population genetics, social evolution, speciation and types of selection.

**Literature**

Textbook:

- Evolutionary Analysis
- Scott Freeman and Jon Herron

**Prerequisites / notice**

The exam is based on lecture and textbook.

**701-0401-00L**

**Hydrosphere**

Abstract

Qualitative and quantitative understanding of the physical processes that control the terrestrial water cycle. Energy and mass exchange, mixing and transport processes are described and the coupling of the hydrosphere with the atmosphere and the solid Earth are discussed.

**Objective**

Qualitative and quantitative understanding of the physical processes that control the terrestrial water cycle. Energy and mass exchange, mixing and transport processes are described and the coupling of the hydrosphere with the atmosphere and the solid Earth are discussed.

**Content**

- Physical properties of water (i.e. density and equation of state)
- Mixing and transport processes are described and the coupling of the hydrosphere with the atmosphere and the solid Earth are discussed.

**Literature**

Suggested literature:


**Prerequisites / notice**

The case studies and the analysis of the questions and problems are integral part of the course.

**Abstract**

This course gives an introduction to chemical processes in aquatic systems and shows applications to various systems. The following topics are treated: acid-base reactions and carbonate system, solubility of solids and weathering, redox reactions, complexation of metals, reactions at the solid/water interface, applications to lakes, rivers and groundwater.

**Objective**

Understanding of basic physical and chemical processes in the atmosphere. Understanding of mechanisms of and interactions between: weather - climate, atmosphere - ocean - continents, troposphere - stratosphere. Understanding of environmentally relevant structures and processes on vastly differing scales. Basis for the modelling of complex interrelations in the atmosphere.

**Content**

Basic principles of the atmosphere, physical structure and chemical composition, trace gases, atmospheric cycles, circulation, stability, radiation, condensation, clouds, oxidation capacity and ozone layer.

**Literature**


**Prerequisites / notice**

The exam is based on lecture and textbook.

**701-0423-00L**

**Chemistry of Aquatic Systems**

Abstract

This course gives an introduction to chemical processes in aquatic systems and shows applications to various systems. The following topics are treated: acid-base reactions and carbonate system, solubility of solids and weathering, redox reactions, complexation of metals, reactions at the solid/water interface, applications to lakes, rivers and groundwater.

**Objective**

Understanding of chemical processes in aquatic systems. Quantitative application of chemical equilibria to processes in natural waters.

**Content**

- Quantitative application of chemical equilibria to processes in natural waters. The following topics are treated: acid-base reactions, carbonate system; solubility of solid phases and weathering; complexation of metals and metal cycling in natural waters; redox reactions; reactions at the interface solid phase-water; applications to lakes, rivers, groundwater.

**Literature**

Numerical Methods in Environmental Sciences  

title: Numerical Methods in Environmental Sciences  

type: W  

credits: 3  

ens: 2G  

aut: C. Schär, O. Fuhrer  

abstract: This lecture imparts the mathematical basis necessary for the development and application of numerical models in the field of Environmental Science. The lecture material includes an introduction into numerical techniques for solving ordinary and partial differential equations, as well as exercises aimed at the realization of simple models.  

objective: This lecture imparts the mathematical basis necessary for the development and application of numerical models in the field of Environmental Science. The lecture material includes an introduction into numerical techniques for solving ordinary and partial differential equations, as well as exercises aimed at the realization of simple models.  

content: Classification of numerical problems, introduction to finite-difference methods, time integration schemes, non-linearity, conservative numerical techniques, an overview of spectral and finite-element methods. Examples and exercises from a diverse cross-section of Environmental Science.  

lecture notes: Is provided (CHF 10.- per copy).  

literature: List of literature is provided.  

Weather Systems  

title: Weather Systems  

type: W  

credits: 3  

ens: 2G  

aut: M. A. Sprenger, C. Grams  

abstract: This lecture introduces the theoretical principles and the observational and analytical methods of atmospheric dynamics. Based on these principles, the following aspects are discussed: the energetics of the global circulation, the basic synoptic- and meso-scale flow phenomena, in particular the dynamics of extratropical cyclones, and the influence of mountains on the atmospheric flow.  

objective: The students are able to  

- explain up-to-date meteorological observation techniques and the basic methods of theoretical atmospheric dynamics  
- to discuss the mathematical basis of atmospheric dynamics, based on selected atmospheric flow phenomena  
- to explain the basic dynamics of the global circulation and of synoptic- and meso-scale flow features  
- to explain how mountains influence the atmospheric flow on different scales  

content: Satellite observations; analysis of vertical soundings; geostrophic and thermal wind; cyclones at mid-latitude; global circulation; north-atlantic oscillation; atmospheric blocking situations; Eulerian and Lagrangian perspective; potential vorticity; Alpine dynamics (storms, orographic wind); planetary boundary layer  

lecture notes: Lecture notes and slides  

literature: Atmospheric Science, An Introductory Survey  

John M. Wallace and Peter V. Hobbs, Academic Press  

Pedosphere  

title: Pedosphere  

type: W  

credits: 3  

ens: 2V  

aut: R. Kretzschmar  

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

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

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

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

literature:  


prerequisites: Basic knowledge in chemistry, biology and geology.  

Microbiology  

title: Microbiology  

type: W  

credits: 2  

ens: 2V  

aut: M. Schuppler, S. Schlegel, J. Vorholt-Zambelli  

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

objective: Teaching of basic knowledge in microbiology.  


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

Laboratory Courses, Seminar Papers, Proseminars, Field Trips  

Further Laboratory Courses arising upon specific written request by the students and permission by the Director of studies.  

Number  

Title  

Type  

ECTS  

Hours  

Lecturers  

529-0011-00L  

Practical Course General Chemistry  

O  

8 credits  

12P  

H. V. Schönberg, E. C. Meister  

Latest online enrolment is 19.09.2016.
Students are accustomed to scientific work and they get to know one specific research field.

Lecturers

Hours

Qualitative analysis (determination of cations and anions), acid-base-equilibria (pH-values, titrations, buffer), precipitation equilibria (gravimetry, potentiometry, conductivity), redox reactions (syntheses, redox-titrations, galvanic elements), metal complexes (syntheses, complexometric titration)

Objectives

Qualitative analysis (simple cation and anion separation process, determination of cations and anions), acid-base-equilibria (strengths of acids and bases, pH- and pKₐ-values, titrations, buffer systems, Kjeldahl determination), precipitation equilibria (gravimetry, potentiometry, conductivity), oxidation state and redox behaviour (syntheses), redox-titrations, galvanic elements, metal complexes (syntheses of complexes, ligand exchange reactions, complexometric titration)

Analysis of measured values (measuring error, average value, error analysis), states of aggregation (vapour pressure), characteristics of electrolytes (conductivity measurements), thermodynamics (calorimetry)

Content

The general aim for the students of the practical course in general chemistry is an introduction in the scientific work and to get familiar with simple experimental procedures in a chemical laboratory. In general, first experiences with the principal reaction behaviour of a variety of different substances will be made. The chemical characteristics of these will be elucidated by a series of quantitative experiments alongside with the corresponding qualitative analyses. In order to get an overview of classes of substances as well as some general phenomena in chemistry suitable experiments have been chosen. In the second part of the practical course, i.e. physical chemistry, the behaviour of substances in their states of aggregation as well as changes of selected physical values will be recorded and discussed.

Lecture notes

Prerequisites / notice

Compulsory: online enrolment latest one week prior start of the semester

529-0129-00L Inorganic and Organic Chemistry II

Abstract

Introduction to the experimental methods of Inorganic Chemistry

Objective

Inorganic chemistry part: Synthesis and analysis of elemento-organic compounds, metal complexes, and organometallic compounds.

Content

Organic synthesis with organometallic compounds and catalysts: Experiments in the framework of a selected specialised project. Possible projects: Rh catalysed asymmetric hydrogenation of enamides, Mn-catalysed epoxidation of olefins, Cu catalysed Diels-Alder reactions, synthesis of organo-boron compounds and Pd catalysed coupling with halides, Ru catalysed transfer hydrogenation.

Lecture notes

Prerequisites / notice

A manual is distributed in the teaching laboratory.

Prerequisites:
- Practical Course General Chemistry (1. Semester, 529-0011-04)
- Practical Course Inorg. and Org. Chemistry I (2. Sem., 529-0230)
- Attendance of Course Inorg. Chemistry I (3. Sem., 529-0121)

If necessary, access priority will be settled according to the results of the first-year examinations.

5. Semester (Physical-Chemical Direction)

Laboratory Courses, Semester Papers, Proseminars, Field Trips

Further Laboratory Courses arising upon specific written request by the students and permission by the Director of studies.

Number Title Type ECTS Hours Lecturers

402-0241-00L Advanced Physics Laboratory I W 9 credits 18P C. Grab, T. M. Ihn

Abstract

This laboratory course provides basic training of experimental skills. These are experimental design, implementation, measurement, data analysis and interpretation, as well as error analysis. Written manuals for the individual experiments are available.

529-0450-00L Semester Project W 18 credits 18A Lecturers

Abstract

In a semester project students extend their knowledge in a particular field, get acquainted with the scientific way of working, and learn to work on an actual research topic.

Objective

Students are accustomed to scientific work and they get to know one specific research field.

529-0020-00L Research Project W 20 credits 20A Lecturers

Abstract

In a research project students extend their knowledge in a particular field, get acquainted with the scientific way of working, and learn to work on an actual research topic. Research projects are carried out in a core or optional subject area as chosen by the student.

Objective

Students are accustomed to scientific work and they get to know one specific research field.

Bachelor's Thesis

Number Title Type ECTS Hours Lecturers

529-0400-00L Bachelor's Thesis O 15 credits 15D Lecturers

Abstract

It completes the Bachelor program and consists of a scientific project carried out independently.

Objective

Encourages students to show independence, to produce scientifically structured work and to apply engineering working methods.

Biochemical-Physical Direction

1. Semester (Biochemical-Physical Direction)

Compulsory Subjects First Year Examinations

Number Title Type ECTS Hours Lecturers

551-0105-00L Fundamentals of Biology IA O 5 credits 5G M. Aebi, E. Hafen

Abstract

The course provides an introduction to the basics of molecular- and cell biology and genetics. Introduction to modern biology and to principal biological concepts.
### Content

The course is divided into several chapters:

1. Basic principles of Evolution.
2. Chemistry of Life: Water; Carbon and molecular diversity; biomolecules
3. The cell; structure; membrane structure and function, cell cycle
4. Metabolism: Respiration; Photosynthesis; Fermentation
5. Inheritance: meiosis and sexual reproduction; Mendelian genetics, chromosomal basis of inheritance, molecular basis of inheritance, from gene to protein, regulation of gene expression; genomes and their evolution

### Literature

- **Lecture notes:** None.
- **Prerequisites / notice:** Certain sections of the text-book must be studied by self-instruction.

### Prerequisites / notice

- **401-0271-00L**  
  **Mathematical Foundations I: Analysis A**  
  Introduction to calculus in one dimension. Building simple models and analysing them mathematically. Functions of one variable: the notion of a function, of the derivative, the idea of a differential equation, complex numbers, Taylor polynomials and Taylor series. The integral of a function of one variable.
  - **Objective:** Introduction to calculus in one dimension. Building simple models and analysing them mathematically.
  - **Content:** Functions of one variable: the notion of a function, of the derivative, the idea of a differential equation, complex numbers, Taylor polynomials and Taylor series. The integral of a function of one variable.
  - **Literature:**
    - G. B. Thomas, M. D. Weir, J. Hass: Analysis 1, Lehr- und Übungsbuch, Pearson-Verlag
    - D. W. Jordan, P. Smith: Mathematische Methoden für die Praxis, Spektrum Akademischer Verlag
    - R. Spörb/M. Akveld: Analysis I (vdf)
    - L. Papula: Mathematik für Ingenieure und Naturwissenschaftler (3 Bände)
  - **Additional:** Further reading suggestions will be indicated during the lecture.

### 401-1261-07L

- **Analysis I**  
  Introduction to the differential and integral calculus in one real variable: fundamentals of mathematical thinking, numbers, sequences, basic point set topology, continuity, differentiable functions, ordinary differential equations, Riemann integration.
  - **Objective:** The ability to work with the basics of calculus in a mathematically rigorous way.
  - **Literature:**
    - K. Königsberger: Analysis I, Springer-Verlag
    - R. Courant: Vorlesungen über Differential- und Integralrechnung, Springer Verlag
    - V. Zörich: Analysis I. Springer Verlag 2006
    - H. Heuser: Lehrbuch der Analysis. Teubner Verlag
    - W. Walter: Analysis I. Springer Verlag
    - O. Forster: Analysis I. Vieweg Verlag
    - J. Appell: Analysis in Beispielen und Gegenbeispielen. Springer Verlag
    - Beutelspacher, Das ist o.B.d.A. trivial

### 401-0231-10L

- **Analysis I**  
  Calculus of one variable: Real and complex numbers, vectors, limits, sequences, series, power series, continuous maps, differentiation and integration in one variable, introduction to ordinary differential equations.
  - **Objective:** Einführung in die Grundlagen der Analysis
  - **Lecture notes:** Konrad Koenigsberger, Analysis I.
  - **Christian Blatter: Ingenieur-Analysis (Kapitel 1-3)

### 529-0001-00L

- **Introduction to Computer Science**  
  Introduction to UNIX, data representation, introduction to C++ programming, errors, algorithms, computer architecture, sorting and searching, databases, numerical algorithms, types of algorithms, simulation, data communication & networks, chemical structures, operating systems, programming languages, software engineering.
  - **Objective:** For more information: www.csms.ethz.ch/education/infol
  - **Content:** Minimal introduction to UNIX, Data representation and processing, algorithms and programming in C++. Errors, programming guidelines, efficiency, computer architecture, algorithms for sorting and searching, databases, numerical algorithms, types of algorithms, simulation, data communication & networks, chemical structures, operating systems, programming languages, style, software engineering.
  - **Literature:** See: www.csms.ethz.ch/education/infol
  - **Additional:** Since the exercises on the computer do convey and test essentially different skills as those being conveyed during the lectures and tested at the written exam, the results of the exercises are taken into account when evaluating the results of the exam.

### 529-0011-02L

- **General Chemistry (Inorganic Chemistry) I**  
  Introduction to the chemistry of ionic equilibria: Acids and bases, redox reactions, formation of coordination complexes and precipitation reactions.
  - **Objective:** For more information about the lecture: www.csms.ethz.ch/education/infol

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Data: 06.03.2019 12:57  
Autumn Semester 2016  
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### Mathematics III: Partial Differential Equations

**Objective**
Understanding and describing ionic equilibria from both a qualitative and a quantitative perspective

**Content**
Chemical equilibrium and equilibrium constants, mono- and polyprotic acids and bases in aqueous solution, calculation of equilibrium concentrations, acidity functions, Lewis acids, acids in non-aqueous solvents, redox reactions and equilibria, Galvanic cells, electrode potentials, coordination chemistry, stepwise formation of metal complexes, solubility

**Lecture notes**
Copies of the course slides as well as other documents will be provided as pdf files via the moodle platform.

**Literature**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>529-0011-03L</td>
<td>General Chemistry (Organic Chemistry) I</td>
<td>O</td>
<td>3 credits</td>
<td>2V+1U</td>
<td>H. Wennenmers</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>Introduction to Organic Chemistry. Classical structure theory, stereochemistry, chemical bonds and bonding, symmetry, nomenclature, organic thermochemistry, conformational analysis, basics of chemical reactions.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>Introduction to the structures of organic compounds as well as the structural and energetic basis of organic chemistry.</td>
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<tr>
<td><strong>Content</strong></td>
<td>Introduction to the history of organic chemistry, introduction to nomenclature, learning of classical structures and stereochemistry: isomerism, Fischer projections, CIP rules, point groups, molecular symmetry and chirality, topicity, chemical bonding: Lewis bonding model and resonance theory in organic chemistry, description of linear and cyclic conjugated molecules, aromaticity, Huckel rules, organic thermochemistry, learning of organic chemistry reactions, intermolecular interactions.</td>
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<tr>
<td><strong>Lecture notes</strong></td>
<td>Unteralagen werden als PDF über die ILIAS-Plattform zur Verfügung gestellt</td>
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<tbody>
<tr>
<td>529-0011-01L</td>
<td>General Chemistry (Physical Chemistry) I</td>
<td>O</td>
<td>3 credits</td>
<td>2V+1U</td>
<td>F. Merkt</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>Atomic structure and structure of matter; Atomic orbitals and energy levels; Quantum mechanical atom model; Chemical bonding; Equations of state.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>Introduction to Physical Chemistry</td>
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<tr>
<td><strong>Content</strong></td>
<td>Atomic structure and structure of matter: atomic theory, elementary particles, atomic nuclei, radioactivity, nuclear reactions. Atomic orbitals and energy levels: ionisation energies, atomic spectroscopy, term values and symbols. Quantum mechanical atom model: wave-particle duality, the uncertainty principle, Schrödinger’s equation, the hydrogen atom, construction of the periodic table of the elements. Chemical bonding: ionic bonding, covalent bonding, molecular orbitals. Equations of state: ideal gases</td>
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<tr>
<td><strong>Lecture notes</strong></td>
<td>See homepage of the lecture.</td>
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<tr>
<td><strong>Literature</strong></td>
<td>See homepage of the lecture.</td>
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<tr>
<td><strong>Prerequisites / notice</strong></td>
<td>Voraussetzungen: Maturastoff. Insbesondere Integral- und Differentialrechnung.</td>
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### Additional First Year Compulsory Subjects

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<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>529-0011-04L</td>
<td>Practical Course General Chemistry</td>
<td>O</td>
<td>8 credits</td>
<td>12P</td>
<td>H. V. Schönberg, E. C. Meister</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>Qualitative analysis (determination of cations and anions), acid-base-equilibria (pH-values, titrations, buffer), precipitation equilibria (gravimetry, potentiometry, conductivity), redox-reactions (syntheses, redox-titrations, galvanic elements), metal complexes (syntheses, complexometric titration) analysis of measured values, states of aggregation (vapour pressure, conductivity, calorimetry)</td>
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<tr>
<td><strong>Objective</strong></td>
<td>Qualitative analysis (simple cation and anion separation process, determination of cations and anions), acid-base-equilibria (strengths of acids and bases, pH- and pKa-values, titrations, buffer systems, Kjeldahl determination), precipitation equilibria (gravimetry, potentiometry, conductivity), oxidation state and redox behaviour (syntheses), redox-titrations, galvanic elements, metal complexes (syntheses of complexes, ligand exchange reactions, complexometric titration) analysis of measured values (measuring error, average value, error analysis), states of aggregation (vapour pressure), characteristics of electrolytes (conductivity measurements), thermodynamics (calorimetry)</td>
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<tr>
<td><strong>Content</strong></td>
<td>The general aim for the students of the practical course in general chemistry is an introduction in the scientific work and to get familiar with simple experimental procedures in a chemical laboratory. In general, first experiences with the principal reaction behaviour of a variety of different substances will be made. The chemical characteristics of these will be elucidated by a series of quantitative experiments alongside with the corresponding qualitative analyses. In order to get an overview of classes of substances as well as some general phenomena in chemistry suitable experiments have been chosen. In the second part of the practical course, i.e. physical chemistry, the behaviour of substances in their states of aggregation as well as changes of selected physical values will be recorded and discussed.</td>
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<tr>
<td><strong>Lecture notes</strong></td>
<td><a href="http://www.gruetzacher.ethz.ch/education/labcourses">http://www.gruetzacher.ethz.ch/education/labcourses</a></td>
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<tr>
<td><strong>Prerequisites / notice</strong></td>
<td>Compulsory: online enrolment latest one week prior start of the semester</td>
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### 3. Semester (Biochemical-Physical Direction)

#### Compulsory Subjects Examination Block

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>401-0373-00L</td>
<td>Mathematics III: Partial Differential Equations</td>
<td>W</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>F. Da Lio</td>
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<tr>
<td><strong>Objective</strong></td>
<td>The main objective is that the students get a basic knowledge of the classical tools to solve explicitly linear partial differential equations.</td>
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</table>

Data: 06.03.2019 12:57  Autumn Semester 2016  Page 861 of 1571
## Examples of partial differential equations
- Classification of PDEs
- Superposition principle

## One-dimensional wave equation
- D'Alembert's formula
- Duhamel's principle

## Fourier series
- Representation of piecewise continuous functions via Fourier series
- Examples and applications

## Separation of variables
- Resolution of wave and heat equation
- Homogeneous and inhomogeneous boundary conditions, Dirichlet and Neumann boundary conditions

## Laplace equation
- Resolution of the Laplace equation on rectangle, disk and annulus
- Poisson formula
- Mean value theorem and maximum principle

## Fourier transform
- Derivation and Definition
- Inverse Fourier transformation and inversion formula
- Interpretation and properties of the Fourier transform
- Resolution of the heat equation

## Laplace transform
- Definition, motivation and properties
- Inverse Laplace transform of rational functions
- Application to ordinary differential equations

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Lecture notes
There are available some Lecture Notes in English and also in German of the Professor. These can be found following the links provided under the tab 'Lernmaterialien'.

Literature
2) Y. Pinchover and J. Rubinstein, An Introduction to Partial Differential Equations, Cambridge University Press
3) E. Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons (only Chapters 1,2,6,11)

Prerequisites / notice
Prerequisites: Analysis I and II, Fourier series (Komplexe Analysis)
This lecture is an introduction to programming based on the language C++. We cover fundamental types, control statements, functions.

Mechanics (motion, Newton's laws, work and energy, conservation of momentum, rotation, gravitation, fluids)

Introduction to the concepts and tools in physics with the help of demonstration experiments: mechanics of point-like and ridged bodies, periodic motion and mechanical waves.

Abstract

Introduction to the concepts and tools in physics with the help of demonstration experiments: mechanics of point-like and ridged bodies, periodic motion and mechanical waves.

Objective

The concepts and tools in physics, as well as the methods of an experimental science are taught. The student should learn to identify, communicate and solve physical problems in his/her own field of science.

Content

Mechanics (motion, Newton's laws, work and energy, conservation of momentum, rotation, gravitation, fluids)

Lecture notes

The lecture follows the book "Physics" by Paul A. Tipler.

Literature

Paul A. Tipler and Gene P. Mosca, Physics (for Scientists and Engineers), W. H. Freeman and Company

Prerequisites / notice

Prerequisites: Mathematics I & II

402-1701-00L

Physics I

W

7 credits

4V+2U

A. Wallraff

This course gives a first introduction to Physics. The emphasis is on classical mechanics, together with an introduction to thermodynamics.

Acquire knowledge of the basic principles regarding the physics of classical mechanics and thermodynamics. Skills in solving physics problems.

529-0422-00L

Physical Chemistry II: Introduction to Chemical Reaction Kinetics

O

4 credits

3V+1U

H. J. Wörner

Introduction to Chemical Reaction Kinetics


529-0221-00L

Organic Chemistry I

O

3 credits

2V+1U

F. Diederich, C. Schaack

Chemical reactivity and classes of compounds. Eliminations, fragmentations, chemistry of aldehydes and ketones (hydrates, acetals, imines, enamines, nucleophilic additions, organometallic compounds, reactions with phosphorus and sulfur ylides; reactions of enolates as nucleophiles) and of carboxylic acid derivatives. Aldol reactions.

Acquisition of a basic repertoire of synthetic methods including important reactions of aldehydes, ketones, carboxylic acids and carboxylic acid derivatives, as well as eliminations and fragmentations. Particular emphasis is placed on the understanding of reaction mechanisms and the correlation between structure and reactivity. A deeper understanding of the concepts presented during the lecture is reached by solving the problems handed out each time and discussed one week later in the exercise class.

525-0027-00L

Introduction to Programming

W

7 credits

4V+2U

T. Gross

Introduction to fundamental concepts of modern programming and operational skills for developing high-quality programs, including large programs as in industry. The course introduces software engineering principles with an object-oriented approach based.

Many people can write programs. The "Introduction to Programming" course goes beyond that basic goal: it teaches the fundamental concepts and skills necessary to perform programming at a professional level. As a result of successfully completing the course, students master the fundamental control structures, data structures, reasoning patterns and programming language mechanisms characterizing modern programming, as well as the fundamental rules of producing high-quality software. They have the necessary programming background for later courses introducing programming skills in specialized application areas.

Data: 06.03.2019 12:57 Autumn Semester 2016 Page 863 of 1571
Abstract


Objective

The main objective is that the students get a basic knowledge of the classical tools to solve explicitly linear partial differential equations.

Content

- Classification of PDEs
- Superposition principle

- One-dimensional wave equation
  - D'Alembert's formula
  - Duhamel's principle

- Fourier series
  - Representation of piecewise continuous functions via Fourier series
  - Examples and applications

- Separation of variables
  - Resolution of wave and heat equation
  - Homogeneous and inhomogeneous boundary conditions, Dirichlet and Neumann boundary conditions

- Laplace equation
  - Resolution of the Laplace equation on rectangle, disk and annulus
  - Poisson formula
  - Mean value theorem and maximum principle

- Fourier transform
  - Derivation and Definition
  - Inverse Fourier transformation and inversion formula
  - Interpretation and properties of the Fourier transform
  - Resolution of the heat equation

- Laplace transform
  - Definition, motivation and properties
  - Inverse Laplace transform of rational functions
  - Application to ordinary differential equations

Literature


2) Y. Pinchover and J. Rubinstein, An Introduction to Partial Differential Equations, Cambridge University Press

3) E. Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons (only Chapters 1,2,6,11)


Prerequisites / notice

It is required a minimal background of: 1) multivariables functions (Riemann integrals in two or three variables, change of variables in the integrals through the Jacobian, partial derivatives, differentiability, Jacobian) 2) numerical and functional sequences and series, basic knowledge of ordinary differential equations.
### Literature

- Th. Gamelin: *Complex Analysis*. Springer 2001
- E. Titchmarsh: *The Theory of Functions*. Oxford University Press
- D. Salamon: "Funktionentheorie". Birkhauser, 2011. (In German)
- B. Palca: "An introduction to complex function theory."

### Lecture notes

- R. Remmert: *Theory of Complex Functions*. Springer-Verlag

#### 401-2333-00L

**Methods of Mathematical Texts I**

<table>
<thead>
<tr>
<th>W</th>
<th>6 credits</th>
<th>3V+2U</th>
<th>C. A. Keller</th>
</tr>
</thead>
</table>

**Abstract**


**Prerequisites / notice**


#### 402-2203-01L

**Classical Mechanics**

| W | 7 credits | 4V+2U | G. M. Graf |

**Abstract**

A conceptual introduction to theoretical physics: Newtonian mechanics, central force problem, oscillations, Lagrangian mechanics, symmetries and conservation laws, spinning top, relativistic space-time structure, particles in an electromagnetic field, Hamiltonian mechanics, canonical transformations, integrable systems, Hamilton-Jacobi equation.

#### 402-2883-00L

**Physics III**

| W | 7 credits | 4V+2U | J. Home |

**Abstract**

Introductory course on quantum and atomic physics including optics and statistical physics.

**Objective**

A basic introduction to quantum and atomic physics, including basics of optics and equilibrium statistical physics. The course will focus on the relation of these topics to experimental methods and observations.

**Content**


**Literature**

- Statistical mechanics: "Statistical Physics", F. Mandl 0-471-91532-7

#### 551-0103-00L

**Fundamentals of Biology II: Cell Biology**

| W | 5 credits | 5V | E. Hafen, U. Kutay, J. Matos, G. Schertler, U. Suter, S. Werner |

**Abstract**

The goal of this course is to provide students with a wide general understanding in cell biology. With this material as a foundation, students have enough of a cell biological basis to begin their specialization not only in cell biology but also in related fields such as biochemistry, microbiology, pharmacological sciences, molecular biology, and others.

**Objective**

The goal of this course is to provide students with a wide general understanding cell biology. With this material as a foundation, students have enough of a cell biological basis to begin their specialization not only in cell biology but also in related fields such as biochemistry, microbiology, pharmacological sciences, molecular biology, and others.

**Content**

The focus is animal cells and the development of multicellular organisms with a clear emphasis on the molecular basis of cellular structures and phenomena. The topics include biological membranes, the cytoskeleton, protein sorting, energy metabolism, cell cycle and division, viruses, extracellular matrix, cell signaling, embryonic development and cancer research.

**Lecture notes**

The lectures are presented in the Powerpoint format. These are available on the WEB for ETH students over the nethz (Moodle). Some lectures are available on the ETH WEB site in a live format (Livestream) at the above WEB site.

**Literature**


#### 551-1295-00L

**Introduction to Bioinformatics: Concepts and Applications**

| W | 6 credits | 4G | W. Gruissem, K. Bärenfaller, A. Callisch, G. Capitani, J. Fütterer, M. Robinson, A. Wagner |

**Abstract**

Storage, handling and analysis of large datasets have become essential in biological research. The course will introduce students to a number of applications of bioinformatics in biology. Freely accessible software tools and databases will be explained and explored in theory and praxis.
Objective
Introduction to Bioinformatics I: Concepts and Applications (formerly Bioinformatics I) will provide students with the theoretical background of approaches to store and retrieve information from large databases. Concepts will be developed how DNA sequence information can be used to understand phylogenetic relationships, how RNA sequence relates to structure, and how protein sequence information can be used for genome annotation and to predict protein folding and structure. Students will be introduced to quantitative methods for measuring gene expression and how this information can be used to model gene networks. Methods will be discussed to construct protein interaction maps and how this information can be used to simulate dynamic molecular networks.

In addition to the theoretical background, the students will develop hands-on experiences with the bioinformatics methods through guided exercises. The course provides students from different backgrounds with basic training in bioinformatics approaches that have impact on biological, chemical and physics experimentation. Bioinformatics approaches draw significant expertise from mathematics, statistics and computational science.

Although "Introduction to Bioinformatics I" will focus on theory and praxis of bioinformatics approaches, the course provides an important foundation for the course "Introduction to Bioinformatics II: Fundamentals of computer science, modeling and algorithms" that will be offered in the following semester.

Content
Bioinformatics I will cover the following topics:

- From genes to databases and information
  - BLAST searches
  - Prediction of gene function and regulation
  - RNA structure prediction
  - Gene expression analysis using microarrays
  - Protein sequence and structure databases
  - WWW for bioinformatics
  - Protein sequence comparisons
  - Proteomics and de novo protein sequencing
  - Protein structure prediction
  - Cellular and protein interaction networks
  - Molecular dynamics simulation

529-0051-00L

**Analytical Chemistry I**

**Objective**
Introduction into the most important spectroscopical methods and their applications to gain structural information.

**Content**
Application oriented basics of organic and inorganic instrumental analysis and of the empirical employment of structure elucidation methods:

- Mass spectrometry: Ionization methods, mass separation, isotope signals, rules of fragmentation, rearrangements.
- NMR spectroscopy: Experimental basics, chemical shift, spin-spin coupling.
- IR spectroscopy: Revisiting topics like harmonic oscillator, normal vibrations, coupled oscillating systems (in accordance to the basics of the related lecture in physical chemistry); sample preparation, acquisition techniques, laws of Lambert and Beer, interpretation of IR spectra.
- Raman spectroscopy.
- UV/VIS spectroscopy: Basics, interpretation of electron spectra. Circular dichroism (CD) and optical rotation dispersion (ORD).

**Prerequisites / notice**
Exercises are integrated in the lectures. In addition, attendance in the lecture 529-0289-00 "Instrumental analysis of organic compounds" (4th semester) is recommended.

529-0121-00L

**Inorganic Chemistry**

**Objective**
Introduction to the binding theory in complexes of the transition metals. Interpretation of structure, bonding, and spectroscopic properties. General synthetic strategies.

**Content**
The chemical bond (overview). Symmetry and group theory. The chemical bond of coordination compounds (Valence Bond Theory, Crystal Field Theory, Molecular Orbital Theory (sigma- and pi-bonding); pi-Accepting ligands (CO, NO, olefins, dioxygen, dihydrogen, phosphines and phosphites). Electronic spectra of coordination compounds (Tanabe-Sugano diagrams). Coordination numbers and isomers in complexes. Dynamic phenomena (stereochemical nonrigidity), Complexes and kinetics.

**Prerequisites / notice**
Can be bought at the HCI-shop.

752-4001-00L

**Microbiology**

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

**Content**
Teaching of basic knowledge in microbiology.

**Lecture notes**

701-0243-01L

**Biology III: Essentials of Ecology**

**Objective**
The objective of this lecture is to teach basic ecological concepts and the different levels of complexity in ecological research: the individual, the population, the community and the ecosystem level. The students should learn ecological concepts at these different levels in the context of concrete examples from terrestrial and aquatic ecology. Corresponding methods for studying the systems will be presented.

A further aim of the lecture is that students achieve an understanding of biodiversity, why it is threatened and how it can be managed.
### Introduction to Evolutionary Biology (701-0245-00L)

**Objective**
This course introduces important questions about the evolutionary processes involved in the generation and maintenance of biological diversity across all domains of life and how evolutionary science investigates these questions.

**Content**
Topics likely to be covered in this course include research methods in evolutionary biology, adaptation, evolution of sex, evolutionary transitions, human evolution, infectious disease evolution, life history evolution, macroevolution, mechanisms of evolution, phylogenetic analysis, population dynamics, population genetics, social evolution, speciation and types of selection.

**Literature**
- Scott Freeman and Jon Herron
  - Evolutionary Analysis

**Prerequisites**
The exam is based on lecture and textbook.

### Atmosphere (701-0023-00L)

**Abstract**
Basic principles of the atmosphere, physical structure and chemical composition, trace gases, atmospheric cycles, circulation, stability, radiation, condensation, clouds, oxidation capacity and ozone layer.

**Objective**
Understanding of basic physical and chemical processes in the atmosphere. Understanding of mechanisms of and interactions between: weather - climate, atmosphere - ocean - continents, troposphere - stratosphere. Understanding of environmentally relevant structures and processes on vastly differing scales. Basis for the modelling of complex interrelations in the atmosphere.

**Content**
Basic principles of the atmosphere, physical structure and chemical composition, trace gases, atmospheric cycles, circulation, stability, radiation, condensation, clouds, oxidation capacity and ozone layer.

**Lecture notes**
Written information will be supplied.

**Literature**

### Pedosphere (701-0501-00L)

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

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

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

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

**Literature**

### Hydrosphere (701-0401-00L)

**Abstract**
Qualitative and quantitative understanding of the physical processes that control the terrestrial water cycle. Energy and mass exchange, mixing and transport processes are described and the coupling of the hydrosphere with the atmosphere and the solid Earth are discussed.

**Objective**
Qualitative and quantitative understanding of the physical processes that control the terrestrial water cycle. Energy and mass exchange, mixing and transport processes are described and the coupling of the hydrosphere with the atmosphere and the solid Earth are discussed.
Topics of the course.
Physical properties of water (i.e. density and equation of state).
- global water resources
- Exchange at boundaries
- energy (thermal & kinetic), gas exchange
- Mixing and transport processes in open waters
- vertical stratification, large scale transport
- turbulence and mixing
- mixing and exchange processes in rivers
- Groundwater and its dynamics
- ground water as part of the terrestrial water cycle
- ground water hydraulics, Darcy's law
- aquifers and their properties
- hydrochemistry and tracer
- ground water use

Case studies
- 1. Water as resource, 2. Water and climate

In addition to the suggested literature handouts are distributed.

Semester Project

In addition to the suggested literature handouts are distributed.

Numerical Methods in Environmental Sciences
Understanding of chemical processes in aquatic systems. Quantitative application of chemical equilibria to processes in natural waters.

Suggested literature.

Prerequisites / notice
The case studies and the analysis of the questions and problems are integral part of the course.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>529-0450-00L</td>
<td>Semester Project</td>
<td>W</td>
<td>18</td>
<td>18A</td>
<td>Lecturers</td>
</tr>
</tbody>
</table>
In a semester project students extend their knowledge in a particular field, get acquainted with the scientific way of working, and learn to work on an actual research topic.

Students are accustomed to scientific work and they get to know one specific research field.

### Bachelor’s Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0400-00L</td>
<td>Bachelor’s Thesis</td>
<td>O</td>
<td>15 credits</td>
<td>15D</td>
<td>Lecturers</td>
</tr>
</tbody>
</table>

Abstract

It completes the Bachelor program and consists of a scientific project carried out independently.

Objective

Encourages students to show independence, to produce scientifically structured work and to apply engineering working methods.

### Second and Third Year Additional Subjects

For the Bachelor in Interdisciplinary Sciences students can in principle choose from all subjects taught at the Bachelor level at ETH Zurich.

At the beginning of the 2. year an individual study program is established for every student in discussion with the Director of Studies in interdisciplinary sciences. For details see Programme Regulations 2010.

### Other Electives ETH

Further combinations of Compulsory elective subjects arising upon specific written request by the students and permission by the Director of studies.

#### Course Catalogue of ETH

#### GESS Science in Perspective

- see GESS Science in Perspective: Type A: Enhancement of Reflection Capability
- see GESS Science in Perspective: Language Courses ETH/UZH
- Recommended GESS Science in Perspective (Type B) for D-CHAB.

#### Interdisciplinary Sciences Bachelor - Key for Type

<table>
<thead>
<tr>
<th>O</th>
<th>Compulsory</th>
<th>E-</th>
<th>Recommended, not eligible for credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
</tbody>
</table>

#### Key for Hours

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
<th>P</th>
<th>practical/laboratory course</th>
</tr>
</thead>
<tbody>
<tr>
<td>G</td>
<td>lecture with exercise</td>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
<td>R</td>
<td>revision course / private study</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

ECTS

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Interdisciplinary Sciences Master

For the Master in Interdisciplinary Sciences students can in principle choose from all subjects taught at the Master level at ETH Zurich.

At the beginning of the Master studies an individual study program is established for every student in discussion with the Director of Studies in interdisciplinary sciences. For details see Programme Regulations 2007.

▶ Majors

The students can choose from all Majors as provided by the following list: http://www.chab.ethz.ch/lehre/in_msc/index_EN

Furthermore it is also possible to create an individual Majors as specified in Art. 19 paragraph 3 of the Programme Regulations.

▶ General Courses

Selection of courses of ETH, according individual curriculum.

▶ Proseminars, Laboratory Courses, Research Projects and Sem. Papers

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>529-0020-00L</td>
<td>Research Project</td>
<td>W</td>
<td>20 credits</td>
<td>20A</td>
<td>Lecturers</td>
</tr>
</tbody>
</table>

Abstract
In a research project students extend their knowledge in a particular field, get acquainted with the scientific way of working, and learn to work on an actual research topic. Research projects are carried out in a core or optional subject area as chosen by the student.

Objective
Students are accustomed to scientific work and they get to know one specific research field.

▶ GESS Science in Perspective

Recommended GESS Science in Perspective (Type B) for D-CHAB.

see GESS Science in Perspective: Type A: Enhancement of Reflection Capability

see GESS Science in Perspective: Language Courses ETH/UZH

▶ Master's Thesis

If more than 20 credits are acquired by the Master Thesis, select a course of the ETH course catalogue with similar content to the specific major of your study program. Registration by the study administration (HCI H201).

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-1000-00L</td>
<td>Master's Thesis</td>
<td>O</td>
<td>20 credits</td>
<td>43D</td>
<td>Professors</td>
</tr>
</tbody>
</table>

Abstract
In the Master thesis students prove their ability to independent, structured and scientific working. The Master thesis is usually carried out in a core or optional subject area as chosen by the student.

Objective
In the Master Thesis students prove their ability to independent, structured and scientific working.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-1000-30L</td>
<td>Master's Thesis</td>
<td>O</td>
<td>30 credits</td>
<td>64D</td>
<td>Professors</td>
</tr>
</tbody>
</table>

Abstract
In the Master thesis students prove their ability to independent, structured and scientific working. The Master thesis is usually carried out in a core or optional subject area as chosen by the student.

Objective
In the Master Thesis students prove their ability to independent, structured and scientific working.

Interdisciplinary Sciences Master - Key for Type

| W+ | Eligible for credits and recommended |
| O | Compulsory |
| W | Eligible for credits |
| E- | Recommended, not eligible for credits |
| Z | Courses outside the curriculum |
| Dr | Suitable for doctorate |
**Key for Hours**

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
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<tbody>
<tr>
<td>V</td>
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<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

**ECTS**

- European Credit Transfer and Accumulation System
- Special students and auditors need special permission from the lecturers.
### First Year Examinations

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-2001-02L</td>
<td>Chemistry I</td>
<td>O</td>
<td>4</td>
<td>2V+2U</td>
<td>W. Uhlig, J. E. E. Buschmann, S. Canonica, P. Funck, E. C. Meister, R. Verel</td>
</tr>
</tbody>
</table>

**Abstract**

General Chemistry I: Chemical bond and molecular structure, chemical thermodynamics, chemical equilibrium.

**Objective**

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

**Content**

1. Stoichiometry

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

3. Chemical Bonding

4. Thermodynamics

5. Chemical Kinetics

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

**Lecture notes**

Online-Skript mit durchgerechneten Beispielen.

**Literature**

- Brown, LeMay, Bursten CHEMIE (deutsch)
- Housecroft and Constable, CHEMISTRY (englisch)
- Oxtoby, Gillis, Nachtrieb, MODERN CHEMISTRY (englisch)

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<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-0251-00L</td>
<td>Mathematics I</td>
<td>O</td>
<td>6</td>
<td>4V+2U</td>
<td>A. Cannas da Silva</td>
</tr>
</tbody>
</table>

**Abstract**

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

**Objective**

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

The goal of Mathematics I and II is to provide the mathematical foundations relevant for this paradigm. Differential equations are by far the most important tool for modelling and are therefore a main focus of both of these courses.

**Content**

1. Single-Variable Calculus:
   - review of differentiation, linearisation, Taylor polynomials, maxima and minima, antiderivative, fundamental theorem of calculus, integration methods, improper integrals.

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

3. Ordinary Differential Equations:
   - separable ordinary differential equations (ODEs), integration by substitution, 1st and 2nd order linear ODEs, homogeneous systems of linear ODEs with constant coefficients, introduction to 2-dimensional dynamical systems.

**Literature**

- Bretscher, O.: Linear Algebra with Applications (Pearson Prentice Hall).

**Prerequisites / notice**

Prerequisites: familiarity with the basic notions from Calculus, in particular those of function and derivative.

Mathe-Lab (Assistance):

Mondays 12-14, Tuesdays 17-19, Wednesdays 17-19, in Room HG E 41.

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<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>551-0001-00L</td>
<td>General Biology I</td>
<td>O</td>
<td>3</td>
<td>3V</td>
<td>U. Sauer, O. Y. Martin, A. Widmer</td>
</tr>
</tbody>
</table>

**Abstract**

Organismic biology to teach the basic principles of classical and molecular genetics, evolutionary biology and phylogeny. First in a series of two lectures given over two semesters for students of agricultural and food sciences, as well as of environmental sciences.

**Objective**

The understanding of some basic principles of biology (inheritance, evolution and phylogeny) and an overview of the diversity of life.
The first semester focuses on the organismal biology aspects of genetics, evolution and diversity of life in the Campbell chapters 12-34.

**Content**

- **Week 1-7** by Alex Widmer, Chapters 12-25
  - 12 Cell biology: Mitosis
  - 13 Genetics: Sexual life cycles and meiosis
  - 14 Genetics: Mendelian genetics
  - 15 Genetics: Linkage and chromosomes
  - 20 Genetics: Evolution of genomes
  - 21 Evolution: How evolution works
  - 22 Evolution: Phylogenetic reconstructions
  - 23 Evolution: Microevolution
  - 24 Evolution: Species and speciation
  - 25 Evolution: Macroevolution

**Objective**

The objective of this lecture is to teach basic ecological concepts and the different levels of complexity in ecological research. Ecological concepts are exemplified by using aquatic and terrestrial systems; corresponding methodological approaches are demonstrated. In a more applied part of the lecture threats to biodiversity and the appropriate management are discussed.

**Content**

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

**Lecture notes**

- no script

**Literature**


The course is part of the block exam after the first study year. Paper copies can be used (“Open Book”) during the on-line exam, but no other means are allowed. The course is taught in German.

---

**Week 8-14 by Oliver Martin, Chapters 26-34**

26 Diversity of Life: Introduction to viruses
27 Diversity of Life: Prokaryotes
28 Diversity of Life: Origin & evolution of eukaryotes
29 Diversity of Life: Nonvascular & seedless vascular plants
30 Diversity of Life: Seed plants
31 Diversity of Life: Introduction to fungi
32 Diversity of Life: Overview of animal diversity
33 Diversity of Life: Introduction to invertibrates
34 Diversity of Life: Origin & evolution of vertebrates

**Abstract**

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

**Objective**

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

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

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

**Content**


**Lecture notes**

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

**Literature**

Generelle Ökologie:

Aquatische Ökologie:

**World Food System**

**Abstract**

Knowledge about the World Food System will be provided, based on case studies along food value chains in countries with various development stages and dependent on multiple boundary conditions. This shall generate profound understanding of the associated global challenges especially food scarcity, suboptimal diet and nutrition, food quality and safety as well as effects on the environment.

**Objective**

Attending this course, the students will recognize the elements of the World Food System (WFS) approach and the problems it this supposed to treat. They will especially comprehend the four pillars of global food security, namely (I) food availability (including sustainable production and processing), (II) access to food (physical and monetary), (III) food use (including quality and safety as well as the impact on human health and well being) and (IV) resilience to the boundary conditions (environmental, economic and political). This insight will make them aware of the global driving forces behind our ETH research on food security and is expected to alleviate motivation and understanding for the association of subsequent specific courses within a general context. The course equivalently implements agricultural and food sciences, thus supporting the interdisciplinary view on the WFS scope.

**Content**

Case studies on certain foods of plant and animal origin serve to demonstrate the entire food value chain from the production of raw material to processed food and its consumer relevant property functions. In doing so, important corresponding aspects for developed, emerging and developing countries are demonstrated, by use of engineering as well as natural and social science approaches.

**Lecture notes**

Handouts and links are provided online.

**Literature**

Information on books and other literature references is communicated during the course.

---

**Principles of Economics**

**Abstract**

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

**Objective**

The course is part of the block exam after the first study year. Paper copies can be used (“Open Book”) during the on-line exam, but no other means are not allowed. The course is taught in German.
This course covers the bases for understanding micro- and macroeconomic issues and theories. Participants are given the tools to argue in economic and political terms and to evaluate the corresponding measures. Group and individual exercises deepen the knowledge gained.

**Objective**

Students are able to
- describe fundamental micro- and macroeconomic issues and theories.
- apply suitable economic arguments to a given theme.
- evaluate economic measures.

**Content**

Supply and demand behaviour of firm and households; market equilibrium and taxation; national income and indicators; inflation; unemployment; growth; macroeconomics policies

**Lecture notes**

available on electronic platform

**Literature**


**Prerequisites / notice**

Electronic platform

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-0027-00L</td>
<td>Environmental Systems I</td>
<td>O</td>
<td>2</td>
<td>2V</td>
<td>C. Schär, S. Bonhoeffer, N. Dubois</td>
</tr>
<tr>
<td>252-0839-00L</td>
<td>Informatics</td>
<td>O</td>
<td>2</td>
<td>2G</td>
<td>L. E. Fässler, M. Dahinden</td>
</tr>
<tr>
<td>751-0801-00L</td>
<td>Biology I: Laboratory Exercises</td>
<td>O</td>
<td>1</td>
<td>2U</td>
<td>E. B. Truernit</td>
</tr>
<tr>
<td>529-0030-00L</td>
<td>Laboratory Course: Elementary Chemical Techniques</td>
<td>O</td>
<td>3</td>
<td>6P</td>
<td>N. Kobert, M. Morbidelli, M. H. Schroth, B. Wehrli</td>
</tr>
</tbody>
</table>

**Abstract**

The lecture provides a science-based exploration of environmental aspects from three research fields: earth, climate, and health sciences.

**Objective**

The students are able to explain important properties of the three environmental systems, to discuss critical drivers, trends and conflicts of their use, and to compare potential solutions.

**Content**

The lecture discusses the role of the environmental systems based on selected environmental problems, among these the exploration of raw materials and fossil fuels, climate change and its impacts on man and environment, and the spread and control of infectious diseases in the human population and agricultural systems.

**Lecture notes**

Slides are provided by instructors and are accessible via moodle.

### Additional First Year Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
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<tbody>
<tr>
<td>252-0839-00L</td>
<td>Informatics</td>
<td>O</td>
<td>2</td>
<td>2G</td>
<td>L. E. Fässler, M. Dahinden</td>
</tr>
<tr>
<td>529-0030-00L</td>
<td>Laboratory Course: Elementary Chemical Techniques</td>
<td>O</td>
<td>3</td>
<td>6P</td>
<td>N. Kobert, M. Morbidelli, M. H. Schroth, B. Wehrli</td>
</tr>
</tbody>
</table>

**Abstract**

This course provides an introduction to elementary laboratory techniques. The experiments cover a wide range of techniques, including analytical and synthetic techniques (e.g. investigation of soil and water samples or the preparation of simple compounds). Furthermore, the handling of gaseous substances is practised.

**Objective**

This course is intended to provide an overview of experimental chemical methods. The handling of chemicals and proper laboratory techniques represent the main learning targets. Furthermore, the description and recording of laboratory processes is an essential part of this course.

**Content**

The classification and analysis of natural and artificial compounds is a key subject of this course. It provides an introduction to elementary laboratory techniques, and the experiments cover a wide range of analytic and synthetic tasks:

- Selected samples (e.g. soil and water) will be analysed with various methods, such as titrations, spectroscopy or ion chromatography. The chemistry of aqueous solutions (acid-base equilibria and solvation or precipitation processes) is studied.
- The synthesis of simple inorganic complexes or organic molecules is practised.

Furthermore, the preparation and handling of environmentally relevant gaseous species like carbon dioxide or nitrogen oxides is a central subject of the Praktikum.

**Lecture notes**

The script will be published on the web. Details will be provided on the first day of the semester.

Data: 06.03.2019 12:57
Autumn Semester 2016
Page 874 of 1571
Literature

A thorough study of all script materials is requested before the course starts.

Electives

A list with possible electives will be published separately.

Bachelor Studies (Programme Regulations 2010)

3. Semester

Basic Courses II

Examination Block 1

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0063-00L</td>
<td>Physics II</td>
<td>O</td>
<td>5</td>
<td>3V+1U</td>
<td>A. Vaterlaus</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Introduction to the &quot;way of thinking&quot; and the methodology in Physics, with the help of demonstration experiments. The Chapters treated are Electromagnetism, Refraction and Diffraction of Waves, Elements of Quantum Mechanics with applications to Spectroscopy, Thermodynamics, Phase Transitions, Transport Phenomena. Whenever possible, examples relevant to the students' main field of study are given.</td>
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</tbody>
</table>

Objective

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

Content

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

Lecture notes

Skript wird verteilt.

Literature

Friedhelm Kuypers

Physik für Ingenieure und Naturwissenschaftler

Band 2 Elektrizität, Optik, Wellen

Wiley-VCH, 2012

ISBN 3527411445, 9783527411443

Douglas C. Giancoli

Physik

3. erweiterte Auflage

Pearson Studium

Hans J. Paus

Physik in Experimenten und Beispielen

Carl Hanser Verlag, München, 2002, 1068 S.

Paul A. Tipler

Physik

Spektrum Akademischer Verlag, 1998, 1522 S., ca Fr. 120.-

David Halliday Robert Resnick Jearl Walker

Physik

Wiley-VCH, 2003, 1388 S., Fr. 87.- (bis 31.12.03)

dazu gratis Online Ressourcen (z.B. Simulationen): www.halliday.de

701-0071-00L Mathematics III: Systems Analysis

Abstract

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

Objective

Learning and applying of concepts (models) and quantitative methods to address concrete problems of environmental relevance. Understanding and applying the systems-analytic approach, i.e., Recognizing the core of the problem - simplification - quantitative approach - prediction.

Content

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

Lecture notes

Overhead slides will be made available through Ilias.

Literature


752-4001-00L Microbiology

Abstract

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

Objective

Teaching of basic knowledge in microbiology.

Content


Lecture notes

Wird von den jeweiligen Dozenten ausgegeben.

Literature

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

701-0255-00L Biochemistry

Abstract

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

Objective

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

Students are able to describe the relevant metabolic reactions in detail.
### Examination Block 2

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>751-1551-00L</td>
<td>Ressourcen- und Umweltökonomie</td>
<td>O</td>
<td>3</td>
<td>2V</td>
<td>L. Bretschger, A. Müller</td>
</tr>
</tbody>
</table>

**Abstract**

Relationship between economy and environment, market failure, external effects and public goods, contingent valuation, internalisation of externalities; economics of non-renewable resources, economics of renewable resources, cost-benefit analysis, sustainability, and international aspects of resource and environmental economics.

**Objective**

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

**Topics:**

- Introduction to resource and environmental economics
- Importance of resource and environmental economics
- Main issues of resource and environmental economics
- Normative basis
- Utilitarianism
- Fairness according to Rawls
- Economic growth and environment
- Externalities in the environmental sphere
- Governmental internalisation of externalities
- Private internalisation of externalities: the Coase theorem
- Free rider problem and public goods
- Types of public policy
- Efficient level of pollution
- Tax vs. permits
- Command and Control Instruments
- Empirical data on non-renewable natural resources
- Optimal price development: the Hotelling-rule
- Effects of exploration and Backstop-technology
- Effects of different types of markets.
- Biological growth function
- Optimal depletion of renewable resources
- Social inefficiency as result of over-use of open-access resources
- Cost-benefit analysis and the environment
- Measuring environmental benefit
- Measuring costs
- Concept of sustainability
- Technological feasibility
- Conflicts sustainability / optimality
- Indicators of sustainability
- Problem of climate change
- Cost and benefit of climate change
- Climate change as international ecological externality
- International climate policy: Kyoto protocol
- Implementation of the Kyoto protocol in Switzerland
To understand the basic principles of analytical chemistry. To get acquainted with the principles and applications of important routine methods of instrumental food analysis. Economies in natural environment, welfare concepts and market failure, external effects and public goods, measuring externalities and contingent valuation, internalising external effects and environmental policy, economics of non-renewable resources, renewable resources, cost-benefit-analysis, sustainability issues, international aspects of resource and environmental problems, selected examples and case studies.

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

Literature:

Additional Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0000-00L</td>
<td>Laboratory Course in Physics for Students in Food Sciences</td>
<td>O</td>
<td>2 credits</td>
<td>4P</td>
<td>A. Biland, M. Doebeli, M. Münch</td>
</tr>
<tr>
<td>752-4003-00L</td>
<td>Practical Course in Microbiology</td>
<td>O</td>
<td>2 credits</td>
<td>3P</td>
<td>M. Künzler</td>
</tr>
</tbody>
</table>

Basics of Food Science

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>752-1101-00L</td>
<td>Food Analysis I</td>
<td>W+</td>
<td>3 credits</td>
<td>2V</td>
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</tr>
<tr>
<td>752-1000-00L</td>
<td>Food Chemistry I</td>
<td>W+</td>
<td>3 credits</td>
<td>2V</td>
<td>L. Nyström, M. Erzinger</td>
</tr>
</tbody>
</table>
5. Semester

Basics of Food Science

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>752-5001-00L</td>
<td>Food Biotechnology</td>
<td>W</td>
<td>4</td>
<td>3V</td>
<td>C. Lacroix, L. Meile, M. Stevens</td>
</tr>
</tbody>
</table>

**Abstract**
Basic information for understanding biotechnology applied to food processing will be presented. This will include a presentation of the physiology of important productive microorganisms used in food fermentations, closely related to applications in biotechnology; microbial kinetics, and design and operation of bioreactors; and application of modern molecular tools for food biotechnology.

**Objective**
The main goal for this course is to provide students with basic information for understanding biotechnology applied to food processing. For the students, the aim will be:
- To understand the important role of microbial physiology and molecular tools for food biotechnology;
- To understand basic principles of fermentation biotechnology, with particular emphasis on food applications.

**Content**
Biotechnology has been defined as any technique that uses living organisms, or substances from those organisms, to make or modify a product, to improve plants or animals, or to develop microorganisms for specific uses. In this course, basic knowledge for understanding biotechnology as applied to food processing will be presented. This course builds on the application of principles learned from other basic courses in the Bachelor program, especially microbiology and microbial metabolism, molecular biology, biochemistry, physics and engineering. Students will learn about the physiology of important productive microorganisms (lactic acid bacteria, bifidobacteria, propionibacteria and fungi) used in food fermentations, closely related to applications in biotechnology. Microbial kinetics, and design and operation of bioreactors used for both research and industrial scale production of traditional foods and modern food ingredients will be presented. This part will be illustrated by examples of food fermentation processes, representative of specific challenges. Finally, the application of modern molecular tools to food biotechnology will be discussed.

**Lecture notes**
A complete course document and/or a copy of the power point slides from each lecture will be provided.

**Literature**
A list of references will be given at the beginning of the course for the different topics presented during the course.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>752-6001-00L</td>
<td>Introduction to Nutritional Science</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>M. B. Zimmermann, C. Wolfrum</td>
</tr>
</tbody>
</table>

**Abstract**
This course introduces basic concepts of micro- and macronutrient nutrition. Macronutrients studied include fat-soluble and water-soluble vitamins, minerals and trace elements. Macronutrients include proteins, fat and carbohydrates. Special attention is given to nutrient digestion, bioavailability, metabolism and excretion with some focus on energy metabolism.

**Objective**
To introduce the students to the both macro- and micronutrients in relation to food and metabolism.

**Content**
The course is divided into two parts. The lectures on micronutrients are given by Prof. Zimmermann and the lectures on macronutrients are given by Prof. Wolfrum. Prof. Zimmermann discusses the micronutrients, including fat-soluble vitamins, water-soluble vitamins, minerals and trace elements. Prof. Wolfrum introduces basic nutritional aspects of proteins, fats, carbohydrates and energy metabolism. The nutrients are described in relation to digestion, absorptions and metabolism. Special aspects of homeostasis and homeorhesis are emphasized.

**Lecture notes**
There is no script. Powerpoint presentations will be made available.

**Literature**
Elmadfa I & Leitzmann C: Ernährung des Menschen UTB Ulmer, Stuttgart, 4. überarb. Ausgabe 2004

Garrow JS and James WPT: Human Nutrition and Dietetics Churchill Livingstone, Edinburgh, 11th rev. ed. 2005

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>752-4005-00L</td>
<td>Food Microbiology I</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>M. Loessner</td>
</tr>
</tbody>
</table>

This lecture is the first part of a one-year course. It offers insights into the fundamentals and applications of Food Microbiology. Contents include basic microbiology of the different bacteria, yeasts and molds present in foods, as well as the occurrence and control of foodborne pathogens and spoilage organisms.

**Objective**
The lecture offers insights into the basics, practical consequences and applications of Food Microbiology. Contents include basic microbiology of the different bacteria, yeasts, molds and protozoa in foods, as well as the occurrence and control of foodborne pathogens and spoilage organisms.
The focus of this first part of the lecture will be on the organisms, but also on the factors which determine spoilage and foodborne disease.
Content
1. History of Food Microbiology
   1.1. Short synopsis of foodborne microorganisms
   1.2. Spoilage of Foods
   1.3. Foodborne Disease
   1.4. Food Preservation
   1.5. VIP's of Food Microbiology
2. Overview of Microorganisms in Foods
   2.1. Origin of foodborne Microorganisms
   2.2. Bacteria
   2.3. Yeasts
   2.4. Molds
3. Microbial Spoilage of Foods
   3.1. Intrinsic and Extrinsic Parameters
   3.2. Meats, Seafoods, Eggs
   3.3. Milk and Milk Products
   3.4. Vegetable and Fruit Products
   3.5. Miscellaneous (baked goods, nuts, spices, ready-to-eat products)
   3.6. Drinks and Canned Foods
4. Foodborne Disease
   4.1. Significance and Transmission of Foodborne pathogens
   4.2. Staphylococcus aureus
   4.3. Gram-positive Sporeformers (Bacillus & Clostridium)
   4.4. Listeria monocytogenes
   4.5. Salmonella, Shigella, Escherichia coli
   4.6. Vibrio, Yersinia, Campylobacter
   4.7. Brucella, Mycobacterium
   4.8. Parasites
   4.9. Viruses and Bacteriophages
   4.10. Mycotoxins
   4.11. Bioactive Amines
   4.12. Miscellaneous (Antibiotic-resistant Bacteria, Biofilms)

Lecture notes
Electronic copies of the presentation slides (PDF) and additional material will be made available for download.

Literature
Recommendations will be given in the first lecture

Food Science General Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>751-1101-00L</td>
<td>Finances and Accounting System</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>M. Dumondel</td>
</tr>
<tr>
<td>Abstract</td>
<td>To understand accounting as a component of the complex system of the enterprise</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>To understand accounting not as an isolated discipline, but as a part of the complex system of the enterprise</td>
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</tr>
<tr>
<td>Content</td>
<td>Accounting system as a part of management economics. The different steps for scheduling and evaluation of the accountancy will be studied. The main part of the lecture is dedicated to the financial accounting nevertheless the fundamentals of the internal cost-accounting will also be presented. The lecture will also include the clarification of concrete cases and the calculation of practical exercises.</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Literature</td>
<td>Course documentation and specified educational books</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

| 551-0317-00L | Immunology I                               | W    | 3    | 2V    | A. Oxenius, M. Kopf |
| Abstract     | Introduction into structural and functional aspects of the immune system. Basic knowledge of the mechanisms and the regulation of an immune response. |
| Objective    | Introduction into structural and functional aspects of the immune system. Basic knowledge of the mechanisms and the regulation of an immune response. |
| Content      | - Introduction and historical background  |
|              | - Innate and adaptive immunity. Cells and organs of the immune system |
|              | - B cells and antibodies                  |
|              | - Generation of diversity                 |
|              | - Antigen presentation and Major Histoincompatibility (MHC) antigens |
|              | - Thymus and T cell selection             |
|              | - Autoimmunity                            |
|              | - Cytotoxic T cells and NK cells          |
|              | - Th1 and Th2 cells, regulatory T cells   |
|              | - Allergies                               |
|              | - Hypersensitivities                      |
|              | - Vaccines, immune-therapeutic interventions |
| Literature   | Electronic access to the documentation will be provided. The link can be found at "Lernmaterialien" |
| Prerequisites / notice | - Kuby, Immunology, 7th edition, Freeman + Co., New York, 2009 |

| 751-1307-00L | Managerial Economics Agri-Food Chain: Strategic Concepts | W    | 2    | 2G    | M. Weber, B. Höltshchi |
| Abstract     | Learn and exercise strategic concepts in the Agri-Food chain, i.e. theories of economics based decision making combined with entrepreneurial practice. |
| Objective    | The main objective is to understand strategic decisions along the value chain in the Agri-Food Chain. |
| Content      | - Basics of strategy & strategic concepts |
|              | - Classic process of strategy process     |
|              | - Selected alternative processes          |
|              | - Case studies                           |
| Lecture notes | Dokuments will be distributed per lecture. |
| Literature   | Lombriser Roman & Aplanalp Peter: Strategisches Management |

| 752-2120-00L | Consumer Behaviour I                       | W    | 2    | 2V    | M. Siegrist, C. Keller, B. S. Sütterlin |
| Abstract     | Introduction in consumer research. The following aspects will be emphasized in the course: Consumer decision making, indivduad determinants of consumer behavior, environmental influences on consumer behavior, influencing consumer behavior |

Data: 06.03.2019 12:57  Autumn Semester 2016  Page 879 of 1571
### Bachelor’s Thesis

**Number** 752-0220-20L  
**Title** Bachelor’s Thesis  
**Type** O  
**ECTS** 15  
**Hours** 32D  
**Lecturers**  

- **Abstract**  
The Bachelor Thesis completes the Bachelor programme and consists of a scientific project carried out independently under the tutorship of a lecturer at D-HEST.

- **Objective**  
The Bachelor Thesis aims at fostering the student's ability to independent, structured and scientific working and at deepening their knowledge in a specific field.

***Important information!***  
During the course we will work with the food-borne pathogen Listeria monocytogenes. Listeria monocytogenes represents a particular threat in case of pregnancy. Due to biosafety reasons participation is not allowed in case of pregnancy.
### Food Science Bachelor - Key for Type

<table>
<thead>
<tr>
<th>Code</th>
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</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
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<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
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### Key for Hours

<table>
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<tbody>
<tr>
<td>V</td>
<td>lecture</td>
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<tr>
<td>G</td>
<td>lecture with exercise</td>
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<td>exercise</td>
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<td>seminar</td>
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<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
E. Stern

### Educational Science

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0240-00L</td>
<td>Human Learning (EW1)</td>
<td>O</td>
<td>2</td>
<td>2G</td>
<td>E. Stern</td>
</tr>
<tr>
<td></td>
<td>This lecture is only apt for students who intend to enrol in the</td>
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<tr>
<td></td>
<td>programs &quot;Teaching Diploma&quot; or &quot;Teaching Certificate&quot;. It is about</td>
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<td></td>
<td>learning in childhood and adolescence.</td>
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<tr>
<td>Abstract</td>
<td>This course looks into scientific theories and also empirical</td>
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<tr>
<td></td>
<td>studies on human learning and relates them to the school.</td>
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<tr>
<td>Objective</td>
<td>Anyone wishing to be a successful teacher must first of all</td>
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<td></td>
<td>understand the learning process. Against this background, theories</td>
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<tr>
<td></td>
<td>and findings on the way humans process information and on human</td>
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<td></td>
<td>behaviour are prepared in such a manner that they can be used for</td>
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<tr>
<td></td>
<td>planning and conducting lessons. Students additionally gain an</td>
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<tr>
<td></td>
<td>understanding of what is going on in learning and behavioural</td>
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<td></td>
<td>research so that teachers are put in a position where they can</td>
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<tr>
<td></td>
<td>further educate themselves in the field of research into teaching</td>
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<tr>
<td></td>
<td>and learning.</td>
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</tbody>
</table>

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

- **Lernformen:**

- **Lecture notes:**
- Folien werden zur Verfügung gestellt.

- **Literature:**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0240-03L</td>
<td>Introduction to Test Theory and Test Construction in Educational</td>
<td>W</td>
<td>4</td>
<td>2S</td>
<td>University</td>
</tr>
<tr>
<td></td>
<td>Contexts (University of Zürich)</td>
<td></td>
<td></td>
<td></td>
<td>lecturers</td>
</tr>
<tr>
<td></td>
<td>Enrolment only possible with Teaching Diploma or DC matriculation.</td>
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</tr>
<tr>
<td>Abstract</td>
<td>In this seminar, students establish the scientific fundamentals of</td>
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<tr>
<td></td>
<td>performance measurement and educational diagnostics and study them</td>
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<tr>
<td></td>
<td>on the basis of different current issues.</td>
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<tr>
<td>Objective</td>
<td>At the end of the seminar, participants will be in a position to</td>
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<td></td>
<td>- describe the scientific fundamentals of test theory and test</td>
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<td></td>
<td>structure.</td>
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<td></td>
<td>- evaluate examples of scientifically-developed tests in their</td>
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<td></td>
<td>application context.</td>
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<tr>
<td></td>
<td>- if necessary, critically question the performance assessment that</td>
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<tr>
<td></td>
<td>they employ in practice and professionalise it still further.</td>
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</tr>
</tbody>
</table>

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

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

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

- **Prerequisites / notice:**
- Die Leistungsanforderungen richten sich im Umfang nach der Zahl zu erwerbender ECTS-Punkte, wobei 1 ECTS-Punkt einem Zeitaufwand von ca. 30 Arbeitsstunden entspricht. ETHZ-Studierende können im Rahmen dieser Veranstaltung 3 ECTS-Punkte erwerben. Dazu sind folgende Leistungen zu erbringen:
  - Präsenz und aktive mündliche Mitarbeit in der Lehrveranstaltung (MA)
  - Pflichtlektüre entsprechend der Angaben in der Lehrveranstaltung
  - Referat (RE)
  - Schreiben einer schriftlichen Arbeit

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0240-15L</td>
<td>Colloquium on the Science of Learning and Instruction</td>
<td>W</td>
<td>1</td>
<td>1K</td>
<td>E. Stern, P. Greutmann, further lecturers</td>
</tr>
<tr>
<td>Abstract</td>
<td>In the colloquium we discuss scientific projects concerning the</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>teaching in mathematics, computer science, natural sciences and</td>
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<td></td>
<td>technology (STEM). The colloquium is conducted by the professorships</td>
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<td>participating in the Competence Center EducETH (ETH) and in the</td>
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<td></td>
<td>Institute for Educational Sciences (UZH).</td>
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</tbody>
</table>

- **Prerequisites / notice:**
- Die Leistungsanforderungen richten sich im Umfang nach der Zahl zu erwerbender ECTS-Punkte, wobei 1 ECTS-Punkt einem Zeitaufwand von ca. 30 Arbeitsstunden entspricht. ETHZ-Studierende können im Rahmen dieser Veranstaltung 3 ECTS-Punkte erwerben. Dazu sind folgende Leistungen zu erbringen:
  - Präsenz und aktive mündliche Mitarbeit in der Lehrveranstaltung (MA)
  - Pflichtlektüre entsprechend der Angaben in der Lehrveranstaltung
  - Referat (RE)
  - Schreiben einer schriftlichen Arbeit

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0242-05L</td>
<td>Cognitively Activating Instructions in MINT Subjects</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>R. Schumacher</td>
</tr>
<tr>
<td>Abstract</td>
<td>Participants are exemplary introduced to different research methods</td>
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<td></td>
<td>used in research on learning and instruction and learn to weigh</td>
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<tr>
<td></td>
<td>advantages and disadvantages of these approaches.</td>
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</tr>
</tbody>
</table>
This course unit can only be enrolled after successful participation in, or during enrollment in the course "Human Learning (EW 1)".

Abstract
This seminar focuses on teaching units in chemistry, physics and mathematics that have been developed at the MINT Learning Center of the ETH Zurich. In the first meeting, the mission of the MINT Learning Center will be communicated. Furthermore, in groups of two, the students will intensively work on, refine and optimize a teaching unit following a goal set in advance.

Objective
- Get to know cognitively activating instructions in MINT subjects
- Get information about recent literature on learning and instruction

Prerequisites / notice
Für eine reibungslose Semesterplanung wird um frühe Anmeldung und persönliches Erscheinen zum ersten Lehrveranstaltungstermin ersucht.

851-0242-07L Human Intelligence
Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).
Number of participants limited to 30.
This course unit can only be enrolled after successful participation in, or during enrollment in the course "Human Learning (EW 1)".

Abstract
The focus will be on the book "Intelligenz: Grosse Unterschiede und ihre Folgen" by Stern and Neubauer. Participation at the first meeting is obligatory. It is required that all participants read the complete book. Furthermore, in two meetings of 90 minutes, concept papers developed in small groups (5 - 10 students) will be discussed.

Objective
- Understanding of research methods used in the empirical human sciences
- Understanding findings relevant for education

851-0242-08L Research Methods in Educational Science
Number of participants limited to 30.
This course unit can only be enrolled after successful participation in, or during enrollment in the course "Human Learning (EW 1)".

Abstract
Literature from the learning sciences is critically discussed with a focus on research methods.
At the first meeting, working groups will be assembled and meetings with those will be set up. In the small groups students will write critical essays about the read literature. At the third meeting, we will discuss the essays and develop research questions in group work.

Objective
- Understand research methods used in the empirical educational sciences
- Understand and critically examine information from scientific journals and media
- Understand pedagogically relevant findings from the empirical educational sciences

851-0240-22L Coping with Psychosocial Demands of Teaching (EW4 W DZ)
Number of participants limited to 20.
The successful participation in EW1 ("Human Learning") and EW2 ("Designing Learning Environments for School") is recommended, but not a mandatory prerequisite.

Abstract
In this class, students will learn concepts and skills for coping with psychosocial demands of teaching

Objective
Students possess theoretical knowledge and practical competences to be able to cope with the psychosocial demands of teaching.

(1) They know the basic rules of negotiation and conflict management (e.g., mediation) and can apply them in the school context (e.g., in conversations with parents).
(2) They can apply diverse techniques of classroom management (e.g., prevention of disciplinary problems in the classroom) and know relevant authorities for further information (e.g., legal conditions).

Subject Didactics and Professional Training

Number Title Type ECTS Hours Lecturers
752-9020-00L Teaching Internship Including Examination Lessons Food Science
Only for students who enrolled from HS 2011 on into TC.
The teaching internship can just be visited if all other courses of TC are completed. Repetition of the teaching internship is excluded even if the examination lessons are to be repeated.

Abstract
Students apply the insights, abilities and skills they have acquired within the context of an educational institution. They observe 10 lessons and teach 20 lessons independently. Two of them are as assessed as Examination Lessons.

Objective
- Students use their specialist-subject, educational-science and subject-didactics training to draw up concepts for teaching.
- They are able to assess the significance of tuition topics for their subject from different angles (including interdisciplinary angles) and impart these to their pupils.
- They learn the skills of the teaching trade.
- They practise finding the balance between instruction and openness so that pupils can and, indeed, must make their own cognitive contribution.
- They learn to assess pupils’ work.
- Together with the teacher in charge of their teacher training, the students constantly evaluate their own performance.

Die Themen für die beiden Prüfungslektionen am Schluss des Praktikums erfahren die Studierenden in der Regel eine Woche vor dem Prüfungstermin. Sie erstellen eine Vorbereitung gemäss Anleitung und reichen sie bis am Vortrag um 12 Uhr den beiden Prüfungsexperten (Fachdidaktiker/-in, Departementsvertreter/-in) ein. Die gehaltenen Lektionen werden kriteriumsbasiert beurteilt. Die Beurteilung umfasst auch die schriftliche Vorbereitung und eine mündliche Reflexion des Kandidaten/der Kandidatin über die gehaltenen Lektionen im Rahmen eines kurzen Kolloquiums.

**Further Subject Didactics**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>752-9005-00L</td>
<td>Mentored Work Specialised Courses in the Respective Subject with an Educational Focus Food Sc.</td>
<td>O</td>
<td>2 credits</td>
<td>4A</td>
<td>G. Kaufmann, K. Koch, U. Lerch</td>
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</tbody>
</table>

**Abstract**

In the mentored work on their subject specialisation, students link high-school and university aspects of the subject, thus strengthening their teaching competence with regard to curriculum decisions and the future development of the tuition. They compile texts under supervision that are directly comprehensible to the targeted readers - generally specialist-subject teachers at high-school level.

**Objective**

The aim is for the students
- to familiarise themselves with a new topic by obtaining material and studying the sources, so that they can selectively extend their specialist competence in this way.
- to independently develop a text on the topic, with special focus on its mathematical comprehensibility in respect of the level of knowledge of the targeted readership.
- To try out different options for specialist further training in their profession.

**Content**

Thematische Schwerpunkte:


Lernformen:


**Lecture notes**

Eine Anleitung zur mentorierten Arbeit in FV wird zur Verfügung gestellt.

**Literature**

Die Literatur ist themenspezifisch. Sie muss je nach Situation selber beschafft werden oder wird zur Verfügung gestellt.

**Prerequisites / notice**

Die Arbeit sollte vor Beginn des Praktikums abgeschlossen werden.

**Food Science TC - Key for Type**

<table>
<thead>
<tr>
<th>Letter</th>
<th>Type</th>
<th>ECTS</th>
<th>Notice</th>
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</thead>
<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
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<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
<td>Courses outside the curriculum</td>
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<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
<td>Suitable for doctorate</td>
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**Key for Hours**

<table>
<thead>
<tr>
<th>Letter</th>
<th>Type</th>
<th>ECTS</th>
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<tbody>
<tr>
<td>V</td>
<td>lecture</td>
<td>P</td>
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<tr>
<td>G</td>
<td>lecture with exercise</td>
<td>A</td>
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<tr>
<td>U</td>
<td>exercise</td>
<td>D</td>
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<td>S</td>
<td>seminar</td>
<td>R</td>
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<td>K</td>
<td>colloquium</td>
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</tbody>
</table>

**ECTS**

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
In Physics of Food Colloids the principles of colloid science will be applied to the aggregation of food materials based on proteins. Lectures will be given on general introduction (4h), fluid dynamics (2h), complex flow behavior (4h), influence of temperature (2h), rheometrical techniques and 4 credits. Type W+ Lectures include interfacial tension (4h), protein aggregation in bulk and interfaces (4h), Pickering emulsions (2h), gels (4h), aggregation of printed handouts (ca. 180) W+. R. Mezzenga 3 credits 2V W+. P. A. Fischer E. J. Windhab Notes will be handed out during the lectures. - To revive the knowledge of the basic operations of food technology and to become acquainted with the principles and use of several 3 credits Provided in the lecture notes. - To gain experience in the development of an R&D project in the wider food area. - To develop a basic understanding of contextual aspects impacting the work practice of food technologists and food developers. - To be able to assess and select technologies to achieve specific aims in food processing and development. - To be able to quantitatively apply physical principles in the optimization of food processing and in the prediction of the shelf life of foods. - To gain experience in the development of an R&D project in the wider food area.

Food Rheology I

752-3103-00L

Rheology is the science of flow and deformation of matter such as polymers, dispersions (emulsions, foams, suspensions), and colloid systems. The fluid dynamical basis, measuring techniques (rheometry), and the flow properties of different fluids (Newtonian, non-Newtonian, viscoelastic) are introduced and discussed. The course provides an introduction on the link between flow and structural properties of flowing material. Rheometrical techniques and appropriate measuring protocols for the characterization of complex fluids will be discussed. The concept of rheological constitutive equations and the application to different material classes are established.

Lectures will be given on general introduction (4h), fluid dynamics (2h), complex flow behavior (4h), influence of temperature (2h), rheometers (4h), rheological tests (6h) and structure and rheology of complex fluids (4h).

Notes will be handed out during the lectures.

Selected Topics in Food Technology

752-2003-00L

The focus of the lecture course is on both broadening and deepening the knowledge on food technology, and on providing an introduction to the context in which the food technologist will operate. The lecture course is developed from the perspective of the food technologist and the food developer, and will recapitulate and extend practical as well as fundamental aspects of food technology.

I. Introduction

1. Historical aspects of food technology
2. Processes, ingredients, products, systems
3. Food technology and food science
4. Impact of food technology on the modern diet
5. Global food: current situation and possible trends

II. Engineering approaches in food technology

1. Phase transitions in foods
2. The state diagram
3. The state diagram in relation to food processing and food stabilization
4. Materials science of water in foods
5. Encapsulation and delivery of bioactive ingredients

III. Food technology context

1. Elements of project management
2. Intellectual property
3. Food technology and nutrition
4. Interface with food sustainability
5. Cooking & artisanal food preparation

IV. Project work

1. Idea formulation
2. Exploration of scientific and technological background
3. Development of project approaches
4. Presentation of project and preparation of written proposal

Physics of Food Colloids

752-2314-00L

In Physics of Food Colloids the principles of colloid science will be applied to the aggregation of food materials based on proteins, polysaccharides, and emulsifiers. Mixtures of such raw material determine the appearance and performance of our daily food. In a number of examples, colloidal laws are linked to food science and the manufacturing and processing of food.

Lectures include interfacial tension (4h), protein aggregation in bulk and interfaces (4h), Pickering emulsions (2h), gels (4h), aggregation of complex mixtures (4h), and the use of light scattering in investigation complex food structures (6h). Most chapters include some hands-on examples of the gain knowledge to common food products.

Notes will be handed out during the lectures.

Food Process Design and Optimization

752-3021-00L


Quantitative process analysis and derivation of process-structure functions for complex liquid or semi-liquid food systems with non-Newtonian flow properties. Handling of optimisation and up-/down-scaling procedures.

S-PRO2 scheme, reverse engineering approach, dimension analysis, Metzner-Otto and Rieger Novack design schemes of stirred reactors for non-Newtonian fluid processing, mixing/mixing statistics, mixing characteristics, power characteristis, dispersing characteristics, dispersing processes in rotor/ stator and membrane devices, spray processing, extrusion processing, diverse case studies for design and scaling of processes for food structure processing.

Printed handouts (ca. 180)

List of ca. 30 papers and 5 books given in course

VT I-III
Overview Process Automation, Information Management in processes, process data handling and analysis. In-line measurements of complex food systems, Process control schemes, Overview of sensors and sensor principles, integrated process control case studies

Understanding the interplay of in-line measurements of complex food properties in processes, process data handling and data analysis as well as building blocks for process control.

Overview Process Automation, Process Control and process data management, Industrial design of automated/controlled processes, overview on sensors/sensor principles, case studies of in-line measurements and control in/of food production processes

Printed script (120 pages, 80 figures), diverse publications

List of publications and books given in course

VT I-III

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### Methodology Subjects

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-0625-01L</td>
<td>Applied Analysis of Variance and Experimental Design</td>
<td>W+</td>
<td>5 credits</td>
<td>2V+1U</td>
<td>L. Meier</td>
</tr>
</tbody>
</table>

**Abstract**


**Objective**

Participants will be able to plan and analyze efficient experiments in the fields of natural sciences. They will gain practical experience by using the software R.

**Content**


**Literature**


**Prerequisites / notice**

The exercises, but also the classes will be based on procedures from the freely available, open-source statistical software R, for which an introduction will be held.

A script will be available.

Faraway (2005): Linear Models with R

Faraway (2006): Extending the Linear Model with R

Draper & Smith (1998): Applied Regression Analysis

Fox (2008): Applied Regression Analysis and GLMs

Montgomery et al. (2006): Introduction to Linear Regression Analysis

**Prerequisites / notice**

The exercises, but also the classes will be based on procedures from the freely available, open-source statistical software R, for which an introduction will be held.

In the Mathematics Bachelor and Master programmes, the two course units 401-0649-00L "Applied Statistical Regression" and 401-3622-00L "Regression" are mutually exclusive. Registration for the examination of one of these two course units is only allowed if you have not registered for the examination of the other course unit.

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### Optional Subjects

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>752-1301-00L</td>
<td>Special Topics in Toxicology</td>
<td>W</td>
<td>2 credits</td>
<td>2G</td>
<td>S. J. Sturla, K. Hecht</td>
</tr>
</tbody>
</table>

**Abstract**

Journal-club style course involving student presentations and active discussion and critique of recent publications and modern experimental strategies. The focus is on chemical, biochemical, and nutritional aspects of selected topics in Toxicology, with a new group of topics addressed each semester.

**Objective**

- to stimulate student interest and provide advanced knowledge of current research in Toxicology and its related sciences
- to develop skills in critical evaluation of scientific literature, oral presentation and questioning
- to understand modern experimental techniques and research approaches relevant in toxicology

**Content**

The journal-club style course involves student presentations and active discussion of recent publications. The primary focus is on chemical, biochemical, and nutritional aspects of selected current topics in Toxicology. Participants are masters or PhD students in Food Sciences and related disciplines (i.e. Chemistry, Biochemistry, Pharmaceutical Sciences, etc.).

**Literature**

A selection of approximately 20 papers from recent primary scientific literature.

**Prerequisites / notice**

The course is open to Masters or PhD level students.

For Masters level participants, a strict prerequisite is (a) previously taken and passed "Introduction to Molecular Toxicology" (752-1300) and/or (b) previous courses supporting equivalent knowledge plus permission from the instructor. Please contact the instructor before the start of the class, explaining the basis of your previous knowledge other than the Introduction course, to request special permission.

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### Major in Food Quality and Safety

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### Disciplinary Subjects

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>752-0801-00L</td>
<td>Food Law and Legislation</td>
<td>W+</td>
<td>1 credit</td>
<td>1V</td>
<td>C. Spinner, E. Zbinden Kaessner</td>
</tr>
</tbody>
</table>

**Abstract**

Principles of the Swiss food law, introduction to the principles of the EU, international organisations and international contracts.
Objective
Overview about the general principles, institutions and execution of the Swiss food law as well as a presentation of the most important regulations of the Swiss food legislation. Knowledge about the principles and the structure of the EU in general and in the area of food safety, overview on the bilateral agreements CH-EU as well as on the most important international organisations (Codex Alimentarius and WTO) and their influence on the Swiss regulations on food safety.

Content
General introduction into the EU and in the area of food safety (Directorate General SANCO, regulation on food safety), legislative procedure in the EU, introduction into the relevant bilateral agreements CH-EU, introduction into international organisations (e.g. Codex Alimentarius), general principles of the Swiss food law and the most important regulations as well as the most important legal procedures, legal settlement and the duties and responsibilities of the Food control authorities.

Lecture notes
Copies of the presentations will be handed out.

Literature
Documents about Codex Alimentarius, the EU as well as the Swiss food law and some regulations will be handed out.

Prerequisites / notice
Qualifications: General knowledge of the food sciences.

The lecture will be held in German.

---

Objective
To understand use of enzymes in food processing and analysis.

Content
Enzymes in foods: the use of added enzymes in food processing, control and/or utilization of endogenous enzymes, production of enzyme preparations for food use, and chemical analysis of food components by enzymatic methods.

Lecture notes
The lectures are supplemented with handouts.

Prerequisites / notice
Course prerequisites: Food Chemistry I/II and Food Analysis I/II (or equivalent)

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Objective
The course offers detailed information on selected foodborne pathogens and toxin producing organisms; the focus lies on relevant molecular biological aspects of pathogenicity and virulence, as well as on the occurrence and survival of these organisms in foods.

Content
Detailed and current status of research and insights into the molecular basis of foodborne diseases, with focus on interactions of the microorganism or the toxins they produce with the human system. Understanding the relationship between specific types of food and the associated pathogens and microbial risks. Another focus lies on the currently available methods and techniques useful for the various purposes, i.e., detection, differentiation (typing), and antimicrobial agents.

Lecture notes
Electronic copies of the presentation slides (PDF) and additional material will be made available for download to registered students.

Literature
Recommendations will be given in the first lecture.

---

Objective
To understand the principles, roles and mechanisms of microorganisms with metabolic activities of high potential for application in traditional and functional foods utilization with high quality, safety and potential health benefits for the consumers. This course will integrate basic knowledge in food microbiology, microbial physiology, biochemistry, and technology.

Content
Molecular biology of infectious foodborne pathogens (Listeria, Vibrio, E. coli, Campylobacter, etc) and toxin-producing organisms (Bacillus, Clostridium, Staphylococcus). How and under which conditions will toxins and virulence factors be produced, and how do they work? How is the interaction between the human host and the microbial pathogen? What are the roles of food and the environment? What can be done to interfere with the potential risks? Which methods are best suited for what approach? Last, but not least, the role of bacteriophages in microbial pathogenicity will be highlighted, in addition to various applications of bacteriophage for both diagnostics and antimicrobial intervention.

Lecture notes
Lectures (2 hours) will be held as a single session of approximately 60+ minutes (10:15 until approx. 11:15 h), with no break!

Prerequisites / notice
Course contains lectures and a practical group work.

---

Objective
This integration course will discuss new applications of microorganisms with functional properties in food and functional food products. Selected topics will be used to illustrate the rapid development but also limits of basic knowledge for applications of functional microorganisms to produce food with high quality, safety and potential health benefits for consumers.

Content
Selected topics will be used to illustrate the rapid development but also limits of basic knowledge for applications of functional microorganisms to produce food with high quality, safety and potential health benefits for consumers. This course is integrated with basic knowledge in food microbiology, microbial physiology, biochemistry, and technology.

Lecture notes
Copy of the power point slides from lectures will be provided.

Literature
A list of references will be given at the beginning of the course for the different topics presented during this course.

---

Objective
This journal-club style course involves student presentations and active discussion of recent publications. The primary focus is on chemical, biochemical, and nutritional aspects of selected current topics in Toxicology, with a new group of topics addressed each semester.

Content
To stimulate student interest and provide advanced knowledge of current research in Toxicology and its related sciences.

Lecture notes
Copy of the power point slides from lectures will be provided.

Literature
A selection of approximately 20 papers from recent primary scientific literature.
The course is open to Masters or PhD level students.

For Masters level participants, a strict prerequisite is (a) previously taken and passed "Introduction to Molecular Toxicology" (752-1300) and/or (b) previous courses supporting equivalent knowledge plus permission from the instructor. Please contact the instructor before the start of the class, explaining the basis of your previous knowledge other than the Introduction course, to request special permission.

If you would like to take "Special Topics in Toxicology", do not register at the same time for "Advanced Topics in Toxicology". It is only possible to take one, and it is only possible to take the advanced level after completing this course.

### Methodology Subjects

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<td>W+</td>
<td>5 credits</td>
<td>2V+1U</td>
<td>L. Meier</td>
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<td>Objective</td>
<td>Participants will be able to plan and analyze efficient experiments in the fields of natural sciences. They will gain practical experience by using the statistical software R.</td>
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<td>Prerequisites / notice</td>
<td>The exercises, but also the classes will be based on procedures from the freely available, open-source statistical software R, for which an introduction will be held.</td>
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<tr>
<td>401-0649-00L</td>
<td>Applied Statistical Regression</td>
<td>W+</td>
<td>5 credits</td>
<td>2V+1U</td>
<td>M. Dettling</td>
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<tr>
<td>Abstract</td>
<td>This course offers a practically oriented introduction into regression modeling methods. The basic concepts and some mathematical background are included, with the emphasis lying in learning &quot;good practice&quot; that can be applied in every student's own projects and daily work life. A special focus will be laid in the use of the statistical software package R for regression analysis.</td>
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<td>Objective</td>
<td>The students acquire advanced practical skills in linear regression analysis and are also familiar with its extensions to generalized linear modeling.</td>
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<td>Content</td>
<td>The course starts with the basics of linear modeling, and then proceeds to parameter estimation, tests, confidence intervals, residual analysis, model choice, and prediction. More rarely touched but practically relevant topics that will be covered include variable transformations, multicollinearity problems and model interpretation, as well as general modeling strategies.</td>
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<td>Draper &amp; Smith (1998): Applied Regression Analysis</td>
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<td></td>
<td>Fox (2008): Applied Regression Analysis and GLMs</td>
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<td></td>
<td>Montgomery et al. (2006): Introduction to Linear Regression Analysis</td>
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<tr>
<td>Prerequisites / notice</td>
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The last third of the course is dedicated to an introduction to generalized linear models: this includes the generalized additive model, logistic regression for binary response variables, binomial regression for grouped data and poisson regression for count data.

### Optional Subjects

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<th>Hours</th>
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<tr>
<td>752-5111-00L</td>
<td>Gene Technology in Foods</td>
<td>W+</td>
<td>3 credits</td>
<td>2V</td>
<td>L. Meier</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course will increase basic knowledge on biotechnological constructions and application of genetically modified organisms (GMO) which are used worldwide in food production systems. The course discusses health issues, the legislation frame and food safety aspects of GMO applications in agriculture, food production and consumption in Switzerland and EU-countries.</td>
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<tr>
<td>Objective</td>
<td>This course will provide knowledge and biological background on genetically modified organisms (GMO) and food produced with the help of GMO, especially on the molecular basis of GMO constructions with emphasis on genetically modified food in Switzerland and the EU. Criteria of rational food safety and health assessment in agriculture and food consumption will be elaborated.</td>
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<tr>
<td>Content</td>
<td>Overview on application in gene technology, the gene transfer potential of bacteria, plants and other organisms and the mostly used transgenes in food as well as on GMO used for food production and their detection technologies in food; food safety assessment of GMO food; information on the legislation in Switzerland and EU-countries</td>
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<tr>
<td>Literature</td>
<td>Copies of slides from lectures will be provided</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Good knowledge in biology, especially in microbiology and molecular biology are prerequisites. Some contents will be provided by registered students who will individually or as a group present an actual publication.</td>
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<tr>
<td>752-1302-00L</td>
<td>Advanced Topics in Toxicology</td>
<td>W</td>
<td>2 credits</td>
<td>2G</td>
<td>S. J. Sturla</td>
</tr>
<tr>
<td>Abstract</td>
<td>Journal-club style course that involves student presentations of selected topics in Toxicology on the basis of current primary research and review papers.</td>
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<tr>
<td>Objective</td>
<td>The goals are to stimulate student interest and provide advanced knowledge of current research in the interdisciplinary area of Food and Nutrition Toxicology and its related sciences. The student should develop skills in the critical evaluation of scientific literature, oral presentation and questioning, and understanding modern experimental techniques in Molecular Toxicology.</td>
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<tr>
<td>Content</td>
<td>The journal-club style course involves student presentations of recent publications. The primary focus is on chemical and biochemical aspects of selected topics in Toxicology. Participants are generally masters or PhD students in Food Sciences and related disciplines (i.e. Chemistry, Pharmaceutical Sciences, etc.), and strong knowledge of organic chemistry and biochemistry are prerequisite. Selected course topics change every semester.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Participants are required to have completed previously &quot;Special Topics in Toxicology&quot; (752-1301-00L). Both courses are run concurrently every semester. It is only possible to register for one course at a time. Do not register for &quot;Advanced Topics in Toxicology&quot; until after you have completed &quot;Special Topics in Toxicology&quot;</td>
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</table>

### Major in Nutrition and Health

#### Disciplinary Subjects
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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>752-2307-00L</td>
<td>Nutritional Aspects of Food Composition and Processing</td>
<td>W+</td>
<td>3 credits</td>
<td>2V</td>
<td>B. E. Baumer, J. M. Sych</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td>Lecture type course with an interdisciplinary approach for the evaluation of nutritional aspects of changes in food composition due to processing.</td>
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<td></td>
<td><strong>Objective</strong></td>
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<td></td>
<td>Students should be able to</td>
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<td>- describe and compare the major concepts /criteria used for the evaluation of the nutritional quality of food</td>
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<td>- evaluate recent formulation strategies aimed to achieve additional physiological benefits for targeted population groups (i.e. functional foods),</td>
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<tr>
<td></td>
<td><strong>Content</strong></td>
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<td></td>
<td>The course gives inputs on compositional changes in food due to processing (with focus on thermal/chilling, enzymatic, chemical, emerging technologies) or new formulation strategies. Possible evaluation methods for these changes (e.g. nutritional profile) will be addressed.</td>
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<tr>
<td></td>
<td><strong>Lecture notes</strong></td>
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<td></td>
<td>There is no script. Powerpoint presentations and relevant scientific articles will be available on-line for students. A selection of recommended readings will be given at the beginning of the course.</td>
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<tr>
<td></td>
<td><strong>Prerequisites / notice</strong></td>
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<td></td>
<td>The course is open to Master and MAS students in food and science and nutrition or related. Basic knowledge of food chemistry and nutrition is expected, as well as an understanding of food processing.</td>
</tr>
<tr>
<td>752-6101-00L</td>
<td>Dietary Etiologies of Chronic Disease</td>
<td>W+</td>
<td>3 credits</td>
<td>2V</td>
<td>M. B. Zimmermann</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td>To have the student gain understanding of the links between the diet and the etiology and progression of chronic diseases, including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.</td>
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<td><strong>Objective</strong></td>
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<td>To examine and understand the protective effect of foods and food ingredients in the maintenance of health and the prevention of chronic disease, as well as the progression of complications of the chronic diseases.</td>
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<tr>
<td></td>
<td><strong>Content</strong></td>
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<td></td>
<td>The course evaluates food and food ingredients in relation to primary and secondary prevention of chronic diseases including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.</td>
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<tr>
<td></td>
<td><strong>Lecture notes</strong></td>
<td></td>
<td></td>
<td></td>
<td>There is no script. Powerpoint presentations will be made available on-line to students.</td>
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<tr>
<td></td>
<td><strong>Literature</strong></td>
<td></td>
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<td>To be provided by the individual lecturers, at their discretion.</td>
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<tr>
<td></td>
<td><strong>Prerequisites / notice</strong></td>
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<td></td>
<td>No compulsory prerequisites, but prior completion of Human Nutrition I + II (Humanernährung I+II) is strongly advised.</td>
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<tr>
<td>752-6105-00L</td>
<td>Epidemiology and Prevention</td>
<td>W+</td>
<td>3 credits</td>
<td>2V</td>
<td>M. Puhan, R. Heusser</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract</strong></td>
<td></td>
<td></td>
<td></td>
<td>Information for UZH students: Enrolment to this course unit only possible at ETH. No enrolment to module CS16_101 at UZH.</td>
</tr>
<tr>
<td></td>
<td><strong>Objective</strong></td>
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<td></td>
<td>The overall goal of the course is to introduce students to epidemiological thinking and methods, which are critical pillars for medical and public health research. Students will also become aware on how epidemiological facts are used in prevention, practice and politics.</td>
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<tr>
<td></td>
<td><strong>Content</strong></td>
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<td></td>
<td>The module Epidemiology and prevention describes the process of scientific discovery from the detection of a disease and its causes, to the development and evaluation of preventive and treatment interventions and to improved population health.</td>
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<tr>
<td>752-6402-00L</td>
<td>Nutrigenomics</td>
<td>W+</td>
<td>3 credits</td>
<td>2V</td>
<td>G. Vergères</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract</strong></td>
<td></td>
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<td>Nutrigenomics - toward personalized nutrition?</td>
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<tr>
<td></td>
<td>Breakthroughs in biology recently led nutrition scientists to apply modern tools (genomics, transcriptomics, proteomics, metabolomics, genetics, epigenetics) to the analysis of the interactions of food with humans. The lecture presents these tools and illustrates their application in selected topics relevant to human nutrition and food sciences.</td>
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<tr>
<td></td>
<td><strong>Objective</strong></td>
<td></td>
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<td></td>
<td>- Overall understanding of the transdisciplinary research being conducted under the term nutrigenomics.</td>
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<td></td>
<td>- Overall understanding of the omics technologies used in nutrigenomics and their applications to human nutrition and food science.</td>
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<td>- Ability to critically evaluate the potential and risks associated with the field of nutrigenomics</td>
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<td></td>
<td><strong>Content</strong></td>
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<td>- The lecture is completed by an optional project entitled 'Personalized Nutrition' in which the students have the opportunity to receive a personalized nutritional guidance that is based on their own genetic makeup. The scientific literature on which the genetic tests are based is presented by the students during the lecture.</td>
</tr>
</tbody>
</table>
Lecture notes

The script is composed of circa 450 slides (ca 18 slides/lecture) organized in 9 modules

Module A
From biochemical nutrition research to nutrigenomics

Module B
Nutritional genomics

Module C
Nutrigenetics

Module D
Nutri-epigenomics

Module E
Transcriptomics in nutrition research

Module F
Proteomics in nutrition research

Module G
Metabolomics in nutrition research

Module H
Nutritional systems biology

Module I
Individualized nutrition - opportunities and challenges

Literature

No extra reading requested. Most slides in the lecture are referenced with web addresses.

Prerequisites / notice

Basic training in biochemistry, molecular biology, physiology, and human nutrition. Interest in interdisciplinary sciences linking molecular biology to human health. Interest in the application of analytical laboratory methods to the understanding of human biology, in particular nutrition.

Methodology Subjects

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<td>This course offers a practically oriented introduction into regression modeling methods. The basic concepts and some mathematical background are included, with the emphasis lying in learning &quot;good practice&quot; that can be applied in every student's own projects and daily work life. A special focus will be laid in the use of the statistical software package R for regression analysis.</td>
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<tr>
<td></td>
<td>Montgomery et al. (2006): Introduction to Linear Regression Analysis</td>
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<tr>
<td>Prerequisites / notice</td>
<td>The exercises, but also the classes will be based on procedures from the freely available, open-source statistical software R, for which an introduction will be held.</td>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>766-6205-00L</td>
<td>Nutrient Analysis in Foods</td>
<td>W</td>
<td>3 credits</td>
<td>3U</td>
<td>M. B. Zimmermann, V. Galetti</td>
</tr>
<tr>
<td>Number of participants limited to 20. Permission from lecturers required for all students.</td>
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<tr>
<td>Abstract</td>
<td>In this practical course different meals are prepared and then analysed in the laboratory. The analyses comprise energy, macronutrients, specific micronutrients as well as polyphenols and phytic acid. Based on these results, the nutritional value of each meal is critically evaluated and discussed.</td>
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<tr>
<td>Objective</td>
<td>Learning analytical methods to determine macro- and micronutrient content in foods. Critical evaluation of analytical results, critical comparison with values from food composition tables, and interpretation in relation to nutritional value of meals.</td>
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</table>
The practical course nutrient analysis in foods includes the meal preparation (2 hours in December 2016, date to be defined) and chemical analysis of five meals from 5 different types of diets (students will work in groups; one meal per group). The content of macronutrients, specific micronutrients and secondary plant components are analysed using common analytical methods. The analytical results are compared with calculated data from food composition databases by using the nutrition software EbisPro and critically evaluated. The nutritional values of the meals in relation to specific chronic diseases and iron bioavailability are discussed. The practical course is accompanied by a lecture on the basic principles of analytical chemistry.

A script and lecture slides are handed out before course start. Performance is assessed by a short test on course content, oral presentation or results and a short report.

### Optional Subjects

<table>
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<tr>
<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>752-5103-00L</td>
<td>Functional Microorganisms in Foods</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>C. Lacroix, T. de Wouters, L. Meile, C. Schwab</td>
</tr>
<tr>
<td>752-6301-00L</td>
<td>Selected Topics in Physiology Related to Nutrition</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>W. Langhans</td>
</tr>
<tr>
<td>752-6403-00L</td>
<td>Nutrition and Performance</td>
<td>W+</td>
<td>2</td>
<td>2V</td>
<td>S. Mettler, M. B. Zimmermann</td>
</tr>
<tr>
<td>752-5111-00L</td>
<td>Gene Technology in Foods</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>L. Meile</td>
</tr>
</tbody>
</table>

This integration course will discuss new applications of microorganisms with functional properties in food and functional food products. Selected topics will be used to illustrate the rapid development but also limits of basic knowledge for applications of functional microorganisms to produce food with high quality, safety and potential health benefits for consumers.

This course will address selected and current topics on new applications of microorganisms with functional properties in food and functional food products and characterization of functionality and safety of food bacteria. Specialists from the Laboratory of Food Biotechnology, as well as invited speakers from the industry will contribute to the selected topics as follows:

- Probiotics and Prebiotics: Probiotics, functional foods and health, towards understanding molecular modes of probiotic action; Challenges for the production and addition of probiotics to foods; Prebiotics and other microbial substrates for gut functionality.
- Bioprotective Cultures and Antimicrobial Metabolites: Antifungal cultures and applications in foods; Antimicrobial peptide-producing cultures (bacteriocins) for enhancing food quality and safety; Development of new protective cultures, the long path from research to industry.
- Legal and Protection Issues Related Functional Foods
- Industrial Biotechnology of Flavor and Taste Development
- Safety of Food Starter Cultures and Probiotics

Students will be required to complete a group project on food products and ingredients with of from functional bacteria. The project will involve information research and analysis followed by an oral presentation and short written report.

A list of references will be given at the beginning of the course for the different topics presented during this course.

### Lecture notes

- Functional Microorganisms in Foods
  - Lecture notes: Copy of the power point slides from lectures will be provided.
  - Literature: A list of references will be given at the beginning of the course for the different topics presented during this course.

- Selected Topics in Physiology Related to Nutrition
  - Lecture notes: Handouts for each lecture will be made available every week; http://www.fpb.ethz.ch/teaching/handouts.html
  - Literature: Information on further reading will be announced during the lecture. There will be some mandatory as well as voluntary readings.

- Nutrition and Performance
  - Lecture notes: Lecture slides and required handouts will be available on the ETH website.
  - Literature: Information on further reading will be announced during the lecture. There will be some mandatory as well as voluntary readings.

- Gene Technology in Foods
  - Lecture notes: General knowledge about nutrition, human biology, physiology and biochemistry is a prerequisite for this course. The course builds on basic nutrition and biochemistry knowledge to address exercise and performance related aspects of nutrition.
  - Literature: It is strongly recommended to attend the lectures. The lecture (including the handouts) is not designed for distance education.
Content
Overview on application in gene technology, the gene transfer potential of bacteria, plants and other organisms and the mostly used transgenes in food as well as on GMO used for food production and their detection technologies in food; food safety assessment of GMO food; information on the legislation in Switzerland and EU-countries

Lecture notes
Copies of slides from lectures will be provided

Literature
Actual publications from literature will be provided

Prerequisites / notice
Good knowledge in biology, especially in microbiology and molecular biology are prerequisites. Some contents will be provided by registered students who will individually or as a group present an actual publication.

752-1300-00L Special Topics in Toxicology

Abstract
Journal-club style course involving student presentations and active discussion and critique of recent publications and modern experimental strategies. The focus is on chemical, biochemical, and nutritional aspects of selected topics in Toxicology, with a new group of topics addressed each semester

Objective
- to stimulate student interest and provide advanced knowledge of current research in Toxicology and its related sciences
- to develop skills in critical evaluation of scientific literature, oral presentation and questioning
- to understand modern experimental techniques and research approaches relevant in toxicology

Content
The journal-club style course involves student presentations and active discussion of recent publications. The primary focus is on chemical, biochemical, and nutritional aspects of selected current topics in Toxicology. Participants are masters or PhD students in Food Sciences and related disciplines (i.e. Chemistry, Biochemistry, Pharmaceutical Sciences, etc.).

Literature
A selection of approximately 20 papers from recent primary scientific literature.

Prerequisites / notice
The course is open to Masters or PhD level students.

For Masters level participants, a strict prerequisite is (a) previously taken and passed “Introduction to Molecular Toxicology” (752-1300) and/or (b) previous courses supporting equivalent knowledge plus permission from the instructor. Please contact the instructor before the start of the class, explaining the basis of your previous knowledge other than the Introduction course, to request special permission.

If you would like to take “Special Topics in Toxicology”, do not register at the same time for “Advanced Topics in Toxicology”. It is only possible to take one, and it is only possible to take the advanced level after completing this course.

Major in Human Health, Nutrition and Environment

Definition of modules see study guide Food Science

Disciplinary Subjects

Disciplinary courses: Module Public Health plus one additional module (Infectious Deseases Nutrition or Health or Environment and Health). A minimum of 10 CP per module have to be obtained

Number   Title                          Type   ECTS   Hours   Lecturers
401-0629-00L Applied Biostatistics  W      4 credits 3G     M. Müller

Abstract
Principles and main methods in biostatistics with emphasis on practical aspects. Experimental and observational studies. Regression and analysis of variance. Introduction into survival analysis.

Objective
Getting an overview of the problems and statistical methods used in health sciences. Practise in using the software R to analyze data and interpreting the results.

Content

Prerequisites / notice
The statistical package R will be used in the exercises.

If you are unfamiliar with R, I highly recommend the online R course etuR.

551-0223-00L Immunology III          W      4 credits 2V     M. Kopf, M. Bachmann, J. Kisielow, A. Lanzavecchia, S. R. Leibundgut, A. Oxenius, R. Spörri

Abstract
This course provides a detailed understanding of
- development of T and B cells
- the dynamics of a immune response during acute and chronic infection
- mechanisms of immunopathology
- modern vaccination strategies
Key experimental results will be shown to help understanding how immunological text book knowledge has evolved.

Objective
Obtain a detailed understanding of
- the development, activation, and differentiation of different types of T cells and their effectormechanisms during immune responses,
- Recognition of pathogenic microorganisms by the host cells and molecular events thereafter,
- events and signals for maturation of naive B cells to antibody producing plasma cells and memory B cells.
- Optimization of B cell responses by intelligent design of new vaccines

Content
- Development and selection of CD4 and CD8 T cells, natural killer T cells (NKT), and regulatory T cells (Treg)
- NK T cells and responses to lipid antigens
- Differentiation, characterization, and function of CD4 T cell subsets such as Th1, Th2, and Th17
- Overview of cytokines and their effector function
- Co-stimulation (signals 1-3)
- Dendritic cells
- Evolution of the “Danger” concept
- Cells expressing Pattern Recognition Receptors and their downstream signals
- T cell function and dysfunction in acute and chronic viral infections

Literature
Documents of the lectures are available for download at:
https://moodle-app2.let.ethz.ch/course/view.php?id=2581&notlyeditingon=1

Prerequisites / notice
Immunology I and II recommended but not compulsory

701-0263-01L Seminar in Evolutionary Ecology of Infectious Diseases W      3 credits 2G     D. Croll, S. Bonhoeffer, R. R. Regös
Abstract

This is an advanced course that will require significant student participation. Students will learn how to evaluate and present scientific literature and trace the development of ideas related to understanding the ecology and evolutionary biology of infectious diseases. A core set of ~10 classic publications encompassing unifying themes in infectious disease ecology and evolution, such as virulence, resistance, metapopulations, networks, and competition will be presented and discussed. Pathogens will include bacteria, viruses and fungi. Hosts will include animals, plants and humans.

Lecture notes Literature

Publications and class notes can be downloaded from a web page announced during the lecture.

701-1341-00L Water Resources and Drinking Water W 3 credits 2G S. Hug, M. Berg, F. Hammes, U. von Gunten

Abstract

The course covers qualitative (chemistry and microbiology) and quantitative aspects of drinking water from the resource to the tap. Natural processes, anthropogenic pollution, legislation of groundwater and surface water and of drinking water as well as water treatment will be discussed for industrialized and developing countries.

Objective

The goal of this lecture is to give an overview over the whole path of drinking water from the source to the tap and understand the involved physical, chemical and biological processes which determine the drinking water quality.

Content

The course covers qualitative (chemistry and microbiology) and quantitative aspects of drinking water from the resource to the tap. The various water resources, particularly groundwater and surface water, are discussed as part of the natural water cycle influenced by anthropogenic activities such as agriculture, industry, urban water systems. Furthermore legislation related to water resources and drinking water will be discussed. The lecture is focused on industrialized countries, but also addresses global water issues and problems in the developing world. Finally unit processes for drinking water treatment (filtration, adsorption, oxidation, disinfection etc.) will be presented and discussed.

Lecture notes Literature

Handouts will be distributed

752-2122-00L Food and Consumer Behaviour W 2 credits 2V M. Siegrist, C. Hartmann

Abstract

This course focuses on food consumer behavior, consumer's decision-making processes and consumer's attitudes towards food products.

Objective

The course provides an overview about the following topics: Factors influencing consumer's food choice, food and health, attitudes towards new foods and food technologies, labeling and food policy issues.

752-4009-00L Molecular Biology of Foodborne Pathogens W 3 credits 2V M. Loessner, M. Schüppler

Abstract

The course offers detailed information on selected foodborne pathogens and toxin producing organisms; the focus lies on relevant molecular biological aspects of pathogenicity and virulence, as well as on the occurrence and survival of these organisms in foods.

Objective

Detailed and current status of research and insights into the molecular basis of foodborne diseases, with focus on interactions of the microorganism or the toxins they produce with the human system. Understanding the relationship between specific types of food and the associated pathogens and microbial risks. Another focus lies on the currently available methods and techniques useful for the various purposes, i.e., detection, differentiation (typing), and antimicrobial agents.

Content

Molecular biology of infectious foodborne pathogens (Listeria, Vibrio, E. coli, Campylobacter, etc) and toxin-producing organisms (Bacillus, Clostridium, Staphylococcus). How and under which conditions will toxins and virulence factors be produced, and how do they work? How is the interaction between the human host and the microbial pathogen? What are the roles of food and the environment? What can be done to interfere with the potential risks? Which methods are best suited for what approach? Last, but not least, the role of bacteriophages in microbial pathogenicity will be highlighted, in addition to various applications of bacteriophage for both diagnostics and antimicrobial intervention.

Lecture notes Literature

Electronic copies of the presentation slides (PDF) and additional material will be made available for download to registered students.

752-5103-00L Functional Microorganisms in Foods W 3 credits 2G C. Lacroix, T. de Wouters, L. Meile, C. Schwab

Abstract

This integration course will discuss new applications of microorganisms with functional properties in food and functional food products. A core set of ~10 classic publications encompassing unifying themes in infectious disease ecology and evolution, such as virulence, resistance, metapopulations, networks, and competition will be presented and discussed. Pathogens will include bacteria, viruses and fungi. Hosts will include animals, plants and humans.

Objective

To understand the principles, roles and mechanisms of microorganisms with metabolic activities of high potential for application in the production and addition of probiotics to foods; Prebiotics and other microbial substrates for gut functionality.

Content

To have the student gain understanding of the links between the diet and the etiology and progression of chronic diseases, including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

Objective

To examine and understand the protective effect of foods and food ingredients in the maintenance of health and the prevention of chronic disease, as well as the progression of complications of the chronic diseases.

Lecture notes Literature

Copy of the power point slides from lectures will be provided.

752-6101-00L Dietary Etiologies of Chronic Disease W 3 credits 2V M. B. Zimmermann

Abstract

To have the student gain understanding of the links between the diet and the etiology and progression of chronic diseases, including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

Objective

To examine and understand the protective effect of foods and food ingredients in the maintenance of health and the prevention of chronic disease, as well as the progression of complications of the chronic diseases.
The course evaluates food and food ingredients in relation to primary and secondary prevention of chronic diseases including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

Lecture notes
There is no script. Powerpoint presentations will be made available on-line to students.

Literature
To be provided by the individual lecturers, at their discretion.

Prerequisites / notice
No compulsory prerequisites, but prior completion of Human Nutrition I + II (Humanernährung I+II) is strongly advised.

**752-6105-00L Epidemiology and Prevention**

**W 3 credits 2V**

M. Puhan, R. Heusser

*Information for UZH students:*
Enrolment to this course unit only possible at ETH. No enrolment to module CS16_101 at UZH.

*Please mind the ETH enrolment deadlines for UZH students: https://www.ethz.ch/en/studies/non-degree-courses/special-students/special-students-university-of-zurich.html*

Abstract
The module Epidemiology and prevention describes the process of scientific discovery from the detection of a disease and its causes, to the development and evaluation of preventive and treatment interventions and to improved population health.

Objective
The overall goal of the course is to introduce students to epidemiological thinking and methods, which are critical pillars for medical and public health research. Students will also become aware on how epidemiological facts are used in prevention, practice and politics.

Content
The module Epidemiology and prevention follows an overall framework that describes the course of scientific discovery from the detection of a disease to the development of prevention and treatment interventions and their evaluation in clinical trials and real world settings. We will discuss study designs in the context of existing knowledge and the type of evidence needed to advance knowledge. Examples form nutrition, chronic and infectious diseases will be used in order to show the underlying concepts and methods.

**752-6151-00L Public Health Concepts**

**W+ 3 credits 2V**

R. Heusser

Abstract
The module "public health concepts" offers an introduction to key principles of public health. Students get acquainted with the concepts and methods of epidemiology. Students also learn to use epidemiological data for prevention and health promotion purposes. Public health concepts and intervention strategies are presented, using examples from infectious and chronic diseases.

Objective
At the end of this module students are able:
- to interpret the results of epidemiological studies
- to critically assess scientific literature
- to know the definition, dimensions and determinants of health
- to plan health interventions and health promotion projects

Content
Concepts of descriptive and analytical epidemiology, study designs, measures of effect, confounding and bias, screening, surveillance, definition of health and health promotion, health dimensions and health determinants, prevention strategies, public health interventions, public health action cycle, epidemiology and prevention of infectious and chronic diseases (HIV, Tuberculosis, Obesity, Public health nutrition).

Lecture notes
Handouts are provided to students in the classroom.

Prerequisites / notice
Language of the course is english

**752-6402-00L Nutrigenomics**

**W 3 credits 2V**

G. Vergères

Abstract
Nutrigenomics - toward personalized nutrition?
Breakthroughs in biology recently led nutrition scientists to apply modern tools (genomics, transcriptomics, proteomics, metabolomics, genetics, epigenetics) to the analysis of the interactions of food with humans. The lecture presents these tools and illustrates their application in selected topics relevant to human nutrition and food sciences.

Objective
- Overall understanding of the transdisciplinary research being conducted under the term nutrigenomics.
- Overall understating of the omics technologies used in nutrigenomics and their applications to human nutrition and food science.
- Ability to critically evaluate the potential and risks associated with the field of nutrigenomics.

Content
- For the content of the script see section "Skript" below
- The lecture is completed by an optional project entitled 'Personalized Nutrition' in which the students have the opportunity to receive a personalized nutritional guidance that is based on their own genetic makeup. The scientific literature on which the genetic tests are based is presented by the students during the lecture.

Lecture notes
The script is composed of circa 450 slides (ca 18 slides/lecture) organized in 9 modules

Module A
From biochemical nutrition research to nutrigenomics

Module B
Nutritional genomics

Module C
Nutrigenetics

Module D
Nutri-epigenomics

Module E
Transcriptomics in nutrition research

Module F
Proteomics in nutrition research

Module G
Metabolomics in nutrition research

Module H
Nutritional systems biology

Module I
Individualized nutrition - opportunities and challenges

Literature
No extra reading requested. Most slides in the lecture are referenced with web adresses.
Prerequisites / notice

Basic training in biochemistry, molecular biology, physiology, and human nutrition. Interest in interdisciplinary sciences linking molecular biology to human health. Interest in the application of analytical laboratory methods to the understanding of human biology, in particular nutrition.

Methodology Subjects

Methodical courses are equivalent to the module Term Paper and Seminar. Missing CPs can be obtained from the major programs Food Processing, Food Quality and Safety, or Nutrition and Health.

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<th>Number</th>
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<th>Lecturers</th>
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</table>

Abstract

Writing of a review paper of scientific quality on a topic in the domain of Human Health, Nutrition and Environment based on critical evaluation of scientific literature.

Objective

- Acquisition of knowledge in the field of the review paper
- Assessment of original literature as well as synthesis and analysis of the findings
- Practising of academic writing in English
- Giving an oral presentation with discussion on the topic of the review paper

Content

Topics are offered in the domains of the major ‘Human Health, Nutrition and Environment’ covering ‘Public Health’, ‘Infectious Diseases’, ‘Nutrition and Health’ and ‘Environment and Health’.

Lecture notes

Guidelines will be handed out in the beginning.

Literature

Literature will be identified based on the topic chosen.

Optional Subjects

Choice of a module not yet selected as a disciplinary course. Choice between Infectious Diseases, Nutrition and Health, and Environment and Health.

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<tr>
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<tbody>
<tr>
<td>752-4009-00L</td>
<td>Molecular Biology of Foodborne Pathogens</td>
<td>W+</td>
<td>3 credits</td>
<td>2V</td>
<td>M. Loessner, M. Schuppler</td>
</tr>
</tbody>
</table>

Abstract

The course offers detailed information on selected foodborne pathogens and toxin producing organisms; the focus lies on relevant molecular biological aspects of pathogenicity and virulence, as well as on the occurrence and survival of these organisms in foods.

Objective

Detailed and current status of research and insights into the molecular basis of foodborne diseases, with focus on interactions of the microorganism or the toxins they produce with the human system. Understanding the relationship between specific types of food and the associated pathogens and microbial risks. Another focus lies on the currently available methods and techniques useful for the various purposes, i.e., detection, differentiation (typing), and antimicrobial agents.

Content

Molecular biology of infectious foodborne pathogens (Listeria, Vibrio, E. coli, Campylobacter, etc) and toxin-producing organisms (Bacillus, Clostridium, Staphylococcus). How and under which conditions will toxins and virulence factors be produced, and how do they work? How is the interaction between the human host and the microbial pathogen? What are the roles of food and the environment? What can be done to interfere with the potential risks? Which methods are best suited for what approach? Last, but not least, the role of bacteriophages in microbial pathogenicity will be highlighted, in addition to various applications of bacteriophage for both diagnostics and antimicrobial intervention.

Lecture notes

Electronic copies of the presentation slides (PDF) and additional material will be made available for download to registered students.

Literature

Recommendations will be given in the first lecture

Prerequisites / notice

Lectures (2 hours) will be held as a single session of approximately 60+ minutes (10:15 until approx. 11:15 h), with no break!

Immunology III

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<tr>
<th>Number</th>
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<tbody>
<tr>
<td>551-0223-00L</td>
<td>Immunology III</td>
<td>W</td>
<td>4 credits</td>
<td>2V</td>
<td>M. Kopf, M. Bachmann, J. Kisielow, A. Lanzavecchia, S. R. Leibundgut, A. Oxenius, R. Spörri</td>
</tr>
</tbody>
</table>

Abstract

This course provides a detailed understanding of
- development of T and B cells
- the dynamics of a immune response during acute and chronic infection
- mechanisms of immunopathology
- modern vaccination strategies

Key experimental results will be shown to help understanding how immunological text book knowledge has evolved.

Objective

Obtain a detailed understanding of
- the development, activation, and differentiation of different types of T cells and their effectormechanisms during immune responses,
- Recognition of pathogenic microorganisms by the host cells and molecular events thereafter,
- events and signals for maturation of naive B cells to antibody producing plasma cells and memory B cells,
- Optimization of B cell responses by intelligent design of new vaccines

Content

- Development and selection of CD4 and CD8 T cells, natural killer T cells (NK), and regulatory T cells (Treg)
- NK T cells and responses to lipid antigens
- Differentiation, characterization, and function of CD4 T cell subsets such as Th1, Th2, and Th17
- Overview of cytokines and their effector function
- Co-stimulation (signals 1-3)
- Dendritic cells
- Evolution of the “Danger” concept
- Cells expressing Pattern Recognition Receptors and their downstream signals
- T cell function and dysfunction in acute and chronic viral infections

Literature

Documents of the lectures are available for download at: https://moodle-app2.let.ethz.ch/course/view.php?id=2581&notifyeditingon=1

Prerequisites / notice

Immunology I and II recommended but not compulsory

Seminar in Evolutionary Ecology of Infectious Diseases

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<tr>
<td>701-0263-01L</td>
<td>Seminar in Evolutionary Ecology of Infectious Diseases</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>D. Croll, S. Bonhoeffer, R. R. Regös</td>
</tr>
</tbody>
</table>

Abstract

Students of this course will discuss current topics from the field of infectious disease biology. From a list of publications, each student chooses some themes that he/she is going to explain and discuss with all other participants and under supervision. The actual topics will change from year to year corresponding to the progress and new results occurring in the field.

Objective

This is an advanced course that will require significant student participation. Students will learn how to evaluate and present scientific literature and trace the development of ideas related to understanding the ecology and evolutionary biology of infectious diseases.

Content

A core set of ~10 classic publications encompassing unifying themes in infectious disease ecology and evolution, such as virulence, resistance, metapopulations, networks, and competition will be presented and discussed. Pathogens will include bacteria, viruses and fungi. Hosts will include animals, plants and humans.
Lecture notes
Publications and class notes can be downloaded from a web page announced during the lecture.

Papers will be assigned and downloaded from a web page announced during the lecture.

752-6101-00L
Dietary Etiologies of Chronic Disease
W 3 credits 2V
M. B. Zimmermann

Abstract
To have the student gain understanding of the links between the diet and the etiology and progression of chronic diseases, including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

Objective
To examine and understand the protective effect of foods and food ingredients in the maintenance of health and the prevention of chronic disease, as well as the progression of complications of the chronic diseases.

Content
The course evaluates food and food ingredients in relation to primary and secondary prevention of chronic diseases including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

Lecture notes
There is no script. Powerpoint presentations will be made available on-line to students.

Literature
To be provided by the individual lecturers, at their discretion.

Prerequisites / notice
No compulsory prerequisites, but prior completion of Human Nutrition I + II (Humanernährung I+II) is strongly advised.

752-6402-00L
Nutrigenomics
W 3 credits 2V
G. Vergères

Abstract
Nutrigenomics - toward personalized nutrition?

Breakthroughs in biology recently led nutrition scientists to apply modern tools (genomics, transcriptomics, proteomics, metabolomics, genetics, epigenetics) to the analysis of the interactions of food with humans. The lecture presents these tools and illustrates their application in selected topics relevant to human nutrition and food sciences.

Objective
- Overall understanding of the transdisciplinary research being conducted under the term nutrigenomics.
- Overall understating of the omics technologies used in nutrigenomics and their applications to human nutrition and food science.
- Ability to critically evaluate the potential and risks associated with the field of nutrigenomics

Content
- For the content of the script see section "Skript" below
- The lecture is completed by an optional project entitled 'Personalized Nutrition' in which the students have the opportunity to receive a personalized nutritional guidance that is based on their own genetic makeup. The scientific literature on which the genetic tests are based is presented by the students during the lecture.

Lecture notes
The script is composed of circa 450 slides (ca 18 slides/lecture) organized in 9 modules

Module A
From biochemical nutrition research to nutrigenomics

Module B
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Module D
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Module E
Transcriptomics in nutrition research

Module F
Proteomics in nutrition research

Module G
Metabolomics in nutrition research

Module H
Nutritional systems biology

Module I
Individualized nutrition - opportunities and challenges

Literature
No extra reading requested. Most slides in the lecture are referenced with web adresses.

Prerequisites / notice
Basic training in biochemistry, molecular biology, physiology, and human nutrition. Interest in interdisciplinary sciences linking molecular biology to human health. Interest in the application of analytical laboratory methods to the understanding of human biology, in particular nutrition.

752-5103-00L
Functional Microorganisms in Foods
W 3 credits 2G
C. Lacroix, T. de Wouters, L. Meile, C. Schwab

Abstract
This integration course will discuss new applications of microorganisms with functional properties in food and functional food products. Selected topics will be used to illustrate the rapid development but also limits of basic knowledge for applications of functional microorganisms to produce food with high quality, safety and potential health benefits for consumers.

Objective
To understand the principles, roles and mechanisms of microorganisms with metabolic activities of high potential for application in traditional and functional foods utilization with high quality, safety and potential health benefits for the consumers. This course will integrate basic knowledge in food microbiology, microbial physiology, biochemistry, and technology.
Students will require to complete a project on food products and ingredients with of from functional bacteria. The project will involve information research and analysis followed by an oral presentation and short written report.

**Content**

- Evolutionary Medicine for Infectious Diseases
- Safety of Food Starter Cultures and Probiotics
- Legal and Protection Issues Related Functional Foods
- Industrial Biotechnology of Flavor and Taste Development

**Lecture notes**

Copy of the power point slides from lectures will be provided.

**Literature**

A list of references will be given at the beginning of the course for the different topics presented during this course.

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**752-2122-00L**  
**Food and Consumer Behaviour**  
W  
2 credits  
2V  
M. Siegrist, C. Hartmann  

**Abstract**  
This course focuses on food consumer behavior, consumer's decision-making processes and consumer's attitudes towards food products.

**Objective**  
The course provides an overview about the following topics: Factors influencing consumer's food choice, food and health, attitudes towards new foods and food technologies, labeling and food policy issues

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**701-1341-00L**  
**Water Resources and Drinking Water**  
W  
3 credits  
2G  
S. Hug, M. Berg, F. Hammes, U. von Gunten  

**Abstract**  
The course covers qualitative (chemistry and microbiology) and quantitative aspects of drinking water from the resource to the tap. Natural processes, anthropogenic pollution, legislation of groundwater and surface water and of drinking water as well as water treatment will be discussed for industrialized and developing countries.

**Objective**  
The goal of this lecture is to give an overview about the whole path of drinking water from the source to the tap and understand the involved physical, chemical and biological processes which determine the drinking water quality.

**Content**  
The course covers quantitative (chemistry and microbiology) and quantitative aspects of drinking water from the resource to the tap. The various water resources, particularly groundwater and surface water, are discussed as part of the natural water cycle influenced by anthropogenic activities such as agriculture, industry, urban water systems. Furthermore legislation related to water resources and drinking water will be discussed. The lecture is focused on industrialized countries, but also addresses global water issues and problems in the developing world. Finally unit processes for drinking water treatment (filtration, adsorption, oxidation, disinfection etc.) will be presented and discussed.

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**636-0017-00L**  
**Computational Biology**  
W  
4 credits  
3G  
T. Stadler, C. Magnus  

**Abstract**  
The aim of the course is to provide up-to-date knowledge on how we can study biological processes using genetic sequencing data. Computational algorithms extracting biological information from genetic sequence data are discussed, and statistical tools to understand this information in detail are introduced.

**Objective**  
Attendees will learn which information is contained in genetic sequencing data and how to extract information from them using computational tools. The main concepts introduced are:
* stochastic models in molecular evolution
* phylogenetic & phylodynamic inference
* maximum likelihood and Bayesian statistics

Attendees will apply these concepts to a number of applications yielding biological insight into:
* epidemiology
* pathogen evolution
* macroevolution of species

**Content**  
The course consists of four parts. We first introduce modern genetic sequencing technology, and algorithms to obtain sequence alignments from the output of the sequencers. We then present methods to directly analyze this alignment (such as BLAST algorithm, GWAS approaches). Second, we introduce mechanisms and concepts of molecular evolution, i.e. we discuss how genetic sequences change over time. Third, we employ evolutionary concepts to infer ancestral relationships between organisms based on their genetic sequences, i.e. we discuss methods to infer geneologies and phylogenies. We finally introduce the field of phyldynamics. The aim of that field is to understand and quantify the population dynamic processes (such as transmission in epidemiology or speciation & extinction in macroevolution) based on a phylogeny. Throughout the class, the models and methods are illustrated on different datasets giving insight into the epidemiology and evolution of a range of infectious diseases (e.g. HIV, HCV, influenza, Ebola). Applications of the methods to the field of macroevolution provide insight into the evolution and ecology of different species clades. Students will be trained in the algorithms and their application both on paper and in silico as part of the exercises.

**Lecture notes**  
Slides of the lecture will be available online.  
https://www.bsse.ethz.ch/cvo/education/cb-materials.html

**Literature**  
The course is not based on any of the textbooks below, but they are excellent choices as accompanying material:
* Yang, Z. 2006. Computational Molecular Evolution.
* Drummond, A. & Bouckaert, R. 2015. Bayesian evolutionary analysis with BEAST

**Prerequisites / notice**  
Basic knowledge in linear algebra, analysis, and statistics will be helpful. Some programming experience will be useful for the exercises, but is not required. Programming skills will not be tested in the examination.

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**701-1703-00L**  
**Evolutionary Medicine for Infectious Diseases**  
W  
3 credits  
2G  
A. Hall  

**Abstract**  
This course explores infectious disease from both the host and pathogen perspective. Through short lectures, reading and active discussion, students will identify areas where evolutionary thinking can improve our understanding of infectious diseases and, ultimately, our ability to treat them effectively.

**Objective**  
Students will learn to (i) identify evolutionary explanations for the origins and characteristics of infectious diseases in a range of organisms and (ii) evaluate ways of integrating evolutionary thinking into improved strategies for treating infections of humans and animals. This will incorporate principles that apply across any host-pathogen interaction, as well as system-specific mechanistic information, with particular emphasis on bacteria and viruses.
Content

We will cover several topics where evolutionary thinking is relevant to understanding or treating infectious diseases. This includes: (i) determinants of pathogen host range and virulence, (ii) dynamics of host-parasite coevolution, (iii) pathogen adaptation to evade or suppress immune responses, (iv) antimicrobial resistance, (v) evolution-proof medicine. For each topic there will be a short (< 30 minutes) introductory lecture, before students independently research the primary literature and develop half a page of discussion points and questions, followed by interactive discussion in class.

Literature

Students will read the primary literature on each topic, and in places we will use the following books:

- Schmid Hempel 2011 Evolutionary Parasitology
- Stearns & Medzhitov 2016 Evolutionary Medicine

Prerequisites / notice

A basic understanding of evolutional biology, microbiology or parasitology will be advantageous but is not essential.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>701-1471-00L</td>
<td>Ecological Parasitology</td>
<td>3</td>
<td>V+P</td>
<td>1V+1P</td>
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<td>O. E. Seppälä, H. Hartikainen, J. Jokela</td>
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</table>

Abstract

Course focuses on the ecology and evolution of macroparasites and their hosts. Through lectures and practical work, students learn about diversity and natural history of parasites, adaptations of parasites, ecology of host-parasite interactions, applied parasitology, and human macroparasites in the modern world.

Objective

1. Identify common macroparasites in aquatic organisms.
2. Understand ecological and evolutionary processes in host-parasite interactions.
3. Conduct parasitological research.

Content

Lectures:
1. Diversity and natural history of parasites (i.e. systematic groups and life-cycles).
2. Adaptations of parasites (e.g. evolution of life-cycles, host manipulation).
3. Ecology of host-parasite interactions (e.g. parasite communities, effects of environmental changes).
4. Applied parasitology (e.g. aquaculture and fisheries).
5. Human macroparasites (schistosomiasis, malaria).

Practical exercises:
1. Examination of parasites in fish (identification of species and description of parasite communities).
2. Examination of parasites in molluscs (identification and examination of host exploitation strategies).
3. Examination of parasites in amphipods (identification and examination of effects on hosts).

Minors

Food Biotechnology

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<tr>
<td>752-5105-00L</td>
<td>Biotechnology of Alcoholic Beverages</td>
<td>W+</td>
<td>2</td>
<td>2V</td>
<td>H. J. Gafner, S. Schönenberg</td>
</tr>
</tbody>
</table>

Abstract

Basics of beer, wine and distillate production.

Objective

To understand the process cycle and control of beer, wine and distillate production.

Content

Beer Production:
Processes in the brewhouse, malting, diacetylmanagement.

Wine Production:
Where is the origin of the microorganisms for winemaking? What are dry yeasts? What is the meaning of spontaneous alcoholic fermentation? What is a "pied de cuve"? What is the influence of wine yeasts on the aroma of the wines? What is the role of glycerol in wine? What is the optimal fermentation temperature? What do we understand under the name biogenic amines? What is the reason for the occurrence of stuck fermentation? What is the meaning of "Böckser"? What is untypical ageing of wines? Which is the influence of Brettanomyces bruxellensis yeasts on wine quality - the wine "spaniöglet"? What is the task of malolactic fermentation (BSA)? What do we understand under Lindton? What are the reasons for vinagre taint? Diacetylmanagement in wine? Where does the mice taint origin? Which are desired and which are undesired yeasts and bacteria? How can we determine the genotype of grape varieties? What do we understand under cork taint (Zapfen)? Which wine bottle closures are on the market? - a quality analysis. What happens during the filtration process? What is the role of gentechology in winemaking?

Distillates:
Composition of a distillery. What is pre-run, middle-run and post-run? What are quality parameters by spirits.

Lecture notes

The handouts for the lectures will be distributed at the beginning of every lecture unit. In the wine lectures the treated subjects will be examined as self controls in form of multiple choice questions.

Literature

The literature is announced in the handouts for the lecture.

Prerequisites / notice

Sound knowledges in microbiology, molecular genetics, biochemistry and physiology in fermentd beverages are required.

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<tr>
<td>752-5111-00L</td>
<td>Gene Technology in Foods</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>L. Meile</td>
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</table>

Abstract

This course will increase basic knowledge on biotechnological constructions and application of genetically modified organisms (GMO) which are used worldwide in food production systems. The course discusses health issues, the legislation frame and food safety aspects of GMO applications in agriculture, food production and consumption in Switzerland and EU-countries.

Objective

This course will provide knowledge and biological background on genetically modified organisms (GMO) and food produced with the help of GMO, especially on the molecular basis of GMO constructions with emphasis on genetically modified food in Switzerland and the EU.

Content

Overview on application in gene technology, the gene transfer potential of bacteria, plants and other organisms and the mostly used transgenes in food as well as on GMO used for food production and their detection technologies in food; food safety assessment of GMO food; information on the legislation in Switzerland and EU-countries.

Lecture notes

Copies of slides from lectures will be provided.

Literature

Actual publications from literature will be provided.

Prerequisites / notice

Good knowledge in biology, especially in microbiology and molecular biology are prerequisites.

Some contents will be provided by registered students who will individually or as a group present an actual publication.
### Functional Microorganisms in Foods

**Abstract**
This integration course will discuss new applications of microorganisms with functional properties in food and functional food products. Selected topics will be used to illustrate the rapid development but also limits of basic knowledge for applications of functional microorganisms to produce food with high quality, safety and potential health benefits for consumers. To understand the principles, roles and mechanisms of microorganisms with metabolic activities of high potential for application in traditional and functional foods utilization with high quality, safety and potential health benefits for the consumers. This course will integrate basic knowledge in food microbiology, microbial physiology, biochemistry, and technology.

**Content**
This course will address selected and current topics on new applications of microorganisms with functional properties in food and functional food products and characterization of functionality and safety of food bacteria. Specialists from the Laboratory of Food Biotechnology, as well as invited speakers from the industry will contribute to the selected topics as follows:

- Probiotics and Prebiotics: Probiotics, functional foods and health, towards understanding molecular modes of probiotic action; Challenges for the production and addition of probiotics to foods; Prebiotics and other microbial substrates for gut functionality.

- Bioprotective Cultures and Antimicrobial Metabolites: Antifungal cultures and applications in foods; Antimicrobial peptide-producing cultures (bacteriocins) for enhancing food quality and safety; Development of new protective cultures, the long path from research to industry.

- Legal and Protection Issues Related Functional Foods

- Industrial Biotechnology of Flavor and Taste Development

- Safety of Food Starter Cultures and Probiotics

**Lecture notes**
Students will be required to complete a group project on food products and ingredients with of from functional bacteria. The project will involve information research and analysis followed by an oral presentation and short written report.

**Literature**
A list of references will be given at the beginning of the course for the different topics presented during this course.

### Food Chemistry

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<tbody>
<tr>
<td>752-1021-00L</td>
<td>Food Enzymology</td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>L. Nyström</td>
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<tr>
<td>Abstract</td>
<td>The course covers the fundamentals of food enzymology, application of endogenous and exogenous enzymes in food processing, as well as use of enzymes in analytics.</td>
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<tr>
<td>Objective</td>
<td>To understand use of enzymes in food processing and analysis.</td>
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<tr>
<td>Content</td>
<td>Enzymes in foods: the use of added enzymes in food processing, control and/or utilization of endogenous enzymes, production of enzyme preparations for food use, and chemical analysis of food components by enzymatic methods.</td>
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<tr>
<td>Lecture notes</td>
<td>The lectures are supplemented with handouts.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Course prerequisites: Food Chemistry I/II and Food Analysis I/II (or equivalent)</td>
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| 529-0041-00L | Modern Mass Spectrometry, Hyphenated Methods, and Chemometrics | W   | 6    | 3G    | R. Zenobi, M. Badertscher, B. Hettendorf, P. Martinez-Lozano Sinues |
| Abstract     | Modern mass spectrometry, hyphenated analytical methods, speciation, methods of surface analysis, chemometrics. |
| Objective    | Comprehensive knowledge about the analytical methods introduced in this course, and their applications. |
| Content      | Coupling of separation with identification methods such as GC-MS, LC-MS, GC-IR, LC-IR, LC-NMR etc.; importance of speciation. Modern mass spectrometry: Time of flight and ion cyclotron resonance mass spectrometry, ICP-MS. Soft ionization methods, desorption methods, spray methods. Employment of computer science for processing data in chemical analysis (chemometrics). |
| Lecture notes| The lectures will be available in the lecture at production cost. |
| Literature   | Information about relevant literature will be available in the lecture & in the lecture notes. |
| Prerequisites / notice | Experiments are an integral part of the lecture. Prerequisites: 529-0051-00 "Analytische Chemie I (3. Semester)" 529-0058-00 "Analytische Chemie II (4. Semester)" (or equivalent) |

### Food Microbiology

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<th>Number</th>
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<tbody>
<tr>
<td>752-4009-00L</td>
<td>Molecular Biology of Foodborne Pathogens</td>
<td>W+</td>
<td>3</td>
<td>2V</td>
<td>M. Loessner, M. Schuppler</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course offers detailed information on selected foodborne pathogens and toxin producing organisms; the focus lies on relevant molecular biological aspects of pathogenicity and virulence, as well as on the occurrence and survival of these organisms in foods.</td>
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<tr>
<td>Objective</td>
<td>Detailed and current status of research and insights into the molecular basis of foodborne diseases, with focus on interactions of the microorganism or the toxins they produce with the human system. Understanding the relationship between specific types of food and the associated pathogens and microbial risks. Another focus lies on the currently available methods and techniques useful for the various purposes, i.e., detection, differentiation (typing), and antimicrobial agents.</td>
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<tr>
<td>Content</td>
<td>Molecular biology of infectious foodborne pathogens (Listeria, Vibrio, E. coli, Campylobacter, etc) and toxin-producing organisms ( Bacillus, Clostridium, Staphylococcus). How and under which conditions will toxins and virulence factors be produced, and how do they work? How is the interaction between the human host and the microbial pathogen? What are the roles of food and the environment? What can be done to interfere with the potential risks? Which methods are best suited for what approach? Last, but not least, the role of bacteriophages in microbial pathogenicity will be highlighted, in addition to various applications of bacteriophage for both diagnostics and antimicrobial intervention.</td>
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<tr>
<td>Lecture notes</td>
<td>Electronic copies of the presentation slides (PDF) and additional material will be made available for download to registered students.</td>
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<tr>
<td>Literature</td>
<td>Recommendations will be given in the first lecture</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Lectures (2 hours) will be held as a single session of approximately 60+ minutes (10:15 until approx. 11:15 h), with no break!</td>
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</table>
This integration course will discuss new applications of microorganisms with functional properties in food and functional food products. Selected topics will be used to illustrate the rapid development but also limits of basic knowledge for applications of functional microorganisms to produce food with high quality, safety and potential health benefits for consumers. This course will integrate basic knowledge in food microbiology, microbial physiology, biochemistry, and technology.

This course will address selected and current topics on new applications of microorganisms with functional properties in food and functional food products and characterization of functionality and safety of food bacteria. Specialists from the Laboratory of Food Biotechnology, as well as invited speakers from the industry will contribute to the selected topics as follows:

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- Bioprotective Cultures and Antimicrobial Metabolites: Antifungal cultures and applications in foods; Antimicrobial peptide-producing cultures (bacteriocins) for enhancing food quality and safety; Development of new protective cultures, the long path from research to industry.

- Legal and Protection Issues Related Functional Foods

- Industrial Biotechnology of Flavor and Taste Development

- Safety of Food Starter Cultures and Prebiotics

Students will be required to complete a group project on food products and ingredients with of from functional bacteria. The project will involve information research and analysis followed by an oral presentation and short written report.

A list of references will be given at the beginning of the course for the different topics presented during this course.

### Food Process Design

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
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<tbody>
<tr>
<td>752-3021-00L</td>
<td>Food Process Design and Optimization</td>
<td>W</td>
<td>4 credits</td>
<td>2G</td>
<td>E. J. Windhab</td>
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<tr>
<td>Number</td>
<td>Title</td>
<td>Type</td>
<td>ECTS</td>
<td>Hours</td>
<td>Lecturers</td>
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<tr>
<td>752-3023-00L</td>
<td>Process Measurements and Automation</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>E. J. Windhab</td>
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### Food Sensory Science and Consumer Behaviour

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<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>752-2122-00L</td>
<td>Food and Consumer Behaviour</td>
<td>W</td>
<td>2 credits</td>
<td>2V</td>
<td>M. Siegrist, C. Hartmann</td>
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### Public Nutrition and Health

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<tr>
<th>Number</th>
<th>Title</th>
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<th>Hours</th>
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<tr>
<td>752-6101-00L</td>
<td>Dietary Etiologies of Chronic Disease</td>
<td>W</td>
<td>3 credits</td>
<td>2V</td>
<td>M. B. Zimmermann</td>
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The course provides an overview about the following topics: Factors influencing consumer’s food choice, food and health, attitudes towards new foods and food technologies, labeling and food policy issues.
Epidemiology and Prevention

Information for UZH students:
Enrolment to this course unit only possible at ETH. No enrolment to module CS16_101 at UZH.

Please mind the ETH enrolment deadlines for UZH students: https://www.ethz.ch/en/studies/non-degree-courses/special-students/special-students-university-of-zurich.html

Abstract
The module Epidemiology and prevention describes the process of scientific discovery from the detection of a disease and its causes, to the development and evaluation of preventive and treatment interventions and to improved population health.

Objective
The overall goal of the course is to introduce students to epidemiological thinking and methods, which are critical pillars for medical and public health research. Students will also become aware on how epidemiological facts are used in prevention, practice and politics.

Content
The module Epidemiology and prevention follows an overall framework that describes the course of scientific discovery from the detection of a disease to the development of prevention and treatment interventions and their evaluation in clinical trials and real world settings. We will discuss study designs in the context of existing knowledge and the type of evidence needed to advance knowledge. Examples form nutrition, chronic and infectious diseases will be used in order to show the underlying concepts and methods.

Safety and Quality in Agri-Food Chain

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<tr>
<th>Number</th>
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<tr>
<td>751-1555-00L</td>
<td>Applied Food Industrial Organisation</td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>to be announced</td>
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<td>Does not take place this semester.</td>
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<tr>
<td></td>
<td>Abstract</td>
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<td>Concepts of microeconomics and Industrial Organization and their application to the European food sector. Aspects include industry structure as well as strategic actions and performance of food sector firms.</td>
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<td>Objective</td>
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<td>Understanding and application of theoretical concepts along the Structure-Conduct-Performance paradigm. Ability to apply theory to empirical settings; understand and critically evaluate empirical industrial organization research and to replicate the results of such research using econometric methods</td>
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<td>Content</td>
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<td>- Introduction IO</td>
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<td>- Relevant topics for the food sector</td>
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<td>- high competition and market saturation</td>
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<td>- low R&amp;D intensity</td>
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<td>- bargaining power of retailers</td>
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<td>- Private label introduction</td>
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<td>- Theoretical Approaches</td>
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<td>- Structure Conduct Performance</td>
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<td>- Market Based View</td>
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<td>- Porters Five Forces</td>
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<td>- Resource Based View</td>
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<td>- Knowledge Based View</td>
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<td>- Empirical Issues (Based on published research papers)</td>
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<td>- Competition / Concentration</td>
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<td>- Profitability</td>
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<td>- Impact of Innovation / R&amp;D</td>
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<td>- Efficiency</td>
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<td>- Market power</td>
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<td>- Econometric Approaches</td>
</tr>
<tr>
<td></td>
<td>Literature</td>
<td></td>
<td></td>
<td></td>
<td>Carlton and Perloff: Modern Industrial Organization 4th ed., Pearson Addison  Wesley. Several theoretical and empirical IO related research papers</td>
</tr>
</tbody>
</table>

Food and Consumer Behaviour

Abstract
This course focuses on food consumer behavior, consumer's decision-making processes and consumer's attitudes towards food products.

Objective
The course provides an overview about the following topics: Factors influencing consumer's food choice, food and health, attitudes towards new foods and food technologies, labeling and food policy issues.

Nutritional Aspects of Food Composition and Processing

Abstract
Lecture type course with an interdisciplinary approach for the evaluation of nutritional aspects of changes in food composition due to processing.

Objective
Students should be able to:
- describe and compare the major concepts /criteria used for the evaluation of the nutritional quality of food
- apply these criteria when assessing the effects of selected processing technologies on nutritional quality.
- evaluate recent formulation strategies aimed to achieve additional physiological benefits for targeted population groups (i.e. functional foods).

Content
The course gives inputs on compositional changes in food due to processing (with focus on thermal/chilling, enzymatic, chemical, emerging technologies) or new formulation strategies. Possible evaluation methods for these changes (e.g. nutritional profile) will be addressed.

Lecture notes
There is no script. Powerpoint presentations and relevant scientific articles will be available on-line for students. A selection of recommended readings will be given at the beginning of the course.

Prerequisites / notice
The course is open to Master and MAS students in food and science and nutrition or related. Basic knowledge of food chemistry and nutrition is expected, as well as an understanding of food processing.

Horticultural Science: Case Studies (HS)

Abstract
Lectures address 2 horticultural cropping systems and value chains, each one in 4 2h-lecture blocks. Afterwards, the students split in 2 groups for addressing a case study focusing on one of the cropping systems treated before. An excursion to a research site might be included. In a final colloquium, each presents a report on their study and their conclusions.

Objective
Achieve a deepened understanding of horticultural value chain challenges relating to ecological intensification, resource efficiency, climate change and healthy and safe food, and the problem solution strategies and scientific principles behind. Deliver in a team effort a report and a presentation providing a comprehensive insight into a problem of the horticultural value chain and its science-based solution strategy.
In the autumn semester, the two addressed cropping systems and value chains are fruit-production and viticulture. In the spring semester, the two addressed cropping systems and value chains are vegetable-production and berry-production or glasshouse-horticulture. The selected topics address challenges with regard to ecological intensification, resource efficiency or climate change and branch into ongoing research and development projects. The students learn to present a scientific subject in writing and orally to an audience and to defend the presentation in a discussion.

Content

- The Forum "Livestock in the World Food System" will take place in blocks of 2 hours each. Once the general topic has been selected, it comprises two elements:
  - Element 1. Oral Presentation: The students form small groups and are lecturers. There are chair persons (moderators) from outside of these small groups and they also head the discussion. The remaining students and lecturers are the audience.
  - Element 2. Scientific writing: Option 1: preparation of a short scientific type of paper from a result table offered by the lecturers; Option 2: preparation of an abstract with limited word count from a scientific paper; Option 3: writing of a critical review of a paper. The students have to select 2 of the three options each. There will be a discussion be a discussion in small groups at two dates.

Abstract

- Introductions to both forms of presentation will be offered by lecturers.
- The preparation of the oral and written presentations takes place to a small part during the 2-h blocks and mainly outside of this time.

Objective

- Requirements for allocation of the two credit points:
  - Theatre presentation (with handout) at the forum
  - Delivery of written documents of sufficient quality
  - Active participation during the presentations by the other participants

Content

- Good knowledge of biology, especially in microbiology and molecular biology are prerequisites.
- Food; information on the legislation in Switzerland and EU-countries
- GMO applications in agriculture, food production and consumption in Switzerland and EU-countries
- Criteria of rationale food safety and health assessment in agriculture and food consumption will be elaborated.
- Further information available: http://www.worldfoodsystem.ethz.ch/education/summer-schools/upcoming.html

Abstract

- Provide the opportunity for young scientists and practitioners to understand the challenges and opportunities of sustainable agriculture and organic production systems and to connect these to the broader context of the world food system. During the two week summer school at the Gut Rheinau, one of Switzerland's largest organic farms, participants will engage in lectures, workshops, group work, case studies, participatory processes. Connect to a network of expert faculty/practitioners

Objective

- The content framework includes the following modules: world food system overview; agricultural production; Global change drivers; smallholder livelihoods and rural development; Agroforest systems; labelling; International policy and trade; Processing, distribution, and retail; Nutrition and health; National policy and state interventions. The course will conclude with a group work on food system challenges.

Content

- Participants will receive pre-reading material before the course commences.

Pre-requisites

- No prerequisites. Program is open to Masters, PhD and upper level Bachelor students.

Food Physics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>752-3103-00L</td>
<td>Food Rheology I</td>
<td>W</td>
<td>3 credits</td>
<td>2V</td>
<td>P. A. Fischer</td>
</tr>
<tr>
<td>751-0021-00L</td>
<td>World Food System Summer School</td>
<td>W</td>
<td>4 credits</td>
<td>6P</td>
<td>N. Buchmann</td>
</tr>
</tbody>
</table>
Abstract
Rheology is the science of flow and deformation of matter such as polymers, dispersions (emulsions, foams, suspensions), and colloidal systems. The fluid dynamical basis, measuring techniques (rheometry), and the flow properties of different fluids (Newtonian, non-Newtonian, viscoelastic) are introduced and discussed. The course provides an introduction on the link between flow and structural properties of flowing material. Rheometrical techniques and appropriate measuring protocols for the characterization of complex fluids will be discussed. The concept of rheological constitutive equations and the application to different material classes are established. Lectures will be given on general introduction (4h), fluid dynamics (2h), complex flow behavior (4h), influence of temperature (2h), rheometers (4h), rheological tests (6h) and structure and rheology of complex fluids (4h).

Lecture notes
Notes will be handed out during the lectures.

Literature
Provided in the lecture notes.

752-2314-00L  Physics of Food Colloids  W+  3 credits  2V  P. A. Fischer, R. Mezzenga

Abstract
In Physics of Food Colloids the principles of colloid science will applied to the aggregation of food materials based on proteins, polysaccharides, and emulsifiers. Mixtures of such raw material determine the appearance and performance of our daily food. In a number of examples, colloidal laws are linked to food science and the manufacturing and processing of food.

Objective
The underlying colloidal laws reflect the structure of the individual raw material (length scale, time scale, and interacting forces). Once these concepts are appreciated the aggregation of most food systems falls into recognizable patterns that can be used to modify and structure exiting food or to design new products. The application and use of these concepts are discussed in light of common food production.

Content
Lectures include interfacial tension (4h), protein aggregation in bulk and interfaces (4h), Pickering emulsions (2h), gels (4h), aggregation of complex mixtures (4h), and the use of light scattering in investigation complex food structures (6h). Most chapters include some hand-ons examples of the gain knowledge to common food products.

Lecture notes
Notes will be handed out during the lectures.

Literature
Provided in the lecture notes.

Food Toxicology

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>752-1301-00L</td>
<td>Special Topics in Toxicology</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>S. J. Sturla, K. Hecht</td>
</tr>
<tr>
<td>752-1302-00L</td>
<td>Advanced Topics in Toxicology</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>S. J. Sturla</td>
</tr>
</tbody>
</table>

Objective
- to stimulate student interest and provide advanced knowledge of current research in Toxicology and its related sciences
- to develop skills in critical evaluation of scientific literature, oral presentation and questioning
- to understand modern experimental techniques and research approaches relevant in Toxicology

Content
The journal-club style course involves student presentations and active discussion of recent publications. The primary focus is on chemical, biochemical, and nutritional aspects of selected topics in Toxicology. Participants are masters or PhD students in Food Sciences and related disciplines (i.e. Chemistry, Biochemistry, Pharmaceutical Sciences, etc.).

Lecture notes
A selection of approximately 20 papers from recent primary scientific literature.

Prerequisites / notice
The course is open to Masters or PhD level students. For Masters level participants, a strict prerequisite is (a) previously taken and passed "Introduction to Molecular Toxicology" (752-1300) and/or (b) previous courses supporting equivalent knowledge plus permission from the instructor. Please contact the instructor before the start of the class, explaining the basis of your previous knowledge other than the Introduction course, to request special permission.

If you would like to take "Special Topics in Toxicology", do not register at the same time for “Advanced Topics in Toxicology”. It is only possible to take one, and it is only possible to take the advanced level after completing this course.

Prerequisites / notice
Participants are required to have completed previously "Special Topics in Toxicology" (752-1301-00L). Both courses are run concurrently every semester. It is only possible to register for one course at a time. Do not register for "Advanced Topics in Toxicology" until after you have completed "Special Topics in Toxicology".

Project teaching; time frame totals ca. 80 hours.

See recommended literature.
Molecular Biology of Foodborne Pathogens

- **Objective**: Detailed and current status of research and insights into the molecular basis of foodborne diseases, with a focus on interactions of the microorganism or the toxins they produce with the human system. Understanding the relationship between specific types of food and the associated pathogens and microbial risks. Another focus lies on the currently available methods and techniques useful for the various purposes, i.e., detection, differentiation (typing), and antimicrobial agents.

- **Content**: Molecular biology of infectious foodborne pathogens (Listeria, Vibrio, E. coli, Campylobacter, etc) and toxin-producing organisms (Bacillus, Clostridium, Staphylococcus). How and under which conditions will toxins and virulence factors be produced, and how do they work? How is the interaction between the human host and the microbial pathogen? What are the roles of food and the environment? What can be done to interfere with the potential risks? Which methods are best suited for what approach? Last, but not least, the role of bacteriophages in microbial pathogenicity will be highlighted, in addition to various applications of bacteriophage for both diagnostics and antimicrobial intervention.

- **Lecture notes**: Electronic copies of the presentation slides (PDF) and additional material will be made available for download to registered students.

- **Prerequisites / notice**: Lectures (2 hours) will be held as a single session of approximately 60+ minutes (10:15 until approx. 11:15 h), with no break !

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**Epidemiology and Prevention**

- **Abstract**: The module Epidemiology and prevention describes the process of scientific discovery from the detection of a disease and its causes, to the development and evaluation of preventive and treatment interventions and to improved population health.

- **Objective**: The overall goal of the course is to introduce students to epidemiological thinking and methods, which are critical pillars for medical and public health research. Students will also become aware on how epidemiological facts are used in prevention, practice and politics.

- **Content**: The module Epidemiology and prevention follows an overall framework that describes the course of scientific discovery from the detection of a disease to the development of prevention and treatment interventions and their evaluation in clinical trials and real world settings. We will discuss study designs in the context of existing knowledge and the type of evidence needed to advance knowledge. Examples from nutrition, chronic and infectious diseases will be used in order to show the underlying concepts and methods.

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**Master's Thesis**

- **Objective**: The Master thesis completes the master programme and is an independent scientific project. Generally, the topic is selected from the specific field of the major. It is supervised by a professor at D-HEST.

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**Course Units for Additional Admission Requirements**

The courses below are only available for MSc students with additional admission requirements.

- **Number**: 752-1000-AAL
- **Title**: Food Chemistry I
- **Type**: Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.
- **ECTS**: 3 credits
- **Lecturers**: L. Nyström, M. Erzinger

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**Electives**

- **Number**: 752-0005-00L
- **Title**: Public Colloquium in Food Science
- **Type**: W
- **ECTS**: 1 credit
- **Lecturers**: S. J. Sturia

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**Data: 06.03.2019 12:57 Autumn Semester 2016 Page 904 of 1571**
Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract
To familiarise with the structure, properties and reactivity of food constituents. To understand the relationship between the multiple chemical reactions and the quality of food.

Objective
To familiarise with the structure, properties and reactivity of food constituents. To understand the relationship between the multiple chemical reactions and the quality of food.

Content
Descriptive chemistry of food constituents (proteins, lipids, carbohydrates, plant phenolics, flavour compounds). Reactions which affect the colour, flavour, texture, and the nutritional value of food raw materials and food products during processing, storage and preparation in a positive or in a negative way (e.g. lipid oxidation, Maillard reaction, enzymatic browning). Links to food analysis, food processing, and nutrition.

Lecture notes
The lectures are supplemented with handouts.

Literature

752-1101-AAL Food Analysis I  
Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract
To understand the basic principles of analytical chemistry. To get acquainted with the principles and applications of important routine methods of instrumental food analysis (UV/VIS, IR, AAS, GC, HPLC).

Objective
To understand the basic principles of analytical chemistry. To get acquainted with the principles and applications of important routine methods of instrumental food analysis (UV/VIS, IR, AAS, GC, HPLC).

Content

Methods: Optical spectroscopy (basic principles, UV/VIS, IR, and atomic absorption spectroscopy). Chromatography (GC, HPLC).

Lecture notes
The lectures are supplemented with handouts.

Literature

752-3000-AAL Food Process Engineering I  
Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract
To procure the basic physics of food process engineering, especially with the mechanical futures of food systems, i.e. basic principles of engineering mechanics, of thermodynamics, fluid dynamics and of dimension analyses for process design and Non-Newtonian fluid mechanics.

Objective

Content

Lecture notes
Vorlesungsskriptum (ca. 100 Seiten, 60 Abbildungen) wird vor der ersten Vorlesung und Folien jeweils vor der Vorlesung bereit gestellt.


Prerequisites / notice
Die Vorlesung erfordert während des Semesters wöchentliche Vor-/Nachbereitung. Im Unterricht wird aktive Mitarbeit erwartet.

752-6305-AAL Physiology and Anatomy I  
Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract
Imparts a basic understanding of physiology and anatomy in man, focusing on the interrelations between morphology and function of the human organism. This is fostered by discussing all subjects from a functional point of view. One major topic of the lecture is food intake and digestion with its correlated chemosensory, endocrine and metabolic processes.

Objective
At the end of the course the students understand the basic functions of the organ systems and functionally important morphological features. One focus of the course is on aspects related to nutrition and overweight including the resulting diseases.

752-6306-AAL Physiology and Anatomy II  
Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract
Imparts a basic understanding of physiology and anatomy in man, focusing on the close interrelations between morphology and function of the human organism. This is fostered by discussing all subjects from a functional point of view. A major topic of the lecture is food intake and digestion with its correlated endocrine and metabolic processes.

Objective
After this course the students are able to understand basic principles of systems physiology and the mechanisms of the function of the major organ systems.

752-6001-AAL Introduction to Nutritional Science  
Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract
This course introduces basic concepts of micro- and macronutrient nutrition. Micro- and macronutrients studied include fat-soluble and water-soluble vitamins, minerals and trace elements. Macronutrients include proteins, fat and carbohydrates. Special attention is given to nutrient digestion, bioavailability, metabolism and excretion with some focus on energy metabolism.
Objective
To introduce the students to the both macro- and micronutrients in relation to food and metabolism.

Content
The course is divided into two parts. The lectures on micronutrients are given by Prof. Zimmermann and the lectures on macronutrients are given by Prof. Wolfrum. Prof. Zimmermann discusses the micronutrients, including fat-soluble vitamins, water-soluble vitamins, minerals and trace elements. Prof. Wolfrum introduces basic nutritional aspects of proteins, fats, carbohydrates and energy metabolism. The nutrients are described in relation to digestion, absorption and metabolism. Special aspects of homeostasis and homeorhesis are emphasized.

Literature
Elmadfa I & Leitzmann C: Ernährung des Menschen
UTB Ulmer, Stuttgart, 4. überarb. Ausgabe 2004

Garrow JS and James WPT: Human Nutrition and Dietetics
Churchill Livingstone, Edinburgh, 11th rev. ed. 2005

551-0001-AAL General Biology I
Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Abstract
Organismic biology to teach the basic principles of classical and molecular genetics, evolutionary biology and phylogeny.

Objective
The understanding of basic principles of biology (inheritance, evolution and phylogeny) and an overview of the diversity of life.

Content
The first semester focuses on the organismal biology aspects of genetics, evolution and diversity of life in the Campbell chapters 12-34.

Week 1-7 by Alex Widmer, Chapters 12-25
12 Cell biology Mitosis
13 Genetics Sexual life cycles and meiosis
14 Genetics Mendelian genetics
15 Genetics Linkage and chromosomes
20 Genetics Evolution of genomes
21 Evolution How evolution works
22 Evolution Phylogenetic reconstructions
23 Evolution Microevolution
24 Evolution Species and speciation
25 Evolution Macroevolution

Week 8-14 by Oliver Martin, Chapters 26-34
26 Diversity of Life Introduction to viruses
27 Diversity of Life Prokaryotes
28 Diversity of Life Origin & evolution of eukaryotes
29 Diversity of Life Nonvascular&seedless vascular plants
30 Diversity of Life Seed plants
31 Diversity of Life Introduction to fungi
32 Diversity of Life Overview of animal diversity
33 Diversity of Life Introduction to invertebrates
34 Diversity of Life Origin & evolution of vertebrates

Lecture notes
No script

Literature

Prerequisites / notice
This is a virtual self-study lecture for non-german speakers of the “Allgemeine Biology I (551-0001-00L) lecture. The exam will be written jointly with the participants of this lecture.

Example exam questions will be discussed during the lectures, and old exam questions are kept by the various student organisations. If necessary, please contact Prof. Uwe Sauer (sauer@ethz.ch) for details regarding the exam.

551-0002-AAL General Biology II
Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Abstract
Molecular biology approach to teach the basic principles of biochemistry, cell biology, cgenetics, evolutionary biology and form and function of vascular plants.

Objective
The understanding basic concepts of biology: the hierarchy of the structural levels of biological organisation, with particular emphasis on the cell and its molecular functions, the fundamentals of metabolism and molecular genetics, as well as form and function of vascular plants.
Content
The structure and function of biomacromolecules; basics of metabolism; tour of the cell; membrane structure and function; basic energetics of cellular processes; respiration, photosynthesis; cell cycle, from gene to protein; structure and growth of vascular plants, resource acquisition and transport, soil and plant nutrition.

Specifically the following Campbell chapters will be covered:
3 Biochemistry Chemistry of water
4 Biochemistry Carbon: the basis of molecular diversity
5 Biochemistry Biological macromolecules and lipids
7 Cell biology Cell structure and function
8 Cell biology Cell membranes
10 Cell biology Respiration: introduction to metabolism
10 Cell biology Cell respiration
11 Cell biology Photosynthetic processes
16 Genetics Nucleic acids and inheritance
17 Genetics Expression of genes
18 Genetics Control of gene expression
19 Genetics DNA Technology
35 Plant structure&function Plant Structure and Growth
36 Plant structure&function Transport in vascular plants
37 Plant structure&function Plant nutrition
38 Plant structure&function Reproduction of flowering plants
39 Plant structure&function Plants signal and behavior

Lecture notes
No script

Literature

Prerequisites / notice
PLEASE NOTE This lecture is newly conceived and will be held for the first time in the spring semester 2017.

406-0063-AAL

**Physics II**

Enrolment ONLY for MSC students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract
Introduction to the "way of thinking" and the methodology in Physics. The Chapters treated are Magnetism, Refraction and Diffraction of Waves, Elements of Quantum Mechanics with applications to Spectroscopy, Thermodynamics, Phase Transitions, Transport Phenomena. 

Objective
Introduction to the scientific methodology. The student should develop his/her capability to turn physical observations into mathematical models, and to solve the latter. 

The student should acquire an overview over the basic concepts used in the theory of heat and electricity.

Content
Book:

Chapters:

Literature
see "Content"

Friedhelm Kuypers
Physik für Ingenieure und Naturwissenschaftler
Band 2 Elektrizität, Optik, Wellen
Verlag Wiley-VCH, 2003, Fr. 77.-

406-0603-AAL

**Stochastics (Probability and Statistics)**

Enrolment ONLY for MSC students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract
Introduction to basic methods and fundamental concepts of statistics and probability theory for non-mathematicians. The concepts are presented on the basis of some descriptive examples. Learning the statistical program R for applying the acquired concepts will be a central theme.

Objective
The objective of this course is to build a solid fundament in probability and statistics. The student should understand some fundamental concepts and be able to apply these concepts to applications in the real world. Furthermore, the student should have a basic knowledge of the statistical programming language "R".

Content
From "Statistics for research" (online)
Ch 1: The Role of Statistics
Ch 2: Populations, Samples, and Probability Distributions
Ch 3: Binomial Distributions
Ch 6: Sampling Distribution of Averages
Ch 7: Normal Distributions
Ch 8: Student’s t Distribution
Ch 9: Distributions of Two Variables

From "Introductory Statistics with R (online)"
Ch 1: Basics
Ch 2: The R Environment
Ch 3: Probability and distributions
Ch 4: Descriptive statistics and tables
Ch 8: One- and two-sample tests
Ch 6: Regression and correlation
Literature
- "Statistics for research" by S. Dowdy et. al. (3rd edition); Print ISBN: 9780471267355; Online ISBN: 9780471477433; DOI: 10.1002/0471477435
  From within the ETH, this book is freely available online under: http://onlinelibrary.wiley.com/book/10.1002/0471477435
  From within the ETH, this book is freely available online under: http://www.springerlink.com/content/m17578/

Food Science Master - Key for Type

<table>
<thead>
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<th>O</th>
<th>Compulsory</th>
<th>E-</th>
<th>Recommended, not eligible for credits</th>
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<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>W</td>
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<td>Dr</td>
<td>Suitable for doctorate</td>
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Key for Hours

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<tr>
<th>V</th>
<th>lecture</th>
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<th>practical/laboratory course</th>
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<tbody>
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<td>G</td>
<td>lecture with exercise</td>
<td>A</td>
<td>independent project</td>
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<td>U</td>
<td>exercise</td>
<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>S</td>
<td>seminar</td>
<td>R</td>
<td>revision course / private study</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
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ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
MAS in Architecture and Digital Fabrication

Courses Offered

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
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<td>065-0061-00L</td>
<td>MAS in Architecture and Digital Fabrication</td>
<td>E-</td>
<td>0 credits</td>
<td>7K</td>
<td>F. Gramazio, M. Kohler</td>
</tr>
</tbody>
</table>

Abstract

The MAS ETH in Architecture and Digital Fabrication is an interdisciplinary education programme initiated by the National Centre of Competence in Research (NCCR) Digital Fabrication and the ETH Zurich. The focus lies upon the methods and techniques of digital design and fabrication and their significance for future building culture.

Objective

The NCCR Digital Fabrication is an ambitious initiative that brings together leading researchers in the disciplines of architecture, engineering, robotics, material and computer sciences. As the main education platform for this NCCR, the MAS ETH in Architecture and Digital Fabrication will benefit from direct exchange with its investigators and immediate access to cutting edge research and innovation. In the NCCR's unique robotic fabrication facilities, the students will also have the opportunity to research digital design and construction processes, and to implement these directly in large-scale prototypes.

The MAS ETH in Architecture and Digital Fabrication is conceived as a 12 months full-time programme targeted at university graduates with excellent design skills and technical knowledge. The teaching language of the programme will be English. The programme begins on the 14th of September 2015. Applications will be accepted until the 30th of April 2015.

Participants will develop competence in complex design and production challenges and will be able to take leading positions in the field of architecture, construction, or the extended design and production industries.

Detailed information on the programme and the inscription form can be found on our website: www.dfab.ch/mas.

Content

The MAS Digital Fabrication is a 1 year full-time programme and is structured as a series of teaching modules with an independent master thesis. Lessons within the modules are given in the form of lectures, practical workshops, and projects as the main modus for developing skills. Learning will be supported through one on one mentoring in studio, group critiques, symposia, and excursions.

Prerequisites / notice

A Master's degree in architecture or engineering acknowledged by ETH, or equivalent educational qualifications (i.e. a bachelor's degree and a minimum of two years professional experience in a directly related field). Additional critical requirements are proof of creative design skills and technological capabilities. Qualification will be assessed from application documents and skills will be evaluated through portfolio review.

MAS in Architecture and Digital Fabrication - Key for Type

<table>
<thead>
<tr>
<th>Key for Type</th>
<th>Description</th>
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</tr>
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</tr>
<tr>
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Key for Hours

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<th>Key for Hours</th>
<th>Description</th>
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<tr>
<td>V</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
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<td>K</td>
<td>colloquium</td>
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<td>P</td>
<td>practical/laboratory course</td>
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<td>A</td>
<td>independent project</td>
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<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
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</tbody>
</table>

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
The studies take one full year and begin in the autumn semester.

The programme contains 75 CP and is divided into about 6-8 modules of 3-4 weeks, which are taught in seminars that are each concluded with an individual or group project. The studies end with an individual thesis.

For more information about the modules please visit: http://www.caad.arch.ethz.ch/

Teaching languages are English and German. The number of participants is 6 to 12.

Courses Offered

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>065-0069-07L</td>
<td>MAS ETH in Architecture and Information</td>
<td>E-</td>
<td>0 credits</td>
<td>6K</td>
<td>L. Hovestadt</td>
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</table>

After successful completion the students achieve 70 Creditpoints.

Abstract

A fundamental theoretical and practical introduction to the application of information technologies in architecture. The MAS program CAAD is a yearly full time program, consisting of eight 4-weekly instruction modules with practical exercises and a concluding individual Masterthesis.

Objective

Development of new design methods, new construction forms, media architectures, narrative infrastructures, global models. Parametric and generative CAD systems, procedural, object-oriented and agent-based programming, introduction to JAVA/Processing, introduction to diverse computer-controlled machines with practical examples, development of machine-compatible building constructions, development of electronics for automated tasks, implementation of radio networks.

Content

http://www.mas.caad.arch.ethz.ch/

Lecture notes

http://www.mas.caad.arch.ethz.ch/

Literature

http://www.mas.caad.arch.ethz.ch/

MAS in Architecture and Information - Key for Type

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<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
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<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
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<td>Dr</td>
<td>Suitable for doctorate</td>
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Key for Hours

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<td>V</td>
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<td>R</td>
<td>revision course / private study</td>
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</tbody>
</table>

ECTS

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
MAS in Development and Cooperation

The lectures and advanced training courses of NADEL are accessible only for students of the MAS in Development and Cooperation and for qualified employees with at least two years experience in development cooperation and a Master's level or equivalent level of education as recognized by ETH. PhD students doing empirical research in development cooperation may be admitted "sur Dossier".

➤ Study Semester

➤➤ Compulsory Courses

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<thead>
<tr>
<th>Number</th>
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<td>Cultural and Social Aspects of Development</td>
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<td>3</td>
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<td>M.L. Müller</td>
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<tr>
<td>Abstract</td>
<td>In this course essential development issues from historical, sociological and anthropological perspectives are presented and discussed. Topics such as decolonization, migration, racism in development cooperation, development projects in Islamic countries and education will lead to critically question and expand one’s own westernized notions.</td>
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<tr>
<td>Objective</td>
<td>The students will be able to</td>
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<td></td>
<td>- consider which factors influence human action, and discuss their importance for development cooperation</td>
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<td></td>
<td>- explain different conceptions of development in Western and non-Western cultures and indicate possible consequences for development projects</td>
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<td></td>
<td>- display basic knowledge of selected topics on social and cultural development</td>
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<tr>
<td>Content</td>
<td>- Stellenwert der Kultur in der IZA</td>
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<tr>
<td></td>
<td>- Kolonialismus und seine Folgen</td>
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<td>- Afrika und die Moderne</td>
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<td></td>
<td>- Migration - Aufgabenfeld der IZA?</td>
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<td></td>
<td>- Förderung von Bildungssystem, Berufliche Bildung und Arbeitsmarkt</td>
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<td>865-0007-00L</td>
<td>History and Forms of International Development</td>
<td>O</td>
<td>3</td>
<td>4G</td>
<td>R. Battiner</td>
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<tr>
<td>Abstract</td>
<td>This course presents the origins and evolution of the International Development Cooperation during the last six decades and relates the changing paradigms to their political and socio-economic contexts. It looks at the different actors with their specific roles, approaches and challenges from a Swiss as well as a global perspective.</td>
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<td>Objective</td>
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<td></td>
<td>- analyse the evolution of the International Development Cooperation, selected development theories and their practical application in the historic context</td>
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<td></td>
<td>- describe the Swiss landscape of actors in Development Cooperation and its integration into the international community of donors.</td>
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<td></td>
<td>- assess possible implications of the Agenda 2030 for the structure and practice of the international cooperation</td>
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<tr>
<td>Content</td>
<td>- History of the international Development Cooperation: beginnings, change development theories over the time</td>
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<td></td>
<td>- International efforts to increase sustainability and aid effectiveness</td>
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<td>- Swiss bilateral agencies for development: SDC and SECO</td>
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<td>- Multilateral development agencies and banks: UN-agencies and Bretton Woods Institutions</td>
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<td></td>
<td>- Non-governmental Organisations: Challenges today - in Switzerland and in partner countries</td>
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<td>- Economy. Private foundation and philanthropie: New actors with high aspirations</td>
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<td>- Humanitarian Aid between intervention in crises, prevention and development tasks</td>
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<td>865-0003-00L</td>
<td>Development Economics</td>
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<td>3</td>
<td>4G</td>
<td>I. Günther, K. Harttgen</td>
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<td>Only for MAS in Development and Cooperation.</td>
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<tr>
<td>Abstract</td>
<td>This course is an introduction to theoretical and empirical discussions on economic development, with a focus on the challenges of developing countries over the last 50 years. The course provides answers to the following questions: How can and should development be measured? What factors drive economic growth and contribute to poverty reduction?</td>
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<tr>
<td>Objective</td>
<td>Students are able to</td>
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<td></td>
<td>- critically discuss economic questions in the context of developing countries</td>
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<td></td>
<td>- critically discuss policy recommendations for economic development.</td>
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<tr>
<td>Content</td>
<td>- measurement of development, poverty and inequality,</td>
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<td></td>
<td>- growth theories</td>
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<td>- trade and development</td>
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<td>- education, health, population and development</td>
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<td>- states and institutions</td>
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<td></td>
<td>- economic policies for economic growth and poverty reduction</td>
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<td></td>
<td>- economics of development aid</td>
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<td>865-0010-00L</td>
<td>Politics and Governance</td>
<td>O</td>
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<td>3G</td>
<td>F. Brugger</td>
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<tr>
<td>Abstract</td>
<td>The course focuses on selected issues of governance systems in developing countries, and on possible interventions of development cooperation to improve the quality of governance.</td>
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<tr>
<td>Objective</td>
<td>The course introduces students to the basics of governance systems in developing countries and to possible interventions of development cooperation to improve the quality of governance.</td>
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<tr>
<td>865-0010-01L</td>
<td>Environment and Natural Resources</td>
<td>O</td>
<td>3</td>
<td>4G</td>
<td>L. B. Nilsen</td>
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<td>Only for MAS in Development and Cooperation.</td>
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<tr>
<td>Abstract</td>
<td>Degradation of the environment and non-sustainable use of natural resources, including land, water, forests and biodiversity is threatening individual livelihoods as well as local, national and international economies. This lecture series will address conflicts related to unsustainable resource use and discuss trade-offs between environmental sustainability and economic development.</td>
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<tr>
<td>Objective</td>
<td>The student will be able to</td>
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<tr>
<td></td>
<td>- describe the current status and threats of natural resource use and environmental degradation</td>
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<td></td>
<td>- portray the management of natural resources such as land, forest, water, and biodiversity in different contexts and discuss the key challenges in each sector</td>
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<td>- examine the implications of climate change on development and the sustainable management of natural resources</td>
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<td></td>
<td>- analyze conflicts and trade-offs between natural resource use and economic development</td>
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<td></td>
<td>- discuss the global priorities relating to human-induced changes to the environment, and how these can be met</td>
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➤➤ Electives

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<tr>
<th>Number</th>
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<th>Lecturers</th>
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<tr>
<td>865-0068-00L</td>
<td>Justice and Normative Aspects of Development</td>
<td>W</td>
<td>2</td>
<td>3G</td>
<td>F. Brugger, R. Battiner</td>
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<td>Only for MAS in Development and Cooperation.</td>
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</table>
Abstract
This course discusses ethical questions of development relevant for international cooperation. Examples include: possibilities and limits of normative justification of development aid; theories of justice, human rights and the 'rights-based' approach to development, epistemological foundations of development theories, ethical questions of globalization.

Objective
What is justice and why are human rights valid? What is development and what is the responsibility of the State? The answers always include normative judgements. Where these normative dimensions remain implicit, international development cooperation risks the unreflected export of its own value and belief systems. This course enables students to identify implicit normative dimensions, put them into the ethical context and to critically reflect on those normative aspects.

865-0011-01L Sanitation and Water Supply in Development
Only for MAS in Development and Cooperation.

Abstract
The course provides an overview of the links among sanitation, water supply, waste management and environmental and health aspects. It gives an understanding of the specific challenges and possible solutions in ensuring environmental services and illustrates their impact on the population and settlements.

Objective
The participants are able to:
- present the global situation and development trends in the sector of sanitation, water supply, waste management and for its main actors;
- discuss the relationships between water supply, sanitation and health;
- explain the principles of technologies for drinking water treatment, the management of sewage and waste, as well as appraise their strengths and weaknesses;
- explain which sustainable concepts are implemented and how they can be inserted into the technical, institutional and social structures so that they are economically, ecologically and socially sustainable;
- provide information where good professional resources are available.

865-0010-02L Food Security and Agriculture
Generally only for MAS in Development and Cooperation.

Abstract
Food security has been on top of the policy agenda for decades, but still a considerable proportion of the population in developing countries remains hungry and malnourished. This lecture series will explore how we produce and distribute food; analyse the concept of food security and discuss ways and means for increasing the availability and accessibility of food in developing countries.

Objective
The student will be able to:
- describe the most important milestones in the history of food and agriculture
- understand the concept of food security and discuss causes and impacts of food insecurity
- compare different approaches to promote and increase crop- and livestock production in a sustainable manner
- reflect on some of the main economic challenges of the world food system and understand some of the tradeoffs between smallholders' decisions of labor, consumption, and production of food
- give insights in how international organizations work with farmers and governments in developing countries to ensure availability and equal access to food

860-0006-00L Applied Statistics and Policy Evaluation
Number of participants limited to 20.

Abstract
This course introduces students to key statistical methods for analyzing social science data with a special emphasis on causal inference and policy evaluation. Students learn to choose appropriate analysis strategies for particular research questions and to perform statistical analyses with the statistical Software Stata.

Objective
Students are able to:
- have a sound understanding of linear and logit regression
- know strategies to test causal hypotheses using regression analysis and/or experimental methods
- are able to formulate and implement a regression model for a particular policy question and a particular type of data
- are able to critically interpret results of applied statistics, in particular, regarding causal inference
- are able to critically read and assess published studies on policy evaluation
- are able to use the statistical software STATA for data Analysis

Content
The topics covered in the first part of the course are a revision of basic statistics and linear and logit regression analysis. The second part of the course focuses on causal inference and introduces methods such as panel data analysis, difference-in-difference methods, instrumental variable estimation, and randomized controlled trials methodology. The course shows how the various methods differ in terms of the required identifying assumptions to infer causality as well as the data needs. Students will apply the methods from the lectures by solving weekly assignments using statistical software and data sets provided by the instructors. These data sets will cover topics at the interface of policy, technology and society. Solving the assignments contributes to the final grade with a weight of 30%. Students are assisted in solving the assignments during the exercises session.

865-0067-00L Foundations of Sustainable Development Practice
Generally only for MAS in Development and Cooperation.

Abstract
The course provides students with an introduction to concepts of sustainable development, with an emphasis on the Sustainable Development Goals (SDGs). Both conceptual and practical issues are presented, with the intention of challenging students to critically assess and debate on current issues of global development.

Objective
The students are able to:
- define the main underlying concepts of the SDGs like "sustainability" and "development"
- explain the background of the Agenda 2030, its intention, the process of its development and the guiding principles for its implementation
- discuss practical difficulties in pursuing and achieving sustainable development through development & cooperation interventions;
- describe the relevant actors and their roles and responsibilities;
- discuss the merits and limitations of such an ambitious, multi-disciplinary, universally agreed upon framework;
- examine what the SDGs could mean for "developed nations" like Switzerland.

Content
- Setting the stage: What is sustainable? What is development? Why Sustainable Development Goals (SDGs)?
- The Agenda 2030: 17 goals and 169 targets
- Actors: Who are the actors in the SDG debate? How do these actors influence decisions? What are the roles of civil society, of the private sector, and of governments in implementing the SDGs?
- Switzerland: What does the Agenda 2030 mean for Switzerland's national and international agendas? Which SDGs does Switzerland focus on at home and abroad?
- Focus on a selection of SDGs and their related targets (not dealt with in other courses).

865-0069-00L Health and Development - Health Related Aspects of

Abstract
Students

Number of participants limited to 20.

Objective
Students are able to:
- are able to use the statistical software STATA for data Analysis
- are able to critically read and assess published studies on policy evaluation
- are able to use the statistical software STATA for data Analysis

Content
The topics covered in the first part of the course are a revision of basic statistics and linear and logit regression analysis. The second part of the course focuses on causal inference and introduces methods such as panel data analysis, difference-in-difference methods, instrumental variable estimation, and randomized controlled trials methodology. The course shows how the various methods differ in terms of the required identifying assumptions to infer causality as well as the data needs. Students will apply the methods from the lectures by solving weekly assignments using statistical software and data sets provided by the instructors. These data sets will cover topics at the interface of policy, technology and society. Solving the assignments contributes to the final grade with a weight of 30%. Students are assisted in solving the assignments during the exercises session.
International Development Aid
Only for MAS in Development and Cooperation.

Abstract
The following topics will be discussed: Basic principles of epidemiology and global burden of disease distribution, Health systems and health system strengthening including economic aspects and health insurance, communicable diseases such as HIV/AIDS, Malaria, tuberculosis and neglected tropical diseases, mother and child health, non-communicable diseases and transition in health in LAMICs.

Objective
This course aims at providing a public health driven overview on most important topics related to health and health care in low- and middle-income countries (LAMICs). After the module participants shall have broad understanding of challenges for health, health care and health systems in LAMICs. They shall be able to discuss more in depth some major global health topics, such as health systems, transition in health, malaria, neglected tropical diseases and HIV/AIDS. The course will provide an insight into current strategies and approaches addressing major global health topics.

Semester Thesis

<table>
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No direct enrolment to this course unit in myStudies. For registration, please contact the Administration MAS Development and Cooperation directly.

MAS in Development and Cooperation - Key for Type

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<th>Letter</th>
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<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
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<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
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Key for Hours

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<td>G</td>
<td>lecture with exercise</td>
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<td>colloquium</td>
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ECTS
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
## MAS in Nutrition and Health

### Disciplinary Subjects

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<th>Lecturers</th>
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<tbody>
<tr>
<td>752-6402-00L</td>
<td>Nutrigenomics - toward personalized nutrition?</td>
<td>W+</td>
<td>3 credits</td>
<td>2V</td>
<td>G. Vergères</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td>Breakthroughs in biology recently led nutrition scientists to apply modern tools (genomics, transcriptomics, proteomics, metabolomics, genetics, epigenetics) to the analysis of the interactions of food with humans. The lecture presents these tools and illustrates their application in selected topics relevant to human nutrition and food sciences.</td>
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<td></td>
<td><strong>Objective</strong></td>
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<td></td>
<td>- Overall understanding of the transdisciplinary research being conducted under the term nutrigenomics.</td>
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<td></td>
<td>- Overall understating of the omics technologies used in nutrigenomics and their applications to human nutrition and food science.</td>
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<td></td>
<td>- Ability to critically evaluate the potential and risks associated with the field of nutrigenomics</td>
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<tr>
<td></td>
<td><strong>Content</strong></td>
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<td></td>
<td>- The lecture is completed by an optional project entitled 'Personalized Nutrition' in which the students have the opportunity to receive a personalized nutritional guidance that is based on their own genetic makeup. The scientific literature on which the genetic tests are based is presented by the students during the lecture.</td>
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<tr>
<td></td>
<td><strong>Lecture notes</strong></td>
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<tr>
<td></td>
<td>The script is composed of circa 450 slides (ca 18 slides/lecture) organized in 9 modules</td>
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<td></td>
<td><strong>Module A</strong></td>
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<td></td>
<td>From biochemical nutrition research to nutrigenomics</td>
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<td></td>
<td><strong>Module B</strong></td>
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<tr>
<td></td>
<td>Nutritional genomics</td>
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<td></td>
<td><strong>Module C</strong></td>
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<tr>
<td></td>
<td>Nutrigenetics</td>
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<td><strong>Module D</strong></td>
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<tr>
<td></td>
<td>Nutri-epigenomics</td>
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<td><strong>Module E</strong></td>
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<tr>
<td></td>
<td>Transcriptomics in nutrition research</td>
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<td><strong>Module F</strong></td>
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<tr>
<td></td>
<td>Proteomics in nutrition research</td>
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<td></td>
<td><strong>Module G</strong></td>
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<tr>
<td></td>
<td>Metabolomics in nutrition research</td>
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<td><strong>Module H</strong></td>
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<tr>
<td></td>
<td>Nutritional systems biology</td>
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<td></td>
<td><strong>Module I</strong></td>
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<td></td>
<td>Individualized nutrition - opportunities and challenges</td>
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<tr>
<td></td>
<td><strong>Literature</strong></td>
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<tr>
<td></td>
<td>No extra reading requested. Most slides in the lecture are referenced with web adresses.</td>
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<td></td>
<td><strong>Prerequisites / notice</strong></td>
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<td>Basic training in biochemistry, molecular biology, physiology, and human nutrition. Interest in interdisciplinary sciences linking molecular biology to human health. Interest in the application of analytical laboratory methods to the understanding of human biology, in particular nutrition.</td>
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</table>

| 752-6105-00L | Epidemiology and Prevention                     | W+   | 3 credits | 2V    | M. Puhan, R. Heusser |
|              | **Abstract**                                    |      |           |       |                   |
|              | The module Epidemiology and prevention describes the process of scientific discovery from the detection of a disease and its causes, to the development and evaluation of preventive and treatment interventions and to improved population health. |
|              | **Objective**                                   |      |           |       |                   |
|              | The overall goal of the course is to introduce students to epidemiological thinking and methods, which are critical pillars for medical and public health research. Students will also become aware on how epidemiological facts are used in prevention, practice and politics. |
|              | **Content**                                     |      |           |       |                   |
|              | The module Epidemiology and prevention follows an overall framework that describes the course of scientific discovery from the detection of a disease to the development of prevention and treatment interventions and their evaluation in clinical trials and real world settings. We will discuss study designs in the context of existing knowledge and the type of evidence needed to advance knowledge. Examples form nutrition, chronic and infectious diseases will be used in order to show the underlying concepts and methods. |
|              | **Lecture notes**                               |      |           |       |                   |
|              | There is no script. Powerpoint presentations and relevant scientific articles will be available on-line for students. A selection of recommended readings will be given at the beginning of the course. |
|              | **Prerequisites / notice**                      |      |           |       |                   |
|              | The course is open to Master and MAS students in food and science and nutrition or related. Basic knowledge of food chemistry and nutrition is expected, as well as an understanding of food processing. |

| 752-2307-00L | Nutritional Aspects of Food Composition and Processing | W+   | 3 credits | 2V    | B. E. Baumer, J. M. Sych |
|              | **Abstract**                                    |      |           |       |                   |
|              | Lecture type course with an interdisciplinary approach for the evaluation of nutritional aspects of changes in food composition due to processing. |
|              | **Objective**                                   |      |           |       |                   |
|              | Students should be able to                      |      |           |       |                   |
|              | - describe and compare the major concepts /criteria used for the evaluation of the nutritional quality of food |
|              | - apply these criteria when assessing the effects of selected processing technologies on nutritional quality. |
|              | - evaluate recent formulation strategies aimed to achieve additional physiological benefits for targeted population groups (i.e. functional foods). |
|              | **Content**                                     |      |           |       |                   |
|              | The course gives inputs on compositional changes in food due to processing (with focus on thermal/chilling, enzymatic, chemical, emerging technologies) or new formulation strategies. Possible evaluation methods for these changes (e.g. nutritional profile) will be addressed. |
|              | **Lecture notes**                               |      |           |       |                   |
|              | There is no script. Powerpoint presentations and relevant scientific articles will be available on-line for students. A selection of recommended readings will be given at the beginning of the course. |

| 752-6301-00L | Selected Topics in Physiology Related to Nutrition | W+   | 3 credits | 2V    | W. Langhans        |
|              | **Abstract**                                    |      |           |       |                   |
|              | **Objective**                                   |      |           |       |                   |
|              | **Content**                                     |      |           |       |                   |
|              | **Lecture notes**                               |      |           |       |                   |
|              | **Prerequisites / notice**                      |      |           |       |                   |
|              | **Literature**                                  |      |           |       |                   |
|              | **Prerequisites / notice**                      |      |           |       |                   |

*Data: 06.03.2019 12:57  Autumn Semester 2016  Page 914 of 1571*
The course will cover elementary aspects of sports nutrition physiology, including carbohydrate, glycogen, fat, protein and energy metabolism. Learning analytical methods to determine macro- and micronutrient content in foods. Critical evaluation of analytical results, critical comparison with values from food composition tables, and interpretation in relation to nutritional value of meals.

Abstract
In this practical course different meals are prepared and then analysed in the laboratory. The analyses comprise energy, macronutrients, specific micronutrients as well as polyphenols and phytic acid. Based on these results, the nutritional value of each meal is critically evaluated and discussed.

Objective
To have the student gain understanding of the links between the diet and the etiology and progression of chronic diseases, including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

Content
To examine and understand the protective effect of foods and food ingredients in the maintenance of health and the prevention of chronic diseases, as well as the progression of complications of the chronic diseases.

Lecture notes
There is no script. Powerpoint presentations will be made available on-line to students.

Literature
To be provided by the individual lecturers, at their discretion.

Prerequisites / notice
No compulsory prerequisites, but prior completion of Human Nutrition I + II (Humanernährung I+II) is strongly advised.

Number of participants limited to 20.

Permission from lecturers required for all students.

Admission in compulsory for the lecture, the laboratory work, and the oral presentation.

Abstract
The course introduces basic concepts of the interaction between nutrition and exercise and cognitive performance.

Objective
Dietary Etiologies of Chronic Disease

Content
The course evaluates food and food ingredients in relation to primary and secondary prevention of chronic diseases including diabetes, gastrointestinal diseases, kidney disease, cardiovascular diseases, arthritis and food allergies.

Lecture notes
Lecture slides and required handouts will be available on the ETH website.

Literature
Information on further reading will be announced during the lecture. There will be some mandatory as well as voluntary readings.

Prerequisites / notice
General knowledge about nutrition, human biology, physiology and biochemistry is a prerequisite for this course. The course builds on basic nutrition and biochemistry knowledge to address exercise and performance related aspects of nutrition.

The course is designed for 3rd year Bachelor students, Master students and postgraduate students (MAS/CAS).

Language: English

It is strongly recommended to attend the lectures. The lecture (including the handouts) is not designed for distance education.

**Electives**

<table>
<thead>
<tr>
<th>Electives Code</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>752-2122-00L</td>
<td>Food and Consumer Behaviour</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>M. Siegrist, C. Hartmann</td>
</tr>
<tr>
<td>752-0801-00L</td>
<td>Food Law and Legislation</td>
<td>W</td>
<td>1</td>
<td>1V</td>
<td>C. Spinner, E. Zbinden Kaessner</td>
</tr>
</tbody>
</table>

**Electives Note**

Number of participants limited to 20.

Permission from lecturers required for all students.

Admission in compulsory for the lecture, the laboratory work, and the oral presentation.

Abstract
This course focuses on food consumer behavior, consumer's decision-making processes and consumer's attitudes towards food products. The course provides an overview about the following topics: Factors influencing consumer's food choice, food and health, attitudes towards new foods and food technologies, labeling and food policy issues.

Objective
Principles of the Swiss food law, introduction to the principles of the EU, international organisations and international contracts.

Content
Overview about the general principles, institutions and execution of the Swiss food law as well as a presentation of the most important regulations of the Swiss food legislation. Knowledge about the principles and the structure of the EU in general and in the area of food safety, overview on the bilateral agreements CH-EU as well as on the most important international organisations (Codex Alimentarius and WTO) and their influence on the Swiss regulations on food safety.

Lecture notes
Documents about Codex Alimentarius, the EU as well as the Swiss food law and some regulations will be handed out.

Literature
Qualifications: General knowledge of the food sciences.

The lecture will be held in German.
A list of references will be given at the beginning of the course for the different topics presented during this course.

The module "public health concepts" offers an introduction to key principles of public health. Students get acquainted with the concepts and methods of epidemiology. Students also learn to use epidemiological data for prevention and health promotion purposes. Public health concepts and intervention strategies are presented, using examples from infectious and chronic diseases.

Concepts of descriptive and analytical epidemiology, study designs, measures of effect, confounding and bias, screening, surveillance, definition of health and health promotion, health dimensions and health determinants, prevention strategies, public health interventions, public health action cycle, epidemiology and prevention of infectious and chronic diseases (HIV, Tuberculosis, Obesity, Public health nutrition).

Copies of slides from lectures will be provided.

Students will be required to complete a group project on food products and ingredients with of from functional bacteria. The project will involve information research and analysis followed by an oral presentation and short written report.

Copies of slides from lectures will be provided.

Good knowledge in biology, especially in microbiology and molecular biology are prerequisites.

Some contents will be provided by registered students who will individually or as a group present an actual publication.

Handouts are provided to students in the classroom.

Language of the course is English.
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>766-6500-00L</td>
<td>MAS Master's Thesis</td>
<td>O</td>
<td>20 credits</td>
<td>43D</td>
<td>Lecturers</td>
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</table>

*Only for MAS in Nutrition and Health.*

**Abstract**
The study program is completed with the Master thesis, an independent scientific work. Topics are selected within the domains of the MAS program. The work is supervised by a lecturer of the MAS program.

**Objective**
The Master thesis must demonstrate the student's ability to independent, structured and scientific working.

### MAS in Nutrition and Health - Key for Type

<table>
<thead>
<tr>
<th>E-</th>
<th>Recommended, not eligible for credits</th>
<th>O</th>
<th>Compulsory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
<td>W</td>
<td>Eligible for credits</td>
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### Key for Hours

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
<th>P</th>
<th>practical/laboratory course</th>
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<tr>
<td>G</td>
<td>lecture with exercise</td>
<td>A</td>
<td>independent project</td>
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<td>exercise</td>
<td>D</td>
<td>diploma thesis</td>
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<td>S</td>
<td>seminar</td>
<td>R</td>
<td>revision course / private study</td>
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<td>K</td>
<td>colloquium</td>
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**ECTS**

European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
MAS in Building Process Leadership

Courses Offered

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>065-0013-00L</td>
<td>MAS-Programme “Building Process Leadership” After successful completion the students achieve 60 Creditpoints.</td>
<td>E-</td>
<td>0</td>
<td>12G</td>
<td>A. Paulus</td>
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</tbody>
</table>

Abstract
The MAS program “Competency in the Building Process” provides graduates of the program with a thorough understanding of the complexities of a project, instilling them with an increased capacity to assess the consequences of their actions and decisions. Upon successful completion of the studies, graduates are qualified to assume the complex duties of an overall project leader in building projects.

Objective
Over the course of the MAS program, students review and closely examine professional experiences gained so far. The goal of the program is to develop an understanding and form opinions on the present-day building process. The course directs students to draw independent conclusions and set forecasts for design professionals in the building process, creating a basis, in conjunction with group discussions, for independent study.

Content
The Master of Advanced Studies in «Competency in the Building Process» imparts an integral view of the building process. Ever-changing technical and social demands, complex permit processes and increasing pressure to speed up production and completion times have led to the fragmentation and specialization of services and work performed by building process participants. Maintaining an overview of the project are the architects and engineers, who draw from a broad knowledge base as they direct, coordinate and moderate all disciplines involved in the design and construction process.

The MAS program «Competency in the Building Process» is a part-time study for professionally experienced architects and engineers. It provides graduates of the program with a thorough understanding of the complexities of a project, instilling them with an increased capacity to assess the consequences of their actions and decisions. Upon successful completion of the studies, graduates are qualified to assume the complex duties of an overall project leader in building projects.

The first three semesters of the study are comprised of: «Construction Participants», «Services» and «Strategies Interests». Explored in the first semester is communication as it relates to qualifications, acquisition and the organisation chart of the participating client, architects and design and construction professionals. The second semester then turns to the building process as a sequence of activities, placing its focus on basic principles and the services, i.e., the commission for design services, the service model, relevant economic considerations, the overall project leader, coordination of specialty engineers and the project leader. Over the course of the third semester, correlations are then drawn between the topic areas as they relate to the strategies and interests of building industry players. An in-depth look is also taken at the competencies of design professionals. The masters thesis in the fourth and final semester completes the course of study.

Over the course of the MAS program, students review and closely examine professional experiences gained so far. The goal of the program is to develop an understanding and form opinions on the present-day building process. The course directs students to draw independent conclusions and set forecasts for design professionals in the building process, creating a basis, in conjunction with group discussions, for independent study.

Literature
Literaturempfehlungen unter www.bauprozess.arch.ethz.ch
Sacha Menz (Hrsg.), Drei Bücher über den Bauprozess, vdf Hochschulverlag an der ETH Zürich, 2009

MAS in Building Process Leadership - Key for Type

<table>
<thead>
<tr>
<th>Letter</th>
<th>Description</th>
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<tr>
<td>O</td>
<td>Compulsory</td>
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<td>W+</td>
<td>Eligible for credits and recommended</td>
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<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
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<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
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<tr>
<td>Dr</td>
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Key for Hours

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<th>Letter</th>
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ECTS
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.

Data: 06.03.2019 12:57  Autumn Semester 2016  Page 918 of 1571
The MAS-program in "History and Theory of Architecture" is a two-year half-time course and contains 60 CP. The course starts in the autumn semester.

Attendance of classes supplemented by independent research; practical training periods and excursions; lectures/seminars on one to two days per week, in total 600 ca. contact hours, in addition private study ca. 600 hours (for each in-class day one day of work preparation), two individually tutored seminar papers on chosen subjects (200 hours) and credited Master's thesis (600 hours).

Courses Offered

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>065-0003-00L</td>
<td>MAS-Programme &quot;History and Theory of Architecture&quot; E-</td>
<td>0 credits</td>
<td>4V</td>
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<td>S. Claus</td>
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</table>

Abstract
The program aims at enhancing students' understanding of subject matter and methods in the field of research into architectural theory and at assisting them in the critical investigation of the history and theory of architecture.

Objective
The historical and social roots of architecture are an essential aspect of the work of architects. To adapt the past to one's own thinking and knowledge, is a challenge. This will be done in a lively and reflecting process. Anyone faced with this challenge in the practical work will find a quality for his buildings that can't be reached by only considering urbanistic, aesthetic and functional factors. Based on selected issues, the participants of the MAS-program «Geschichte und Theorie der Architektur» get acquainted with the methods of historic research. Participants will gain a deeper insight into the subjects and methods of architectural historians and will be supported in scientific discourses.

Content
The MAS-program «Geschichte und Theorie der Architektur» includes a weekly four-hour seminar in which the techniques of scientific work (methodology, creating a bibliography, researching, textual criticism, editing) and practicing essential aspects of art and architecture are discussed on the basis of texts and buildings before they are written down in textual form. Historiographical and methodological aspects as well as training in analyzing and describing architectural phenomena are at the forefront. A major concern is also to improve the ability for writing of texts (encyclopedia articles, short essays, project descriptions, academic papers). Writing is a key instrument not only of disciplinary discourse, but also the public exchange of research. Depending on the topic of the course, there is a single or multi-day trip, during which the participants talk about the buildings that are visited. In addition, each semester, at least two additional courses of the Institute gta have to be visited. The course concludes with a diploma thesis written on a subject that is chosen by the students. The concept and writing of this work are intended to be a process that evolves continuously while studying. The thesis can be extended into a dissertation, provided the student has a graduate degree that is acknowledged by the ETH.

MAS in History and Theory of Architecture (GTA) - Key for Type

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<th>O</th>
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Key for Hours

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</table>

ECTS European Credit Transfer and Accumulation System
Special students and auditors need special permission from the lecturers.
MAS in Housing

The course offered within the MAS-program "Housing" is classified in four relevant modules:

- Module 1: social and historical context of housing, housing design and construction.
- Module 2: Housing design, past and present: Typology; building, biography of usage.
- Module 3: Housing as a contribution of urban design and neighborhood development.
- Module 4: Sustainable development - a new goal in housing design and construction.

Also see separate program.

The attendance of the lecture "Housing" of Prof. Eberle in the autumn semester is compulsory.

Individual chosen 3-4 further lectures or seminars in the Autumn or Spring Semester have to be attended (6 CP).

The modules 3 and 4 are offered in the Spring Semester.

Courses Offered

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>065-0059-00L</td>
<td>MAS-Programme &quot;Housing&quot;</td>
<td>E-</td>
<td>0 credits</td>
<td>8K</td>
<td>M. A. Glaser</td>
</tr>
</tbody>
</table>

Abstract

Relevant issues about the provision, the design and the construction of housing and quality of living are explored based on an interdisciplinary analysis. The MAS thesis is focused on studying, for example, the interdependence of architectural, social, spacial and urban planning considerations, and shifting demand and usage patterns related to housing.

Objective

Against the backdrop of jointly developed theoretical ideas, the students job-related skills and accomplishments in the fields of drawing up concepts, analysis, interpretation, and conversion as well in oral and written conveying are consolidated and expanded in discussions and in joint work. The course of study does not strive to train generalists. Instead it deals with the formulation of questions and procedures elaborated by the students in a generalistic or interdisciplinary way. This is the decisive factor in the qualitative added value of methods which span over several disciplines.

Content

Relevant issues about the provision, the design and the construction of housing and quality of living are explored based on an interdisciplinary analysis. The MAS thesis is focused on studying, for example, the interdependence of architectural, social, spacial and urban planning considerations, and shifting demand and usage patterns related to housing.

MAS in Housing - Key for Type

| O  | Compulsory          | E-   | Recommended, not eligible for credits |
| W+ | Eligible for credits and recommended | Z    | Courses outside the curriculum |
| W  | Eligible for credits | Dr   | Suitable for doctorate |

Key for Hours

| V  | lecture         | P    | practical/laboratory course |
| G  | lecture with exercise | A    | independent project |
| U  | exercise        | D    | diploma thesis |
| S  | seminar         | R    | revision course / private study |
| K  | colloquium      |      |                           |

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
MAS in Landscape Architecture

The Master of Advanced Studies in Landscape Architecture is a one-year full-time postgraduate diploma programme delivered in English. It deals mainly with a scale of landscape that is between that of project design and landscape planning. The focus is on peripheral landscapes and their integration into our cities. In the context of the MAS LA these are discussed and developed in respect to their contemporary functional, ecological and aesthetic potentials. Language: English, contact hours: 600h.

For further information please visit: http://www.girot.arch.ethz.ch/

Courses Offered

The programme is a one-year full-time master programme, structured around two main poles: a landscape design studio (laboratory), and a theory seminar (oratory). Emphasis within the programme on Landscape Video will also help provide a strong analytical basis in both theory and design. The studies are held during the semester from Tuesday to Friday. The programme will conclude with an individual thesis work.

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>065-0063-00L</td>
<td>MAS-Programme &quot;Landscape Architecture&quot;</td>
<td>E-</td>
<td>0</td>
<td>16K</td>
<td>C. Girot</td>
</tr>
</tbody>
</table>

Abstract

Within the "Master of Advanced Studies in Landscape Architecture" (MAS LA), the use of the latest modeling and visualization possibilities as well as the actual 3D depiction of landscape architecture make up the core emphasis. Here, the focus lies on the integration of CAD/CAM technologies as a design-supporting medium.

Objective

Through an intensive investigation of the latest software and techniques, the students are capable of the following:
- Represent complex design tasks
- Develop spatial perception at different levels of scales
- Handle current problems efficiently and experimentally
- Develop new visualization and communication techniques using new media
- Communicate design ideas professionally

Content

The MAS LA is a one-year (academic) postgraduate diploma programme delivered in English. It is divided into themed modules and a concluding synthesis module. The chosen CAD programs (i.e. Rhino) are particularly appropriate for the visualization of large-scale landscape designs and offer the possibility for export to computer-steered milling machines.

In addition, superior competency enhancement in the area of 3D GIS and the use of photography as a design tool and video as tool for illustration and design round off the goal-oriented program.

MAS in Landscape Architecture - Key for Type

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
</tbody>
</table>

Key for Hours

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
MAS in Management, Technology, and Economics

Introductory Event for MAS MTEC students of the degree course 2016-2018:
Friday, 26.08.2016, 18:00-20.00 h, Dozentenfoyer

1. Semester

Core Courses

General Management and Human Resource Management

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-0301-00L</td>
<td>Work Design and Organizational Change</td>
<td>W+</td>
<td>3 credits</td>
<td>2G</td>
<td>G. Grote</td>
</tr>
<tr>
<td>Abstract</td>
<td>Good work design is crucial for individual and company effectiveness and a core element to be considered in organizational change. Meaning of work, organization-technology interaction, and uncertainty management are discussed with respect to work design and sustainable organizational change. As course project, students learn and apply a method for analyzing and designing work in business settings.</td>
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</tbody>
</table>
| Objective       | - Know effects of work design on competence, motivation, and well-being  
                  - Understand links between design of individual jobs and work processes  
                  - Know basic processes involved in systematic organizational change  
                  - Understand the interaction between organization and technology and its impact on organizational change  
                  - Understand relevance of work design for company performance and strategy  
                  - Know and apply methods for analyzing and designing work |
| Content         | - Work design: From Adam Smith to job crafting  
                  - Effects of work design on performance and well-being  
                  - Approaches to analyzing and designing work  
                  - Modes of organizational change and change methods  
                  - Balancing stability and flexibility in organizations as design criterion  
                  - The organization-technology interaction and its impact on work design and organizational change  
                  - Example Flexible working arrangements  
                  - Strategic choices for work design |
| Literature      | A list of required readings will be provided at the beginning of the course. |
| Prerequisites / notice | The course includes the completion of a course project to be conducted in groups of four students. The project entails applying a particular method for analyzing and designing work processes and is carried out by means of interviews and observations in companies chosen by the students. |

| 363-0341-00L    | Introduction to Management                     | W+   | 3 credits | 2G    | S. Brusoni, P. Baschera |
| Abstract        | This course is an introduction to the critical management skills involved in planning, structuring, controlling and leading an organization. We develop a 'systemic' view of organizations. We look at organizations as part of an industry context, which is affected by different elements like strategy, structure, culture, tasks, people and outputs. We consider how managerial decisions are made in any one of these domains affect decisions in each of the others. |
| Objective       | Further information is available on the Tim Group Chair's website:  
                  http://www.timgroup.ethz.ch/en/courses  
                  and on the Moodle of the course:  
                  https://moodle-app2.let.ethz.ch/course/view.php?id=2209  
                  (The Enrollment Key to Moodle will be provided during the course)  
                  The content of the course will rely on the book:  
                  Selected readings from the book and additional learning materials will be available on the course Moodle:  
                  https://moodle-app2.let.ethz.ch/course/view.php?id=2209  
                  All the materials uploaded on Moodle must be considered as required readings. |
| Lecture notes   | The content of the course will rely on the book:  
                  Selected readings from the book and additional learning materials will be available on the course Moodle:  
                  https://moodle-app2.let.ethz.ch/course/view.php?id=2209  
                  All the materials uploaded on Moodle must be considered as required readings. |
| Prerequisites / notice | Further information is available on the Tim Group Chair's website:  
                  http://www.timgroup.ethz.ch/en/courses  
                  and on the Moodle of the course:  
                  https://moodle-app2.let.ethz.ch/course/view.php?id=2209  
                  (The Enrollment Key to Moodle will be provided during the course)  
                  The content of the course will rely on the book:  
                  Selected readings from the book and additional learning materials will be available on the course Moodle:  
                  https://moodle-app2.let.ethz.ch/course/view.php?id=2209  
                  All the materials uploaded on Moodle must be considered as required readings. |
| 363-0303-00L    | Introduction to Marketing                      | W+   | 3 credits | 2G    | F. von Wangenheim |
| Abstract        | The course is designed to convey a profound understanding of marketing's role in modern firms, its interactions and interfaces with other disciplines, its main instruments and recent trends. Particular attention is given to emerging marketing concepts and instruments, and the role of marketing in technology firms. |
| Objective       | After taking the lecture, students should have knowledge on  
                  1) The definition and role of marketing (marketing basics)  
                  2) Creating marketing insights - understanding customer behavior  
                  - Theoretical concepts in customer behavior (customer behavior)  
                  - Analytical means to extend knowledge on customer behavior (marketing research)  
                  - Strategic tools to quantify customer behavior (OLV, CE)  
                  3) Strategic marketing - translating marketing insights into actionable marketing strategies  
                  - Segmentation, Targeting, and Positioning  
                  - Attracting customers (marketing mix, 4Ps)  
                  - Maintaining profitable customer relations (CRM) |
| Content         | The course is designed to convey a profound understanding of marketing's role in modern firms, its interactions and interfaces with other disciplines, its main instruments and recent trends. Particular attention is given to emerging marketing concepts and instruments, and the role of marketing in technology firms. The lecture features a short tutorial that is held at irregularly spaced intervals throughout the semester (approximately every third week). The tutorial is embedded within the lecture and consists of short sessions of about 30 minutes. It serves to illustrate theoretical and methodological concepts from the lecture by walking students through the analysis of real-world data from the telecommunications industry. The case data will be provided so that students practice and apply the concepts of the lecture on their own. The tutorial is held jointly by two Teaching Assistants (Zhiying Cui and Jana Gross) and the professor (Prof. F. v. Wangenheim). |
Information Management, Operations Management

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-0445-00L</td>
<td>Production and Operations Management</td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>T. Netland, P. Schönseben</td>
</tr>
<tr>
<td>Abstract</td>
<td>This core course on Production and Operations Management provides the students insights into the basic theories, principles, concepts, and techniques used to design, analyze, and improve the operational capabilities of an organization.</td>
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<tr>
<td>Objective</td>
<td>Students learn why and how operations can be a competitive weapon; how to design, plan, control, and manage production and service processes; how to improve effectiveness and efficiency in operations; how to take advantage of new technological advancements; and how environmental and social concerns affect decisions in global production networks.</td>
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<tr>
<td>Content</td>
<td>The course covers the most fundamental strategic and tactical concepts in production and operations management. The lectures cover: Introduction to POM; Operations strategy; Capacity management; Production planning and control; Production philosophies; Lean management; Performance measurement; Problem solving; Service operations; New technologies in POM; Servitization; Global production; and Triple-bottom line.</td>
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Mastering Digital Business Models

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<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-0421-00L</td>
<td>Mastering Digital Business Models</td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>E. Fleisch</td>
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<tr>
<td>Number of participants limited to 100</td>
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<tr>
<td>Abstract</td>
<td>This lecture provides a theory- and practice-based understanding of how today’s information technologies enable new digital business models and disrupt existing markets.</td>
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<tr>
<td>Objective</td>
<td>A. After the lecture, the student is able to evaluate digital business models from different angles, including theory-based views:</td>
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<tr>
<td></td>
<td>- Definition and classification of business models</td>
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<td>- Digital business model patterns</td>
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<td></td>
<td>- Theoretical frameworks that explain why and how digital business models function</td>
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<td></td>
<td>- Impact of digital business model patterns on P&amp;L and balance sheet</td>
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<td></td>
<td>Students know how to measure &amp; evaluate investments into the digital space as</td>
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<tr>
<td></td>
<td>- a decision maker in an established company (should I invest in project A or B?)</td>
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<td></td>
<td>- an entrepreneur (should I pursue this venture?)</td>
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<td></td>
<td>- an investor (should I invest in start-up xy?)</td>
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<tr>
<td>Content</td>
<td>Uber, Airbnb, Nest and Jawbone - A wide range of innovative companies exist, which successfully implemented ICT enabled business models and continue to grow at a rapid pace. Examples, illustrating how digitalization, including the “Internet of Things” currently fosters business model innovation across various industries. This course is designed to help students to understand and critically assess such newly emerging (digital) business models.</td>
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<td></td>
<td>For the lecture students will get access to one of the leading online teaching platforms (called edX) also offered by other top universities (incl. MIT, Harvard, Berkeley, etc.). Using the edX platform, will allow students to collaborate in online discussions, solve online exercises and present a short educational video as part of a group project.</td>
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<tr>
<td>Key Topics</td>
<td>Business model innovation; (digital) business model patterns; business value of IT; the concept of integration; transaction cost perspective; network economics perspective; essentials and impact of web 2.0, internet of things, mobile computing, market places, social analytics and big data; IT governance and portfolio management; entrepreneurship in the digital space, etc.</td>
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</table>

Quantitative and Qualitative Methods

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-0541-00L</td>
<td>Systems Dynamics and Complexity</td>
<td>W+</td>
<td>3</td>
<td>3G</td>
<td>F. Schweitzer, G. Casiraghi, V. Nanumyan</td>
</tr>
<tr>
<td></td>
<td>Implementing solutions: project management, critical path method, quality control feedback loop.</td>
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<tr>
<td></td>
<td>Controlling solutions: Vensim software, feedback cycles, control parameters, instabilities, chaos, oscillations and cycles, supply and demand, production functions, investment and consumption</td>
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<tr>
<td>Objective</td>
<td>A successful participant of the course is able to:</td>
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<tr>
<td></td>
<td>- understand why most real problems are not simple, but require solution methods that go beyond algorithmic and mathematical approaches</td>
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<tr>
<td></td>
<td>- apply the problem solving cycle as a systematic approach to identify problems and their solutions</td>
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<tr>
<td></td>
<td>- calculate project schedules according to the critical path method</td>
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<tr>
<td></td>
<td>- setup and run systems dynamics models by means of the Vensim software</td>
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<tr>
<td></td>
<td>- identify feedback cycles and reasons for unintended systems behavior</td>
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<tr>
<td></td>
<td>- analyse the stability of nonlinear dynamical systems and apply this to macroeconomic dynamics</td>
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</tbody>
</table>

Data: 06.03.2019 12:57  Autumn Semester 2016  Page 923 of 1571
Why are problems not simple? Why do some systems behave in an unintended way? How can we model and control their dynamics? The course provides answers to these questions by using a broad range of methods encompassing systems oriented management, classical systems dynamics, nonlinear dynamics and macroeconomic modeling.

The course is structured along three main tasks:

1. Finding solutions
2. Implementing solutions
3. Controlling solutions

PART 1 introduces complexity as a system immanent property that cannot be simplified. It introduces the problem solving cycle, used in systems oriented management, as an approach to structure problems and to find solutions.

PART 2 discusses selected problems of project management when implementing solutions. Methods for identifying the critical path of subtasks in a project and for calculating the allocation of resources are provided. The role of quality control as an additional feedback loop and the consequences of small changes are discussed.

PART 3, by far the largest part of the course, provides more insight into the dynamics of existing systems. Examples come from biology (population dynamics), management (inventory modeling, technology adoption, production systems) and economics (supply and demand, investment and consumption). For systems dynamics models, the software program VENSIM is used to evaluate the dynamics. For economic models analytical approaches, also used in nonlinear dynamics and control theory, are applied. These together provide a systematic understanding of the role of feedback loops and instabilities in the dynamics of systems. Emphasis is on oscillating phenomena, such as business cycles and other life cycles.

Lecture notes

Weekly self-study tasks are used to apply the concepts introduced in the lectures and to come to grips with the software program VENSIM.

The lecture slides are provided as handouts - including notes and literature sources - to registered students only. All material is to be found on the Moodle platform. More details during the first lecture.

Prerequisites / notice

Self-study tasks (discussion exercises, Vensim exercises), are provided as home work. Weekly exercise sessions (45 min) are used to discuss selected solutions. Regular participation in the exercises is an efficient way to understand the concepts relevant for the final exam.

Economics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-0565-00L</td>
<td>Principles of Macroeconomics</td>
<td>W+</td>
<td>3</td>
<td>2V</td>
<td>J.E. Sturm</td>
</tr>
</tbody>
</table>

Abstract

This course examines the behaviour of macroeconomic variables, such as gross domestic product, unemployment and inflation rates. It tries to answer questions like: How can we explain fluctuations of national economic activity? What can economic policy do against unemployment and inflation? What significance do international economic relations have for Switzerland?

Objective

This lecture will introduce the fundamentals of macroeconomic theory and explain their relevance to everyday economic problems.

Content

This course helps you understand the world in which you live. There are many questions about the macroeconomy that might spark your curiosity. Why are living standards so meagre in many African countries? Why do some countries have high rates of inflation while others have stable prices? Why have some European countries adopted a common currency? These are just a few of the questions that this course will help you answer. Furthermore, this course will give you a better understanding of the potential and limits of economic policy. As a voter, you help choose the policies that guide the allocation of society’s resources. When deciding which policies to support, you may find yourself asking various questions about economics. What are the burdens associated with alternative forms of taxation? What are the effects of free trade with other countries? What is the best way to protect the environment? How does the government budget deficit affect the economy? These and similar questions are always on the minds of policy makers.

Lecture notes

The course webpage (to be found at https://moodle-app2.let.ethz.ch/course/view.php?id=2467) contains announcements, course information and lecture slides.

Literature


We advise you to also buy access to Aplia. This internet platform will support you in learning for this course. To save money, you should buy the book together with Aplia. This is sold as a bundle (ISBN: 9781473715998).

Besides this textbook, the slides and lecture notes will cover the content of the lecture and the exam questions.

<table>
<thead>
<tr>
<th>Number</th>
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<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-0503-00L</td>
<td>Principles of Microeconomics</td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>M. Filippi</td>
</tr>
</tbody>
</table>

Abstract

The course introduces basic principles, problems and approaches of microeconomics.

The learning objectives of the course are:

1. Students must be able to discuss basic principles, problems and approaches in microeconomics.
2. Students can analyse and explain simple economic principles in a market using supply and demand graphs.
3. Students can contrast different market structures and describe firm and consumer behaviour.
4. Students can identify market failures such as externalities related to market activities and illustrate how these affect the economy as a whole.
5. Students can apply simple mathematical treatment of some basic concepts and can solve utility maximization and cost minimization problems.

Lecture notes

Lecture notes, exercises and reference material can be downloaded from Moodle.

Literature

N. Gregory Mankiw and Mark P. Taylor (2014), "Economics", 3rd edition, South-Western Cengage Learning. The book can also be used for the course 'Principles of Macroeconomics' (Sturm)

For students taking only the course ‘Principles of Microeconomics’ there is a shorter version of the same book:


Complementary:

Financial Management

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-0711-00L</td>
<td>Accounting for Managers</td>
<td>W+</td>
<td>3</td>
<td>2V</td>
<td>M. Passardi</td>
</tr>
</tbody>
</table>
Abstract
Overview of financial and managerial accounting
Accounting for current and fixed assets
Liabilities and owners equity
Recording change in balance sheet
Measuring financial performance
Managing financial reporting
Full and variable costing system
Using accounting information for decision making purposes

Objective
Understand the different procedures involved in the accounting system
Record change in financial position
Measure business income
Prepare final accounts
Understand the principles of cost accounting
Calculate the different product costs
Make decisions about the acceptance or rejection of a particular product

Content
Financial Accounting: Balance sheet, income statement, double-entry accounting, journal and ledger, accounting for merchandising activities, value-added tax, adjustments before final accounts, provisions, depreciation, valuation,
Managerial Accounting: Full costing, variable costing, cost-volume profit, break-even analysis, activity-based costing

Prerequisites / notice
This course is a prerequisite for the course Financial Management.

3. Semester
Core Courses
Strategy, Technology and Innovation Management

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-0392-00L</td>
<td>Strategic Management</td>
<td>W+</td>
<td>3 credits</td>
<td>2G</td>
<td>G. von Krogh</td>
</tr>
</tbody>
</table>

Registration through myStudies (first come, first served). If you are unable to sign up through myStudies, please contact the course assistant:
http://www.smi.ethz.ch/education/strategic-management.html

Abstract
This course conveys concepts and methods in strategic management, with a focus on competitive strategy. Competitive strategy aims at improving and establishing position of firms within an industry.

Objective
The lecture "Strategic Management" is designed to teach relevant competences in strategic planning and -implementation, for both professional work-life and further scientific development. The course provides an overview of the basics of strategy and the most prevalent concepts and methods in strategic management. The course is given as a combination of lectures about concepts/methods, and case studies where the students solve strategic issues of the case companies. In two sessions, the students will also be addressing real-time strategic issues of firms that are represented by executives.

Content
Contents:
- a. Introduction to strategy
- b. Industry dynamics I: Industry analysis
- c. Industry dynamics II: Analysis of technology and innovation
- d. The resource-based theory of the firm
- e. The knowledge-based theory of the firm

Prerequisites / notice
Session #0: (September 19) Introductory Guest Lecture & Organizational Issues
Session #1: (September 26) Introduction & How to Solve a Case
Session #2: (October 3) Industry Dynamics I
Session #3: (October 24) Guest Lecture
Session #4: (October 31) Industry Dynamics II
Session #5: (November 7) Resource-Based Theory
Session #6: (November 14) Knowledge-Based Theory
Session #7: (November 28) Guest Lecture

For participants of the MAS-MTEC program we offer a complementary course Practicing Strategy in which students will apply the concepts of Strategic Management to their real-life contexts and organizations. Please register simultaneously for both courses if you want to take part in this course.

For more information please see:
http://www.smi.ethz.ch/education/practicing-strategy.html

365-1059-00L | Practicing Strategy       | W+   | 1 credit | 1S   | G. von Krogh, S. Herting

Exclusively for MAS MTEC students (third semester).
A prior/parallel enrolment for the lecture Strategic Management (363-0392-00) is mandatory.
Limited number of participants: a minimum of 10 persons and a maximum of 25 persons.
Please register through myStudies to enrol for the course no later than 27.10.2016.

Abstract
This lecture is a special course for MAS students which supplements the Strategic Management course. Participants work on real-life strategy problems in a two-day workshop and apply concepts & methods from the Strategic Management course to develop suitable solutions.

Objective
The goal of the course is that participants are able to transfer and use the concepts and methods from the Strategic Management lecture to develop solutions for strategic issues in real-life business contexts.

Prerequisites / notice
Successful registration and prior/parallel enrollment in "363-0392-00 G Strategic Management" required (see course catalogue page for details).
The following textbook is mandatory:

**Overview of the key concepts of corporate sustainability and topics related to Water, Energy, Mobility, and Food**

**Understand the limits and the potential of corporate sustainability for sustainable development**

The lecture treats the main challenges of business transformation and the alignment of corporate development and IT activities. It presents

**Corporate Sustainability**

Critical thinking skills for corporate sustainability.

Content

Overview of the key concepts of corporate sustainability and topics related to Water, Energy, Mobility, and Food.

Business implications of sustainable development, in particular for the assessment of sustainability performance, strategic change towards sustainability, technological innovations and sustainability, and finance and corporate sustainability.

In-depth case studies of corporate sustainability challenges in the track phase: How to deal with environmental pressure groups? How to use the strengths of business to solve pressing sustainability problems? How to catalyze technological innovations for sustainability? How to invest money in a sustainable way?

Lecture notes

Presentation slides will be made available on moodle prior to lectures.

Literature

Recommendations will be distributed during the lecture.

### Information Management, Operations Management

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-0425-00L</td>
<td>Transformation: Corporate Development and IT</td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>T. Gutzwiller</td>
</tr>
</tbody>
</table>

**Abstract**

The lecture treats the main challenges of business transformation and the alignment of corporate development and IT activities. It presents a holistic approach to business transformation projects by introducing an integrated model dealing with three main design areas “strategy”, “processes” and “information systems” and applying this model to various case studies.

**Objective**

The goal of the lecture is to understand the main challenges of corporate transformation and to demonstrate the application of a holistic project procedure model for corporate transformation projects with special emphasis on the alignment of business and IT.

The student should understand and be able to explain

- the main reasons for corporate transformation,
- the relevant management processes to manage corporate transformation,
- the interdependencies between strategy, processes and information systems, especially how this three levels interrelate,
- the critical success factors for the successful accomplishment of large scale corporate transformation projects,
- the main instruments of project, quality and change management and
- the different types of resulting IT projects.

**Content**

The globalization of the world leads to an increasingly faster pace in business transformation. Enterprises have to adapt faster and even faster to the environmental changes in a global economy to remain competitive and to make sure they stay in business. In today's information age this does not only mean to adapt business strategy and business processes but also to adapt information systems to the new circumstances. The fast adaptation through large scale corporate transformation projects that change strategy, business processes and information systems is critical to ensure competitiveness for tomorrow. The introduction of new business processes and information systems typically takes years in very complex large scale projects. Many projects fail because of insufficient alignment between decision makers in business and IT. Unclear understanding of the overall project scope, undefined roles and responsibilities, unclear project processes, quality problems and resistance to change are some typical problems found in such projects. The lecture is subdivided into following modules:

- Corporate development introduction and motivation,
- Parallelization of corporate development and complexity reduction,
- Planning process and project portfolio management in corporate development,
- Management of large scale projects, integration of strategy, processes and information systems,
- Quality management in large scale projects,
- Project management in large scale projects,
- Change management within projects. The lecture is accompanied by four case studies that are used to exemplify the contents of the lecture by applying the concepts to real situations in corporate life.

<table>
<thead>
<tr>
<th>Number</th>
<th>Strategic Supply Chain Management</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-0453-00L</td>
<td></td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>S. Wagner</td>
</tr>
</tbody>
</table>

**Abstract**

The course offers an introduction to the theory and practice of supply chain management. Students will learn how to develop supply chain strategies and supply chain networks based on firms' competitive strategies and marketing priorities.

**Objective**

The task of designing and managing supply chains requires that managers apply strategic, decision making and leadership skills in a supply chain context. The goal of this course is to develop and practice these skills.

**Content**

Effective supply chains ought to be aligned with and support the achievement of the firms' corporate, business and product strategies, taking into account future opportunities and risks. This course will familiarize students with modern supply chain management theory and practice to develop and manage supply chains. The topics covered range from fundamental logistics and supply chain concepts (e.g. push vs. pull, postponement) to the development of supply chain strategies, relationships and networks.

**Lecture notes**

Course material will be available for download from the homepage of the Chair of Logistics Management:

http://www.scm.ethz.ch/teaching/courses.html

Login will be provided in the first lecture or can be obtained from the Teaching Assistant Dagmar Reinerth (dreinerth@ethz.ch).

**Literature**

The following textbook is mandatory:


The following textbook is supplementary:


**Prerequisites / notice**

The final course grade will be a weighted average of the following:

- Exam (semester end): 70%
- Case studies (during the semester): 30%

Students (at least in groups of two) must bring a laptop with MS Excel and the Excel Solver installed to class.

### Quantitative and Qualitative Methods
<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-0305-00L</td>
<td>Empirical Methods in Management</td>
<td>W+</td>
<td>3 credits</td>
<td>2G</td>
<td>A. Scherer</td>
</tr>
<tr>
<td>Abstract</td>
<td>Evidence-based management requires valid empirical research. In this course, students will learn the basics of research design, fundamentals of data collection and statistical methods to analyze the data acquired in social science research. Students are expected to apply their knowledge in class discussions and out-of-class assignments.</td>
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</tbody>
</table>
| Objective    | - Ability to formulate research questions and designing an appropriate study  
- Ability to collect and analyze data using a variety of methods  
- Ability to critically assess the quality of empirical research in management  
- Applied knowledge of empirical methods through out-of-class assignments |
| Content      | 1) Introduction to empirical management research  
2) Research designs: exploratory, descriptive, experimental  
3) Measurement and scaling  
4) Data collection and sampling  
5) Data analysis methods  
6) Reporting and presenting empirical research |
| Prerequisites / notice | Assignments and projects: This course includes out-of-class assignments and projects to give students some hands-on experience in conducting empirical research in management. Projects will focus on one particular aspect of empirical research, like the formulation of a research question or the design of a study. Students will have at least one week to work on each assignment. Students are expected to work on these assignments individually. Duplicate answers will receive no credit and will be subject to a disciplinary review. Assignments will be graded and need to be turned-in on time. |

Class participation: Class participation is encouraged and can greatly improve students’ learning in this class. In this spirit, students are expected to attend class regularly and come to class prepared.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>363-1004-00L</td>
<td>Operations Research</td>
<td>W+</td>
<td>3 credits</td>
<td>2G</td>
<td>M. Laumanns</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course provides an introduction to operations research methods in the fields of management science and economics. Requisite mathematical concepts are introduced with a practical, problem-solving perspective.</td>
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</tbody>
</table>
| Objective    | - Introduction to building and using quantitative models in a business / industrial environment  
- Introduction to basic optimization techniques (Linear Programming and extensions, network flows, integer programming, dynamic and stochastic optimization)  
- Understanding the integration of quantitative models into the managerial decision process |
| Content      | The following topics are covered: Systems and models, linear models and the importance of linear programming, duality theory and shadow prices, integer programming, optimization under uncertainty and applications in inventory management. |
| Lecture notes | A printed script will be made available. |
| Literature   | Any standard textbook in Operations Research is a useful complement to the course. |

Economics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-0537-00L</td>
<td>Resource and Environmental Economics</td>
<td>W+</td>
<td>3 credits</td>
<td>2G</td>
<td>L. Bretschger, A. Braumann</td>
</tr>
<tr>
<td>Abstract</td>
<td>Relationship between economy and environment, market failure, external effects and public goods, contingent valuation, internalisation of externalities; economics of non-renewable resources, economics of renewable resources, cost-benefit analysis, sustainability, and international aspects of resource and environmental economics.</td>
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<tr>
<td>Objective</td>
<td>Understanding of the basic issues and methods in resource and environmental economics; ability to solve typical problems in the field using the appropriate tools, which are concise verbal explanations, diagrams or mathematical expressions.</td>
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</tbody>
</table>
| Topics       | Introduction to resource and environmental economics  
Importance of resource and environmental economics  
Main issues of resource and environmental economics  
Normative basis  
Utilitarianism  
Fairness according to Rawls  
Economic growth and environment  
Externalities in the environmental sphere  
Goverment internalisation of externalities  
Private internalisation of externalities: the Coase theorem  
Free rider problem and public goods  
Types of public policy  
Efficient level of pollution  
Tax vs. permits  
Command and Control Instruments  
Empirical data on non-renewable natural resources  
Optimal price development: the Hotelling-rule  
Effects of exploration and Backstop-technology  
Effects of different types of markets.  
Biological growth function  
Optimal depletion of renewable resources  
Social inefficiency as result of over-use of open-access resources  
Cost-benefit analysis and the environment  
Measuring environmental benefit  
Measuring costs  
Concept of sustainability  
Technological feasibility  
Conflicts sustainability / optimality  
Indicators of sustainability  
Problem of climate change  
Cost and benefit of climate change  
Climate change as international ecological externality  
International climate policy: Kyoto protocol  
Implementation of the Kyoto protocol in Switzerland |
Content
Economy and natural environment, welfare concepts and market failure, external effects and public goods, measuring externalities and contingent valuation, internalising external effects and environmental policy, economics of non-renewable resources, renewable resources, cost-benefit-analysis, sustainability issues, international aspects of resource and environmental problems, selected examples and case studies.

Lecture notes
Learning material and script can be found here:
https://moodle-app2.let.ethz.ch/course/view.php?id=328

Literature

Financial Management
Number Title Type ECTS Hours Lecturers
363-0561-00L Financial Market Risks W+ 3 credits 2G D. Sornette

Abstract
I aim to introduce students to the concepts and tools of modern finance and to make them understand the limits of these tools, and the many problems met by the theory in practice. I will put this course in the context of the on-going financial crises in the US, Europe, Japan and China, which provide fantastic opportunities to make the students question the status quo and develop novel solutions.

Objective
The course explains the key concepts and mechanisms of financial economics, their depth and then stresses how and why the theories and models fail and how this is impacting investment strategies and even a global view of citizenship, given the present developing crises in the US since 2007 and in Europe since 2010.

- Development of the concepts and tools to understand these risks and master them.
- Working knowledge of the main concepts and tools in finance (Portfolio theory, asset pricing, options, real options, bonds, interest rates, inflation, exchange rates)
- Strong emphasis on challenging assumptions and developing a systemic understanding of financial markets and their many dimensional risks

Content
1. The Financial Crises: what is really happening? Historical perspective and what can be expected in the next decade(s). Bubbles and crashes. The illusion of the perpetual money machine.
2. Risks in financial markets
   - What is risk?
   - Measuring risks of financial assets
   - Introduction to three different concepts of probability
   - History of financial markets, diversification, market risks
3. Introduction to financial risks and its management.
   - Relationship between risk and return
   - Portfolio theory: the concept of diversification and optimal allocation
   - How to price assets: the Capital Asset Pricing Model
   - How to price assets: the Arbitrage Pricing Theory, the factor models and beyond
4. Financial markets: role and efficiency
   - What is an efficient market?
   - Financial markets as valuation engines: exogeneity versus endogeneity (reflexivity)
   - Deviations from efficiency, puzzles and anomalies in the financial markets
   - Financial bubbles, crashes, systemic instabilities
5. An introduction to Options and derivatives
   - Calls, Puts and Shares and other derivatives
   - Financial alchemy with options (options are building blocks of any possible cash flow)
   - Determination of option value; concept of risk hedging
6. Valuation and using options
   - A first simple option valuation model
   - The Binomial method for valuing options
   - The Black-scholes model and formula
   - Practical examples and implementation
   - Realized prices deviate from these theories: volatility smile and real option trading
   - How to imperfectly hedge with real markets?
7. Real options
   - The value of follow-on investment opportunities
   - The timing option
   - The abandonment option
   - Flexible production
   - Conceptual aspects and extensions
8. Government bonds and their valuation
   - Relationship between bonds and interest rates
   - Real and nominal rates of interest
   - Term structure and Yields to maturity
   - Explaining the term structure
   - Different models of the term structure
9. Managing international risks
   - The foreign exchange market
   - Relationships between exchange rates and interest rates, inflation, and other economic variables
   - Hedging currency risks
   - Currency speculation
   - Exchange risk and international investment decisions

Lecture notes
Lecture slides will be available on the site of the lecture
Corporate Finance, Eighth edition

+ additional paper reading provided during the lectures

363-0723-00L
Corporate Finance

Objective
Introduction in theory and practical application of Corporate Finance, with a particular focus on financing of operations and transactions, analysed from multiple aspects, including legal and tax.

Content
Corporate Finance, investment management, business valuation, value based management & compensation, financial reporting today & in future, financial reporting value chain, reporting on non-financial measures, such as corporate sustainability reporting, mergers & acquisitions, legal aspects, taxes, corporate governance - risk management - internal controls & mgmt. information systems, turnaround.

Lecture notes

Literature

363-0311-00L
Psychological Aspects of Risk Management and Technology

Objective
Using uncertainty management by organizations and individuals as conceptual framework, risk management and risk implications of new technologies are treated. Three components of risk management (risk identification/evaluation, risk mitigation, risk communication) and underlying psychological and organizational processes are discussed, using company case studies to promote in-depth understanding.

Content
- understand basic components of risk management in organizations
- know and apply methods for risk identification/evaluation, risk mitigation, risk communication
- know psychological foundations of risk perception, decision-making under risk, and risk communication
- know organizational principles for managing uncertainty
- apply theoretical foundations to applied issues such as safety management, regulatory activities, and technology design and implementation in different domains (e.g. transport systems, IT, insurance)

Lecture notes
There is no script, but slides will be made available before the lectures.

Literature
There are texts for each of the course topics made available before the lectures.

Prerequisites / notice
The course is restricted to 40 participants who will work closely with the lecturers on case studies prepared by the lecturers on topics relevant in their own companies (Swiss Re, Skyguide, Swiscom).

365-0351-00L
Presentation Skills

Abstract
Limited number of participants: a minimum of 10 persons and a maximum of 12 persons per course.

Pre-registration required: Monday 12.09.2016 (10:00) to Thursday 22.09.2016 (10:00) via Moodle https://moodle-app2.let.ethz.ch/course/view.php?id=2360. Once your pre-registration has been confirmed, a registration in myStudies is possible as of 26 September 2016.

Objective
This course will cover how to prepare and deliver your future presentations. You will be more confident presenting yourself. Thanks to the feedback from your colleagues, the trainer and the video you will be able to identify your strengths and weaknesses.

Content
This course will cover how to prepare and deliver your future presentations. The following contents will be covered: the most important elements of a powerful presentation, structure of prepared presentations, do's and don't of a professional presentation, dealing with nervousness, how to work with Power Point, body language (gestures, facial expressions, voice, eye contact), handling of Q&A, speaking elements of a powerful presentation, structure of prepared presentations, do's and don'ts of a professional presentation, dealing with nervousness, how to work with Power Point, body language (gestures, facial expressions, voice, eye contact), handling of Q&A, speaking

Literature
Skipwith, Thomas; Reto B. Rüegger: To catch fish use the right bait, DESCUBRIS Press, Zurich, May 2014.

363-0393-00L
Corporate Strategy

Abstract
Due to didactic considerations, the number of participants for this course is limited to 50. Please register through myStudies to enroll for the course. Slots are assigned on a first-come first-serve basis (in the order of the registration date on myStudies). We will confirm your registration by e-mail. If you have any
This course focuses on the challenges in managing multi-business corporations, and covers topics related to the vertical and horizontal scope of business activities. 70% of the final grade consists of a final closed-book written exam and 30% of the final grade will consist of individual/group assignments.

**Objective**

Course Topic and Learning Objectives:
Large- and medium-sized corporations play a central role in the economic activity of most developed and developing countries. Many of these organizations perform multiple business activities in multiple markets. In the face of increasing international competition, globalization, technological development, deregulation, and the emergence of new markets and industries, operating such a portfolio of business activities poses important managerial challenges forcing corporations to continuously re-consider their vertical and horizontal scope and boundaries.

The course Corporate Strategy draws from a wide range of theories and methods to develop an understanding of the conceptual frameworks, debates, and developments concerning decisions associated with the management of multi-business corporations. We will cover the key questions driving a firm's corporate strategy, including:

- In what markets to compete with which businesses?
- Which activities should be performed by the firm and which should be outsourced (i.e. "make" or "buy" decisions)?
- What are the most appropriate approaches to growth and divestiture?
- How do institutional forces impact corporate strategy?

Specifically, we will examine how organizations manage their portfolio of business activities and markets to achieve competitive advantage through vertical integration, cooperative strategies such as strategic alliances and joint ventures, corporate diversification, mergers and acquisitions, divestitures, and globalization/international strategies, and strategic renewal.

**Format:**
The course is a combination of lectures about concepts/methods, guest lectures, case studies/assignments, and group debates/assignments.

**Content**
The course homepage can be found at: http://www.smi.ethz.ch/education/courses/corporatestrategy

**Prerequisites / notice**
Having participated in the course Strategic Management by Prof. Georg von Krogh/Dr. Zeynep Erden is an advantage but not a requirement.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>W</th>
<th>G</th>
<th>C. G. C. Marxt</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-0861-00L</td>
<td>Alliance Advantage - Exploring the Value Creation Potential of Collaborations</td>
<td>3 credits</td>
<td>2G</td>
<td>C. G. C. Marxt</td>
</tr>
</tbody>
</table>

**Abstract**
The development of new business models coping with the constantly augmenting complexity of technologies and systems as well as the ever increasing global competition force organizations to focus on close collaboration with key partners. These alliances are key value creation opportunities and constitute the core part of this lecture.

**Objective**
Learning outcomes professional competence
- The students learn and understand the management basics of inter-firm cooperation and organizational networks (business models, incl. risk, communication, etc.)
- Realize the value creation potentials of alliances (added value)
- Understand underlying theoretical models (Transaction cost theory, principal agent, game theory)
- Identify and understand specific forms of collaboration (Strat. All., JV, Networks, M&A, etc.)
- Apply tools hands on in real companies (in coll. with companies)

Learning outcomes methodological competence
- Writing academic papers
- Developing structured documentation of interviews
- Transferring theory directly into application
- Contributing to the learning journey

Learning outcomes social competence
- Work together with industrial partners
- Improving communication skills as basics for collaboration
- Developing and applying team work skills
- Coping with conflicts resolution in teams

**Content**
The constantly augmenting complexity of technologies and systems, the increased pressure caused by competition, the need for shortening time-to-market and the thereby implied growing risks force organizations to increasingly focus on core competencies. Collaboration with external partners is a key value creation opportunity for successful ventures. This type of cooperation also has implications on daily management activities. This lecture will provide a better understanding of special requirements needed for management of cooperation issues. Content:

- Introduction to theory and management of inter-firm collaboration and networks.
- Description of the formation, management and evolution of collaborations and networks.
- Collaborations in marketing, development, manufacturing (e.g. NUMMI).
- Special forms of collaborations: mergers & acquisition (e.g. pre- and post-merger activities, joint venture, strategic alliances (e.g. Doz & Hamel, networks, virtual communities)

**Learning journey:**
In an introductory lecture we will give an overview of the theoretical framework and explain the concept of the lecture (Sept. 18, 2014). In weeks 2-5 you will work on a first assignment on six different aspects of the underlying framework: strategy and activities, structure and process, culture and people orientation, interaction and roles, risk and trust, knowledge and learning. This first assignment will give you the basics to participate in the second part (Oct. 30-31, 2014) of this seminar. There you will present the results of the first assignment and get additional theoretical input to perform the 2nd assignment. The second assignment will be to analyze real alliance projects in the partner companies. The final lesson will be used as a best practice exchange together with our industrial partners (Dec. 18, 2014).

**Lecture notes**
- Lecture script
- Current course material
- Harvard Case Studies
- Reader with current papers

**Literature**
A list with recommended publications will be distributed in the lecture.

**Additional Books:**
- HBR Collaborating Effectively ISBN 978-1-4221-6264 4
- HBR on Mergers and Acquisitions: ISBN 1-57851-555-6
Prerequisites / notice

The number of students participating in the lecture is limited to 30.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>W</th>
<th>3 credits</th>
<th>2G</th>
<th>S. Häfliger, S. Spaeth</th>
</tr>
</thead>
<tbody>
<tr>
<td>351-0555-00L</td>
<td>Open- and User Innovation</td>
<td></td>
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</tbody>
</table>

Abstract

The course introduces the students to the long-standing tradition of actively involving users of technology and other knowledge-intensive products in the development and production process, and through own cases they develop an entrepreneurial understanding of product development under distributed, user-centered, or open innovation strategies.

Objective

The course includes both lectures and exercises alternately. The goal is to understand the opportunity of user innovation for management and develop strategies to harness the value of user-developed ideas and contributions for firms and other organizations.

The students actively participate in discussions during the lectures and contribute presentations of case studies during the exercises. The combination should allow to compare theory with practical cases from various industries.

The course presents and builds upon recent research and challenges the students to devise innovation strategies that take into account the availability of user expertise, free and public knowledge, and the interaction with communities that span beyond one organization.

Grading is based on the final exam, the class presentations (including the slides) as well as class participation.

Content

This course on user innovation extends courses on knowledge management and innovation as well as marketing. The students are introduced to the long-standing tradition of actively involving users of technology and other knowledge-intensive products in the development and production process, and through own cases they develop an entrepreneurial understanding of product development under distributed, user-centered, or open innovation strategies. Theoretical underpinnings taught in the course include models of innovation, the structuration of technology, and an introduction to entrepreneurship.

Grading is based on the final exam, the class presentations (including the slides) as well as class participation.

Abstract

This course is a preparation course for theses in industry: Criteria of scientific work, writing the final report, using research resources at ETH. Using case studies, content of other lectures is discussed with regard to the special challenges during theses: Systems Engineering, Social science methods for empirical data collection and analysis, project management, presentation technique.

Objective

The objective of this course is to provide students with a practical toolset of techniques, procedures and hints for a successful scientific thesis (Bachelor/Master/MAS Thesis) in industry. The course is held by assistants of professorships at D-MTEC.

Content

Methodology: Systems Engineering, problem solving process, situation analysis, SWOT, objectives, solution finding, evaluation.

Social science methods for empirical data collection and analysis: how to develop a good research question: methodological awareness and practical considerations, criteria in social research: reliability and validity.

Research Designs and Strategies: qualitative and quantitative research.

Methods for data collection and analysis: observation, interview, questionnaire, document and literature analysis, and combinations.

Project Management: tasks plan, milestones, roles, communication

Scientific work: research, resources, citation, argumentation

Presentation: techniques, procedure, handouts, significance

Final report: organization, layout, figures, formal requirements, appendix

Lecture notes

Handouts of the presentations / course materials have to be downloaded and printed out before the course (see link above).

Literature

Further reading:


Technology ventures are significantly changing the global economic picture. Technological skills increasingly need to be complemented by
Z. Erden Özkol
Lecture Cycle Purchasing
U. Claesson
This lecture is about practical and theoretical issues in the field of purchasing & supply management. Purchasing managers from various
W. Wagner
This course teaches students about the basic principles of scientific work in the field of social sciences. The goal is to motivate students to
Development Research
W. Wagner
This course provides theory-grounded knowledge and practice-driven skills for founding, financing, and growing new technology ventures.
1V. Clarysse
The course is intended for students who want to carry out a thesis in industry, in general these are:
Prerequisites / notice
(1) MSc-students MTEC or MAVT with master thesis (MA) during the next term and supervised by MTEC, (corresponds to 3rd or 4th semester Master) and
(2) BSc-students MAVT with bachelor thesis (BA) in industry and supervised by MTEC, as well as with full MTEC focus (corresponds to 5th or 6th semester Bachelor) or
(3) MAS MTEC students in 3rd semester for MA during the next term.
Important note: Credits will only be awarded to students according to (1), (2) or (3). Prerequisites for obtaining the credit or "Testat": being present during the whole course (presence list) and prior study of documents provided on the Internet and of the book Züst, R.: Einstieg ins Systems Engineering. 3. Aufl., Verlag Industrielle Organisation, Zürich 2004.
Other students on request (limited places).
Important: the chair coaching your BA/MA defines whether the course is mandatory. Please contact your chair!
Electronic enrollment until 08.09.2015 required. Without electronic enrollment participation in the course can't be confirmed. The course is held "en bloc" at the beginning of the semester.
Date: Friday 11.09.2015 (13:15-17:00), location: HG E33.1 (ETH main building) and Saturday, 12.09.2015 (09:15-17:00), location: HG E33.1 (ETH main building). Participation at both days required (Friday afternoon and Saturday whole day).
The course is held in English; handouts are available in English.
Besonderes (deutsche Version):
Der Kurs richtet sich an Studierende, welche an einer Professur des D-MTEC eine Arbeit in der Wirtschaft schreiben werden. Im Allgemeinen sind dies:
(1) MSc-Studierende MTEC oder MAVT mit Masterarbeit (MA) im kommenden Semester, die vom MTEC betreut wird, (entspricht 3. oder 4. Semester Master) sowie
(2) BSc-Studierende MAVT mit Bachelorarbeit (BA) in der Wirtschaft, die vom MTEC betreut wird, sowie mit vollem MTEC Fokus (entspricht 5. oder 6. Semester Bachelor) oder
(3) MAS MTEC -Studierende im 3. Semester für MA im kommenden Semester.
Andere Studierende auf Anfrage (beschränkte Anzahl Plätze).
Wichtig: die Professor, welche die jeweilige BA/MA betreut, legt fest, ob der Besuch der Veranstaltung obligatorisch ist. Bitte informieren Sie sich dort!
Elektronische Einschreibung bis zum 08.09.2015 notwendig. Ohne elektronische Einschreibung kann Ihre Teilnahme am Kurs nicht bestätigt werden.
Der Kurs wird als Blockkurs zu Beginn des Semesters gehalten.
Termin: Freitag, den 11.09.2015 (13:15-17:00) im HG E33.1 und Samstag, 12.09.2015 (09:15- ca. 17:00) im HG E33.1 (ETH Hauptgebäude). Anwesenheitspflicht an beiden Tagen (Freitagnachmittag und Samstag ganztags).
Die Veranstaltung wird auf Englisch gehalten; Handouts sind in Englisch verfügbar.
363-0790-00L Technology Entrepreneurship W 2 credits 2V U. Claesson, B. Clarysse
Abstract
Technology ventures are significantly changing the global economic picture. Technological skills increasingly need to be complemented by entrepreneurial understanding.
This course offers the fundamentals in theory and practice of entrepreneurship in new technology ventures. Main topics covered are success factors in the creation of new firms, including founding, financing and growing a venture. A critical understanding of dos and don'ts is provided through highlighting and discussing real life examples and cases.
Objective
This course provides theory-grounded knowledge and practice-driven skills for founding, financing, and growing new technology ventures.
Content
See course website: http://www.entrepreneurship.ethz.ch/sresources/courses/tech-entrepreneurship.html
Lecture notes
Lecture slides and case material
363-0345-01L Lecture Cycle Purchasing W 2 credits 1V S. Wagner
Abstract
This course is about practical and theoretical issues in the field of purchasing & supply management. Purchasing managers from various industries examine the importance of purchasing for corporate success. Possible topics of the presentations could be: Corporate and purchasing strategy, supplier networks, innovations in purchasing, supply chain redesign, sustainability in purchasing.
The goal of this lecture is to get an overview about the challenges of purchasing managers, get to know the procurement department as an important corporate function and to understand the importance of purchasing & supply management with regard to corporate success.
Objective
The speakers are executives from purchasing and supply chain management departments as well as from general management. They will discuss recent issues in purchasing and supply management such as: Corporate and purchasing strategy, supplier networks, procurement organization, innovations in purchasing, supply chain redesign, sustainability in purchasing & supply management.
Content
The course is mandatory for MSc students and recommended for MAS students who write their Master Thesis at the Chair of Strategic Management and Innovation.
Participation to both sessions are mandatory to receive the credit, there will be no exceptions.
If a student can't take part in one of the sessions, the course has to be taken the following semester.
Abstract
This course teaches students about the basic principles of scientific work in the field of social sciences. The goal is to motivate students to develop an own thesis design and write scientific articles.
1S. Wagner
363-0887-00L Management Research ■ W 1 credit 1S Z. Erden Özkol
The course is mandatory for MSc students and recommended for MAS students who write their Master Thesis at the Chair of Strategic Management and Innovation.
Participation to both sessions are mandatory to receive the credit, there will be no exceptions.
If a student can't take part in one of the sessions, the course has to be taken the following semester.
Abstract
This course teaches students about the basic principles of scientific work in the field of social sciences. The goal is to motivate students to develop an own thesis design and write scientific articles.
Objective
This course teaches students about the basic principles of scientific work in the field of social sciences. The goal is to motivate students to develop an own thesis design and write scientific articles.

Content
This course teaches students about the basic principles of scientific work in the field of social sciences. It is an introduction into the fascinating field of research. The course shows the power of theory and literature, helps formulating intriguing research questions, provides an overview of scientific methods and data analysis, and gives hints on how to derive insightful conclusions out of results. The goal is to motivate students to find and read research papers relevant to their field, develop an own thesis design and write scientific articles.

Literature
Nicolay Siggelkow (2007) Persuasion with Case Study AMJ Vol. 50, No. 1

Prerequisites / notice
The course is mandatory for MSc. students and recommended for MAS students who write their Master Thesis at the Chair of Strategic Management and Innovation - those will be served first.
· The course will be given once every semester by Dr. Zeynep Erden Özkol and the PhD students of the chair
· The course takes two days, one for lecture, one for student paper presentations. Participation to both sessions are mandatory to receive the credit, there will be no exceptions.
· Students who participate in the lecture and present a paper receive 1 credit point. The course and the presentations will be given in English.
· Students might benefit more if they take this course towards the end of their studies, before writing their master thesis.

363-0445-02L Production and Operations Management (Additional Cases)

Abstract
Extension to course 363-0445-00 Production and Operations Management.

Objective
Extension to course 363-0445-00 Production and Operations Management.

Content
Additional cases to course 363-0445-00 Production and Operations Management.

363-0622-00L Basic Management Skills

Abstract
With the aim of preparing the students to take on managerial responsibility, this 2x5 days-seminar teaches basic and practical management skills.

Objective
To convey management behaviour based on practical examples, own experiences and team discussions complemented by short theory sessions (subsidized from the donation for promotion and training in enterprise sciences at the ETHZ).

Content
1 Fundamentals of Communication Psychology
2 Communication in Business-Life
3 Fundamentals of Leadership
4 Self-Management and Life Balance
5 Leadership Tools
6 Problem Solving and Decision Making Techniques
7 Performance Coaching
8 Conflict Management
9 Personality
10 Summary-Day, Domino-Examination

Lecture notes
Will be provided as electronic version at www.entrepreneurship.ethz.ch at least one week before the seminar starts

Prerequisites / notice
Limited number of participants: Mandatory registration required.

365-1019-00L Human Resource Management: Skills in Practice

Exclusively for MAS MTEC students (third semester).

Limited number of participants: a minimum of 10 persons and a maximum of 25 persons. Please register by 27.10.2016 at the latest via myStudies

Prerequisites: Prior participation in the lecture “Human Resource Management: Leading Teams” (363-0302-00L)
This lecture will introduce the fundamentals of monetary economics and explain the working and impact of monetary policy.

### 363-1022-00L Entrepreneurial Leadership

**Objective**

Limited number of participants.

**Abstract**

This seminar provides master students at MTEC with the challenging opportunity of a real case on strategy, innovation and leadership in close collaboration with the top management of leading Swiss technology company.

**Content**

In your team, you will work on a specific assignment that flows from the current strategic agenda of the board. While gaining substantial insights into the structure, dynamics and challenges of the industry, you immerse into the business model and strategic landscape of the corporate partner. You visit their headquarters, conduct interviews with members of the management team as well as internal and external experts before you discuss your ideas with top executives. To secure impact, it is key that you formulate your recommendations from a deep understanding of the authentic leadership culture of the corporate partner.

**Prerequisites / notice**

Please apply for this course via the official website (www.mtec.ethz.ch) - to be opened by end of May 2016. Apply no later than August 22. The number of participants is limited to 18.

ECTS: 4

Participants receive a certificate.

### 363-1021-00L Monetary Policy

**Objective**

Limited number of participants.

**Abstract**

The main aim of this course is to analyse the goals of monetary policy and to review the instruments available to central banks in order to pursue these goals. It will focus on the transmission mechanisms of monetary policy and the differences between monetary policy rules and discretionary policy. It will also make connections between theoretical economic concepts and current world issues.

**Literature**

This lecture will introduce the fundamentals of monetary economics and explain the working and impact of monetary policy.

**Prerequisites / notice**

Basic knowledge in international economics and a good background in macroeconomics. The course website can be found at: https://moodle-app2.let.ethz.ch/course/view.php?id=2457

### 365-1029-00L Harvard Business School: Financial Accounting Online

**Objective**

Exclusive for MAS MTEC students (first semester).

**Abstract**

The online course will be open from 19.09.2016 to 22.01.2017. Within this time, students can proceed through the course at their own convenience. Seat time is about 26 hours.

All MAS MTEC students will receive further information by e-mail on 19.09.2016.

**Content**

This course is a web-based, online, interactive introduction to financial accounting within the context of management requirements. It has been developed by Harvard Business Publishing.

**Literature**

The online course uses the case study "Global Grocer" to guide the students from company foundation with a simple balance sheet towards more complex balance sheets, income and cash flow statements. This ensures an integrated understanding of company transactions.

**Lecture notes**

The Financial Accounting online-course is an ideal complement to the lectures "Accounting for Managers (363-0711-00)" as well as "Financial Management (363-0560-00)" with the purpose to further deepen the student's knowledge of accounting. Parts of the course content are overlapping, however, it is provided in a different context. Not covered in the online course is managerial accounting which is an important topic in the lecture "Accounting for Managers".

**Literature**

Needles & Powers (2010), Financial Accounting, 11e, South-Western College Pub
The online course will be open from 19.09.2016 to 22.01.2017. Within this time, students can proceed through the course at their own convenience. Seat time is about 25 hours. The online course should be accessed and activated only if students wish to take and complete it.

No lectures are offered for this course. Specific course topics can be discussed with other course participants, and any questions regarding the course content will be answered by an expert on the learning platform Moodle.

Prerequisites: Successful completion of lectures “363-1039-00L Introduction to Negotiation”.

Abstract
The block-seminar combines lectures introducing negotiation, negotiation engineering and specific aspects of successful negotiation with the respective application through in-class negotiation case studies and games.

Objective
Students obtain a concentrated insight into key aspects of the field of negotiations, negotiation engineering and specific aspects of successful negotiation. Multiple opportunities to apply that knowledge in different negotiation situations allow for an in-depth learning experience.

365-1035-00L Quality Management
Does not take place this semester.

Abstract
The design of this course is intended to introduce quality management from an operations and manufacturing viewpoint. Many of the key topics covered throughout the course can be located in the Content section below.

Objective
This course will provide students with the underlying principles and techniques surrounding Quality Management with an emphasis on the application in manufacturing and services settings. Students will learn to view quality from a variety of functional perspectives and in the process, gain a better understanding of the problems associated with improving quality. The course aims to impart knowledge on the quality management process and key quality management activities. Specifically it aims to: Compare and contrast the various tools used in quality management, comprehend the concepts of customer’s value, discuss the emerging tendencies toward global competitiveness, understand different perspectives on quality, explore six-sigma management and its tools, demonstrate how to design quality into product and services, describe the importance of developing a strategic plan for Quality Management, and discuss the importance of 'benchmarking' as a means of identifying the choice of markets.

Content
Major Topics:
- Total Quality Management (TQM): Excellence in manufacturing/service, factors of excellence, applications of TQM
- Process Management: Quality function development (QFD) and quality assurance systems, factors affecting process management
- Benchmarking Procedures
- Statistical Process Control (SPC) and failure mode and effect analysis (FMEA) procedures
- Demming's 14 points of Management
- Continuous Improvement
- Supplier Evaluation: Managing Supplier Quality
- Manufacturing capabilities: Quality as a core focus, cost management, competencies
- Environmental Factors: Turbulent environments, manufacturing intensity, uncertainty
- Quality Systems Certification Policy:
  - Six Sigma
  - ISO 9001, 9002, 9003 / ISO 14001 (Environmental quality policies)

Literature
Readings:
Required:
Recommended:

363-1049-00L Contemporary Conflict Management

Abstract
The course provides students with theoretical background and practical insights in conflict management in the 3 areas international, business and interpersonal (legal) relations. Students are introduced into theoretical concepts related to the research field and real world case studies including examples of international conflicts, WWI, old and new regional conflicts, business and mediation.

Objective
Students will gain:
- knowledge of history of conflict management;
- comprehension of major ideas in the theory and practice of conflict management, mediation, transformation and resolution;
- application of theoretical concepts to current conflict situations;
- evaluation of conflict situations in international relations and business.

Content
The following topics will be covered:
- history of international and regional conflicts;
- theoretical concepts of conflict management;
- theoretical models of arms races and conflict escalation;
- case studies in international conflicts, as well as in business.

Distinguished guest speakers will be invited.
### 363-1051-00L Cases in Technology Marketing

**Objective**
This module is designed to introduce students to some key concepts in technology marketing and familiarize them with the challenges that (marketing) managers face in technology-intensive markets. Students will have to solve current and past managerial problems and will be enabled to compare their solutions with what has actually been done.

**Literature**

**Prerequisites / notice**
Students have to apply for this course by sending a CV and a one-page motivation letter via myStudies. Places will be assigned on the basis of your motivation letter.

**Data:** 06.03.2019 12:57

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
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<tr>
<td>363-1051-00L</td>
<td>Cases in Technology Marketing</td>
<td>W</td>
<td>3 credits</td>
<td>1G</td>
<td>F. von Wangenheim, C. Grieder</td>
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</table>

**Abstract**
The aim of this module is to introduce students to some key concepts in technology marketing and familiarize them with the challenges that (marketing) managers face in technology-intensive markets by using real-life cases. Students will have to solve current and past managerial problems and will be enabled to compare their solutions with what has actually been done.

**Content**
This module should enable students to deal with the uncertainty related to challenges in technology marketing by introducing them to some key concepts and letting them apply those concepts to real-life cases. The competences acquired in this module are meant to go beyond the mere understanding of the study material by improving students’ problem-solving capabilities, analytical skills, and capacity for team work. Furthermore, students will be exposed to decision-making styles and procedures in companies.

**Literature**

### 365-1067-00L (Un)ethical Decision Making: Alternative and Critical Thinking in Management

**Objective**
This course is about decision-making processes in complex situations involving financial, relational, and ethical problems. First, it provides fundamental tools for addressing problematic situations. Second, it discusses how stakeholders’ ethical expectations and social responsibility issues can be effectively implemented and integrated in organizational systems and strategic planning processes.

**Literature**

**Prerequisites / notice**
Students have to apply for this course by sending a CV and a one-page motivation letter until 09.09.2015 to mgrohmann@ethz.ch.

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<tr>
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<td>365-1067-00L</td>
<td>(Un)ethical Decision Making: Alternative and Critical Thinking in Management</td>
<td>W</td>
<td>2 credits</td>
<td>2S</td>
<td>A. Vaccaro</td>
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</table>

**Abstract**
This course is about decision-making processes in complex situations involving financial, relational, and ethical problems. First, it provides fundamental tools for addressing problematic situations. Second, it discusses how stakeholders’ ethical expectations and social responsibility issues can be effectively implemented and integrated in organizational systems and strategic planning processes.

**Content**
- Become familiar with tools and procedures to prevent, identify and resolve corporate fraud and crime in organizations
- Understand the mutual relationship between financial, relational and ethical drivers in managerial decision making
- Become familiar with tools and procedures to prevent and resolve corporate crises and scandals
- Understand the opportunities associated with the corporate social responsibility (CSR) movement and how to integrate CSR in organizational and strategic planning
- Create an effective CSR strategic planning process to successfully develop and implement a CSR package
- Understand a variety of strategic CSR planning tools
- Become familiar with creating deep destructive change in pursuit of dual economic and social value
- Fraud and corruption in organizations
- Crisis management
- Personnel problems: Preventing and managing mobbing and sexual harassment
- Global criminal networks

**Lecture notes**
Most classes are taught through a series of mini-cases and notes that represent real management decisions.

**Prerequisites / notice**
No Pre-course preparation as requirement.

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<tbody>
<tr>
<td>363-1080-00L</td>
<td>Power and Leadership</td>
<td>W</td>
<td>3 credits</td>
<td>2S</td>
<td>P. Schmid</td>
</tr>
</tbody>
</table>

**Abstract**
Students will learn about different leadership styles and how power and leadership play out in social interactions. Emphasis is placed on the importance of implementation and application to the workplace.

**Objective**
This course will enhance students’ understanding of the complexity of hierarchical relationships in the workplace. It includes lectures, analysis of leadership situations, case studies, exercises, and group discussions. Students will be introduced to the importance of power and leadership in decision-making processes. They will learn to analyze different elements of leadership, including personality traits, behavior, and skills. With case studies, students will learn to evaluate different types of social and emotional skills related to leadership and will be encouraged to reflect upon their own communication skills and leadership potential. The course further addresses integrity and ethics in leadership. Class presence is mandatory.

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**Objective**
This course will enhance students’ understanding of the complexity of hierarchical relationships in the workplace. It includes lectures, analysis of leadership situations, case studies, exercises, and group discussions. More specifically, students will be informed about how power shapes people’s behaviors and decision-making processes. They will learn to analyze the different elements that make a good leader including personality traits, behavior, and skills. With case studies, students will learn to evaluate different types of social and emotional skills related to leadership and will be encouraged to reflect upon their own communication skills and leadership potential. The course further addresses integrity and ethics in leadership. Class presence is mandatory.

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<tr>
<td>365-1083-00L</td>
<td>Managing the Technology Driven Enterprise</td>
<td>W</td>
<td>2 credits</td>
<td>1S</td>
<td>P. Bubenzher</td>
</tr>
</tbody>
</table>

**Abstract**
This interactive course provides leaders in technology-driven enterprises with critical insights and tools for addressing key challenges in innovation management.

**Prerequisites / notice**
Limited number of participants: a minimum of 20 and a maximum of 40 persons.

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<td>W</td>
<td>2 credits</td>
<td>1S</td>
<td>P. Bubenzher</td>
</tr>
</tbody>
</table>
Objective
This course offers an intensive, two-day integrated learning experience to provide leaders in technology-driven enterprises with critical insights and tools for tackling key innovation management challenges. The course combines an innovative set of lectures with practical case studies and group exercises taught by seasoned industry executives with experience in technology-driven start-ups and large firms in a variety of industries. Unlike more traditional courses, this is a highly interactive immersion into real-life challenges where established frameworks and contemporary models are used to develop leadership capabilities in technologically complex business environments. This course is thus designed to particularly suit the needs and expectations of engineers or other technology specialists who intend to develop into more general leadership roles in technology based enterprises.

Content
This course is tailored to, firstly, enable participants to understand key concepts of technology and innovation management and, secondly, gain practical "real-life based" leadership skills that improve their ability to implement massive innovative change in today's dynamic global work and marketplace. In consequence, the first part of the course explores foundational frameworks in technology and innovation management with a particular focus on the evolution and adoption of technology-based innovations. The second part of the course, then, provides tools for successfully implementing innovation initiatives at all levels - individual, project and organization.

Literature
Literature and readings will be announced beforehand.

363-1082-00L  Enabling Entrepreneurship: From Science to Startup

| Students should provide a brief overview (unto 1 page) of their business ideas that they would like to commercialise through the course. If they do not have an idea, they are required to provide a motivation letter stating why they would like to do this elective.

The total number of students in this first batch will be limited to 30. It is preferable that the students already form teams of at least two persons, where both the team-membe

The students should submit the necessary information and apply before 21st September 2016 to anilsethi@ethz.ch. They will be intimated by 23rd September 2016 to confirm if they have secured a place.

Once the application has been confirmed, a registration in myStudies is possible.

Abstract
Participants form teams and identify an idea, which is then taken through the steps necessary to form a startup. The primary focus of the course is geared to technology startups that want to reach scale.

Objective
Participants want to become entrepreneurs.

The course will enable the students to identify an idea and take all necessary steps to convert it into a company, through the duration of the two semesters.

Content
Participants start from idea identification, forming team, technology and market size validation, assessing time-to-market, customer focus, IP strategy & financials, to become capable of starting the company and finally making the pitch to investors.

The seminar comprises lectures, talks from invited investors regarding the importance of the various elements being covered in content, workshops and teamwork. There is a particular emphasis on market validation on each step of the journey, to ensure the relevance of the idea, relevance to customers, time to market and customer value.

Literature
Book
Sethi, A. "From Science to Startup"
ISBN 978-3-319-30422-9

Prerequisites / notice
This course is only relevant for those students who aspire to become entrepreneurs.

Students applying for this course are requested to submit a 1 page business idea or, in case they don't have a business idea, a brief motivation letter stating why they would like to do this course.

This will be in two modules (autumn and spring), which will run in two consecutive semesters. Priority for the second semester will be given to those students who have attended the first semester.

see Electives Courses, Management, Technology and Economics MSc

▶ Master's Thesis

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<tr>
<th>Number</th>
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<td>365-0899-00L</td>
<td>Master's Thesis in a Company</td>
<td>O</td>
<td>12 credits</td>
<td>24D</td>
<td>Professors</td>
</tr>
</tbody>
</table>

Abstract
In the Master thesis students prove their ability to independent, structured and scientific working. The Master thesis is supervised by the tutor and is performed within a private company.

Objective
In the Master thesis students prove their ability to independent, structured and scientific working. The Master thesis is supervised by the tutor and is performed within a private company.

MAS in Management, Technology, and Economics - Key for Type

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
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### Key for Hours

<table>
<thead>
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<th>V</th>
<th>G</th>
<th>U</th>
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<tbody>
<tr>
<td>lecture</td>
<td>lecture with exercise</td>
<td>exercise</td>
<td>seminar</td>
<td>colloquium</td>
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<td>P</td>
<td>A</td>
<td>D</td>
<td>R</td>
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<tr>
<td>practical/laboratory course</td>
<td>independent project</td>
<td>diploma thesis</td>
<td>revision course / private study</td>
<td></td>
</tr>
</tbody>
</table>

**ECTS** European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Introduction to the fundamentals of medical radiation physics. Functional chain due to radiation exposure from the primary physical effect to X-ray imaging

To understand the physical and technical principles underlying X-ray imaging, computed tomography, single photon and positron emission tomography.

Biostatistics


The course starts with the physical basis of radiography (from X-ray production to image detectors) and continues with the basic principles of ionizing radiation and its physical and biological effects. The physical interactions of photons with matter and the generation of ionizing radiation will be described. In the second part of the lecture series, we will cover the generation of ionizing radiation and its applications. Eventually, the lecture aims to show the students that medical physics is a fascinating and evolving discipline.

Biomedical Imaging

M. Pruschy, F. Kuhn

This 1-week theory and practical class offers the possibility to enjoy a variety of research and clinical areas in diagnostic and nuclear medicine. The practicals will illustrate the theory with an emphasis on the relationship between dose and image quality as well as the security problems related to the work with ionizing radiation.

Physics in Radiodiagnostic and Nuclear Medicine

S. Kozerke, K. P. Prüssmann, M. Rudin

The lecture is covering the basic principles of ionizing radiation and its physical and biological effects. The physical interactions of photons as well as of charged particles will be reviewed and their consequences for medical applications will be discussed. The concept of Monte Carlo simulation will be introduced in the excercises and will help the student to understand the characteristics of ionizing radiation in simple and complex situations. Fundamentals in dosimetry will be provided in order to understand the physical and biological effects of ionizing radiation. Deterministic as well as stochastic effects will be discussed and fundamental knowledge about radiation protection will be provided. In the second part of the lecture series, we will cover the generation of ionizing radiation. This means, the x-ray tube, the clinical linear accelerator, and different radioactive sources in radiology, radiotherapy and nuclear medicine will be addressed. Applications in radiology, nuclear medicine and radiotherapy will be described with a special focus on the physics underlying these applications.

Specialization: Radiation Therapy

Core Courses

Medical Physics I

P. Manser

This 1-week theory and practical class offers the possibility to enjoy a variety of research and clinical areas in diagnostic and nuclear medicine. The practicals will illustrate the theory with an emphasis on the relationship between dose and image quality as well as the security problems related to the work with ionizing radiation.

Radiobiology

M. Pruschy

A script will be provided.
Medical physics is a fascinating and worthwhile scientific discipline, providing many professional opportunities to apply physics to the care of patients, either in the clinic or in industry. It is also an area allowing for exciting, interesting and fulfilling areas of research.

In the second half of the lecture series (lectures 8-13) the style changes somewhat, and we will concentrate on professional aspects of their role in industry and research. For many of this second set of lectures, external experts in the various areas will be invited in order to give the student the best possible insight into the life of a professional medical physicist.
**Objective**

By the end of this course the participants will be able to:

- a) interpret the 5 Rs of radiation oncology in the context of the hallmarks of cancer
- b) understand factors which underpin the differing radiosensitivities of different tumors
- c) follow rational strategies for combined treatment modalities of ionizing radiation with targeted agents
- d) understand differences in the radiation response of normal tissue versus tumor tissue
- e) understand different treatment responses of the tumor and the normal tissue to differential clinical-related parameters of radiotherapy (dose rate, LET etc.).

**Content**

Einführung in die Strahlenbiologie ionisierender Strahlen: Allgemeine Grundlagen und Begriffsbestimmungen; Mechanismen der biologischen Strahlenwirkung; Strahlenwirkung auf Zellen, Gewebe und Organe; Modifikation der biologischen Strahlenwirkung; Strahlenspezifitaten: Chromosomenspaltveränderungen, DNA-Defekte, Reparatursprozesse; Molekulare Strahlenbiologie: Bedeutung inter- und intrazellulärer Signalübermittlungsprozesse, Apoptose, Zellzyklus-Checkpoints; Strahlenrisiko: Strahlensyndrome, Krebsinduktion, Mutationsauslösung, pränatale Strahlenwirkung; Strahlenbiologische Grundlagen des Strahlenschutzes; Nutzen-Risiko-Abwägungen bei der medizinischen Strahlenanwendung; Prädiktive strahlenbiologische Methoden zur Optimierung der therapeutischen Strahlenanwendung.

**Practical Work**

The former number of this course unit is 465-0951-00L.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<td></td>
<td>Abstract</td>
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<tr>
<td></td>
<td>Verification of the resulting dose distribution.</td>
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</tr>
<tr>
<td>465-0800-00L</td>
<td>Practical Work</td>
<td>W</td>
<td>4</td>
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<tr>
<td>227-0965-00L</td>
<td>Micro and Nano-Tomography of Biological Tissues</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>M. Stampani, P. A. Kaestner</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
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<tr>
<td>402-0674-00L</td>
<td>Physics in Medical Research: From Atoms to Cells</td>
<td>W</td>
<td>6</td>
<td>2V+1U</td>
<td>B. K. Müller</td>
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<tr>
<td></td>
<td>Abstract</td>
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<td></td>
<td>Scanning probe and diffraction techniques allow studying activated atomic processes during early stages of epilaxial growth. For quantitative description, rate equation analysis, mean-field nucleation and scaling theories are applied on systems ranging from simple metallic to complex organic materials. The knowledge is expanded to optical and electronic properties as well as to proteins and cells.</td>
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</table>

**Literature**

Literaturliste wird abgegeben.

Objective
The lecture series is motivated by an overview covering the skin of the crystals, roughness analysis, contact angle measurements, protein absorption/activity and monocyte behaviour.

As the first step, real structures on clean surfaces including surface reconstructions and surface relaxations, defects in crystals are presented, before the preparation of clean metallic, semiconducting, oxido and organic surfaces are introduced.

The atomic processes on surfaces are activated by the increase of the substrate temperature. They can be studied using scanning tunneling microscopy (STM) and atomic force microscopy (AFM). The combination with molecular beam epitaxy (MBE) allows determining the sizes of the critical nuclei and the other activated processes in a hierarchical fashion. The evolution of the surface morphology is characterized by the density and size distribution of the nanostructures that could be quantified by means of the rate equation analysis, the mean-field nucleation theory, as well as the scaling theory. The surface morphology is further characterized by defects and nanostructure's shapes, which are based on the strain relieving mechanisms and kinetic growth processes.

High-resolution electron diffraction is complementary to scanning probe techniques and provides exact mean values. Some phenomena are quantitatively described by the kinematic theory and perfectly understood by means of the Ewald construction. Other phenomena need to be described by the more complex dynamical theory. Electron diffraction is not only associated with elastic scattering but also inelastic excitation mechanisms that reflect the electronic structure of the surfaces studied. Low-energy electrons lead to phonon and high-energy electrons to plasmon excitations. Both effects are perfectly described by dipole and impact scattering.

Thin-films of rather complex organic materials are often quantitatively characterized by photons with a broad range of wavelengths from ultra-violet to infra-red light. Asymmetries and preferential orientations of the (anisotropic) molecules are verified using the optical dichroism and second harmonic generation measurements. These characterization techniques are vital for optimizing the preparation of medical implants and the determination of tissue's anisotropies within the human body.

Cell-surface interactions are related to the cell adhesion and the contractile cellular forces. Physical means have been developed to quantify these interactions. Other physical techniques are introduced in cell biology, namely to count and sort cells, to study cell proliferation and metabolism and to determine the relation between cell morphology and function.

3D scaffolds are important for tissue augmentation and engineering. Design, preparation methods, and characterization of these highly porous 3D microstructures are also presented.

Visiting clinical research in a leading university hospital will show the usefulness of the lecture series.

>>> Major in Biomechanics

>>> Core Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>227-0386-00L</td>
<td>Biomedical Engineering</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>J. Vörös, S. J. Ferguson, S. Kozerke, U. Moser, M. Rudin, M. P. Wolf, M. Zenobi-Wong</td>
</tr>
</tbody>
</table>

Abstract
Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The focus is on learning the concepts that govern common medical instruments and the most important organs from an engineering point of view. In addition, the most recent achievements and trends of the field of biomedical engineering are also outlined.

Objective
Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The course provides an overview of the various topics of the different tracks of the biomedical engineering master course and helps orienting the students in selecting their specialized classes and project locations.

Content

Lecture notes
Introduction to Biomedical Engineering by Enderle, Banchard, and Bronzino
AND
https://www1.ethz.ch/lbb/Education/BME

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<tr>
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<td>227-0965-00L</td>
<td>Micro and Nano-Tomography of Biological Tissues</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>M. Stampanoni, P. A. Kaestner</td>
</tr>
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</table>

Abstract
The lecture introduces the physical and technical know-how of X-ray tomographic microscopy. Several X-ray imaging techniques (absorption-, phase- and darkfield contrast) will be discussed and their use in daily research, in particular biology, is presented. The course discusses the aspects of quantitative evaluation of tomographic data sets like segmentation, morphometry and statistics.

Objective
Introduction to the basic concepts of X-ray tomographic imaging, image analysis and data quantification at the micro and nano scale with particular emphasis on biological applications.

Content
Synchrotron-based X-ray micro- and nano-tomography is today a powerful technique for non-destructive, high-resolution investigations of a broad range of materials. The high-brilliance and high-coherence of third generation synchrotron radiation facilities allow quantitative, three-dimensional imaging at the micro and nanometer scale and extend the traditional absorption imaging technique to edge-enhanced and phase-sensitive measurements, which are particularly suited for investigating biological samples.

The lecture includes a general introduction to the principles of tomographic imaging from image formation to image reconstruction. It provides the physical and engineering basics to understand how imaging beamlines at synchrotron facilities work, looks into the recently developed phase contrast methods, and explores the first applications of X-ray nano-tomographic experiments.

The course finally provides the necessary background to understand the quantitative evaluation of tomographic data, from basic image analysis to complex morphometrical computations and 3D visualization, keeping the focus on biomedical applications.

Lecture notes
Available online

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>376-1651-00L</td>
<td>Clinical and Movement Biomechanics</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>S. Lorenzetti, R. List, N. Singh</td>
</tr>
</tbody>
</table>

Abstract
Measurement and modeling of the human movement during daily activities and in a clinical environment.

Objective
The students are able to analyse the human movement from a technical point of view, to process the data and perform modeling with a focus towards clinical application.

Content
This course includes study design, measurement techniques, clinical testing, accessing movement data and analysis as well as modeling with regards to human movement.
### Practical Work

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>465-0800-00L</td>
<td>Practical Work Only for MAS in Medical Physics</td>
<td>O</td>
<td>4</td>
<td></td>
<td>external organisers</td>
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**Abstract**
The practical work is designed to train the students in the solution of a specific problem and provides insights in the field of the selected MAS specialization. Tutors propose the subject of the project, the project plan, and the roadmap together with the student, as well as monitor the overall execution.

**Objective**
The practical work is aimed at training the student's capability to apply and connect specific skills acquired during the MAS specialization program towards the solution of a focused problem.

### Electives

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>151-0255-00L</td>
<td>Energy Conversion and Transport in Biosystems</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>D. Poulilakos, A. Ferrari</td>
</tr>
</tbody>
</table>

**Abstract**
The lecture deals with constitutive models that are relevant for design and calculation of structures. These include anisotropic linear elasticity, linear viscoelasticity, plasticity, viscoplasticity. Homogenization theories and laminate theory are presented. Theoretical models are complemented by examples of engineering applications and experiments.

**Objective**
Basic theories for solving continuum mechanics problems of engineering applications, with particular attention to material models.

**Content**

**Lecture notes**
Material in the form of hand-outs will be distributed.

**Literature**
Lecture notes and references therein.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>151-0524-00L</td>
<td>Continuum Mechanics I</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>E. Mazza</td>
</tr>
</tbody>
</table>

**Abstract**
The lecture deals with constitutive models that are relevant for design and calculation of structures. These include anisotropic linear elasticity, linear viscoelasticity, plasticity, viscoplasticity. Homogenization theories and laminate theory are presented. Theoretical models are complemented by examples of engineering applications and experiments.

**Objective**
Basic theories for solving continuum mechanics problems of engineering applications, with particular attention to material models.

**Content**

**Lecture notes**
one

**Literature**
Lecture notes and references therein.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>151-0604-00L</td>
<td>Microrobotics Does not take place this semester</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>B. Nelson</td>
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</table>

**Abstract**
Microrobotics is an interdisciplinary field that combines aspects of robotics, micro and nanotechnology, biomedical engineering, and materials science. The aim of this course is to expose students to the fundamentals of this emerging field. Throughout the course students are expected to submit assignments. The course concludes with an end-of-semester examination.

**Objective**
The objective of this course is to expose students to the fundamental aspects of the emerging field of microrobotics. This includes a focus on physical laws that predominate at the microscale, technologies for fabricating small devices, bio-inspired design, and applications of the field.

**Content**
Main topics of the course include:
- Scaling laws at micro/nano scales
- Electrostatics
- Electromagnetism
- Low Reynolds number flows
- Observation tools
- Materials and fabrication methods
- Applications of biomedical microrobots

**Lecture notes**
The powerpoint slides presented in the lectures will be made available in hardcopy and as pdf files. Several readings will also be made available electronically.

**Prerequisites / notice**
The lecture will be taught in English.

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<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
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<tbody>
<tr>
<td>263-5001-00L</td>
<td>Introduction to Finite Elements and Sparse Linear System Solving</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>P. Arbenz</td>
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</table>

**Abstract**
The finite element (FE) method is the method of choice for (approximately) solving partial differential equations on complicated domains. In the first third of the lecture, we give an introduction to the method. The rest of the lecture will be devoted to methods for solving the large sparse linear systems of equation that a typical for the FE method. We will consider direct and iterative methods.

**Objective**
Students will know the most important direct and iterative solvers for sparse linear systems. They will be able to determine which solver to choose in particular situations.
I. THE FINITE ELEMENT METHOD

(1) Introduction, model problems.
(2) 1D problems. Piecewise polynomials in 1D.
(3) 2D problems. Triangulations. Piecewise polynomials in 2D.
(4) Variational formulations. Galerkin finite element method.
(5) Implementation aspects.

II. DIRECT SOLUTION METHODS

(6) LU and Cholesky decomposition.
(7) Sparse matrices.
(8) Fill-reducing orderings.

III. ITERATIVE SOLUTION METHODS

(9) Stationary iterative methods, preconditioning.
(10) Preconditioned conjugate gradient method (PCG).
(11) Incomplete factorization preconditioning.
(12) Multigrid preconditioning.
(13) Nonsymmetric problems (GMRES, BiCGstab).
(14) Indefinite problems (SYMMLQ, MINRES).

Literature


Prerequisites / notice

Prerequisites: Linear Algebra, Analysis, Computational Science.
The exercises are made with Matlab.
Abstract

Objective
Overview of the most important concepts of image formation, perception and analysis, and Computer Vision. Gaining own experience through practical computer and programming exercises.

Content
The first part of the course starts off from an overview of existing and emerging applications that need computer vision. It shows that the realm of image processing is no longer restricted to the factory floor, but is entering several fields of our daily life. First it is investigated how the parameters of the electromagnetic waves are related to our perception. Also the interaction of light with matter is considered. The most important hardware components of technical vision systems, such as cameras, optical devices and illumination sources are discussed. The course then turns to the steps that are necessary to arrive at the discrete images that serve as input to algorithms. The next part describes necessary preprocessing steps of image analysis, that enhance image quality and/or detect specific features. Linear and non-linear filters are introduced for that purpose. The course will continue by analyzing procedures allowing to extract additional types of basic information from multiple images, with motion and depth as two important examples. The estimation of image velocities (optical flow) will get due attention and methods for object tracking will be presented. Several techniques are discussed to extract three-dimensional information about objects and scenes. Finally, approaches for the recognition of specific objects as well as object classes will be discussed and analyzed.

Prerequisites / notice
Basic concepts of mathematical analysis and linear algebra. The computer exercises are based on Linux and C. The course language is English.

Practical Work

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<tr>
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<td>465-0800-00L</td>
<td>Practical Work Only for MAS in Medical Physics</td>
<td>O</td>
<td>4 credits</td>
<td>external organisers</td>
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<tr>
<td>151-0605-00L</td>
<td>Nanosystems</td>
<td>W</td>
<td>4 credits</td>
<td>4G</td>
<td>A. Stemmer, J.N. Tisserant</td>
</tr>
</tbody>
</table>

Abstract
From atoms to molecules to condensed matter: characteristic properties of simple nanosystems and how they evolve when moving towards complex ensembles.

Objective
Familiarize students with basic science and engineering principles governing the nano domain.

Content
Self-assembly and directed assembly of 2D and 3D structures.
Special emphasis on the emerging field of molecular electronic devices.

Prerequisites / notice
Course material Script, computer demonstrations, exercises and problem solutions

Literature

Homework: Mini-Reviews
Students select a paper (list distributed in class) and expand the topic into a Mini-Review that illuminates the particular field beyond the immediate results reported in the paper.
Abstract
The lecture introduces the physical and technical know-how of X-ray tomographic microscopy. Several X-ray imaging techniques (absorption-, phase- and darkfield contrast) will be discussed and their use in daily research, in particular biology, is presented. The course discusses the aspects of quantitative evaluation of tomographic data sets like segmentation, morphometry and statistics.

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The course finally provides the necessary background to understand the quantitative evaluation of tomographic data, from basic image analysis to complex morphometrical computations and 3D visualization, keeping the focus on biomedical applications.

Lecture notes
Available online

Literature
Will be indicated during the lecture.

227-0967-00L
Computational Neuroimaging Clinic

| W | 3 credits | 2V | K. Stephan |

Abstract
This seminar teaches problem solving skills for computational neuroimaging, based on joint analyses of neuroimaging and behavioural data. It deals with a wide variety of real-life problems that are brought to this meeting from the neuroimaging community at Zurich, e.g. mass-univariate and multivariate analyses of fMRI/EEG data, or generative models of fMRI, EEG, or behavioural data.

Objective
1. Consolidation of theoretical knowledge (obtained in the following courses: 'Methods & models for fMRI data analysis', 'Translational Neuromodeling', 'Computational Psychiatry') in a practical setting.
2. Acquisition of practical problem solving strategies for computational modeling of neuroimaging data.

Content
This seminar teaches problem solving skills for computational neuroimaging, based on joint analyses of neuroimaging and behavioural data. It deals with a wide variety of real-life problems that are brought to this meeting from the neuroimaging community at Zurich, e.g. mass-univariate and multivariate analyses of fMRI/EEG data, or generative models of fMRI, EEG, or behavioural data.

Prerequisites / notice
The participants are expected to have successfully completed at least one of the following courses: 'Methods & models for fMRI data analysis', 'Translational Neuromodeling', 'Computational Psychiatry'.

227-0969-00L
Methods & Models for fMRI Data Analysis

| W | 6 credits | 4V | K. Stephan |

Abstract
This course teaches methods and models for fMRI data analysis, covering all aspects of statistical parametric mapping (SPM), incl. preprocessing, the general linear model, statistical inference, multiple comparison corrections, event-related designs, and Dynamic Causal Modelling (DCM), a Bayesian framework for identification of nonlinear neuronal systems from neurophysiological data.

Objective
1. Consolidation of theoretical knowledge (obtained in the following courses: 'Methods & models for fMRI data analysis', 'Translational Neuromodeling', 'Computational Psychiatry') in a practical setting.
2. Acquisition of practical problem solving strategies for computational modeling of neuroimaging data.

Content
This course teaches state-of-the-art methods and models for fMRI data analysis. It covers all aspects of statistical parametric mapping (SPM), incl. preprocessing, the general linear model, frequentist and Bayesian inference, multiple comparison corrections, and event-related designs, and Dynamic Causal Modelling (DCM), a Bayesian framework for identification of nonlinear neuronal systems from neurophysiological data. A particular emphasis of the course will be on methodological questions arising in the context of studies in psychology, psychiatry and neuroeconomics.

376-1279-00L
Virtual Reality in Medicine

| W | 3 credits | 2V | R. Rieder |

Abstract
Virtual Reality has the potential to support medical training and therapy. This lecture will derive the technical principles of multi-modal (audiovisual, haptic, tactile etc.) input devices, displays and rendering techniques. Examples are presented in the fields of surgical training, intra-operative augmentation, and rehabilitation. The lecture is accompanied by practical courses and excursions.

Objective
Provide theoretical and practical knowledge of new principles and applications of multi-modal simulation and interface technologies in medical education, therapy, and rehabilitation.

Content
Virtual Reality has the potential to support descriptive and practical information for medical training and therapy while relieving the patient and/or the physician. Multi-modal interactions between the user and the virtual environment facilitate the generation of high-fidelity sensory impressions, by using not only visual and auditory modalities, but also kinesthetic, tactile, and even olfactory feedback. On the basis of the existing physiological constraints, this lecture will derive the technical requirements and principles of multi-modal input devices, displays, and rendering techniques. Several examples are presented that are currently being developed or already applied for surgical training, intra-operative augmentation, and rehabilitation. The lecture will be accompanied by several practical courses on graphical and haptic display devices as well as excursions to facilities equipped with large-scale VR equipment.

Target Group:
Students of higher semesters and PhD students of - D-HEST, D-MAVT, D-ITET, D-INFK, D-PHYS - Robotics, Systems and Control Master - Biomedical Engineering/Movement Science and Sport - Medical Faculty, University of Zurich
Students of other departments, faculties, courses are also welcome!

Literature
Book: Virtual Reality in Medicine, Rieder, Robert; Harders, Matthias; 2012 Springer.

Prerequisites / notice
The course language is English. Basic experience in Information Technology and Computer Science will be of advantage. More details will be announced in the lecture.

402-0674-00L
Physics in Medical Research: From Atoms to Cells

| W | 6 credits | 2V+1U | B. K. R. Müller |

Abstract
Scanning probe and diffraction techniques allow studying activated atomic processes during early stages of epitalial growth. For quantitative description, rate equation analysis, mean-field nucleation and scaling theories are applied on systems ranging from simple metallic to complex organic materials. The knowledge is expanded to optical and electronic properties as well as to proteins and cells.
The lecture series is motivated by an overview covering the skin of the crystals, roughness analysis, contact angle measurements, protein absorption/activity and monocyte behaviour.

As the first step, real structures on clean surfaces including surface reconstructions and surface relaxations, defects in crystals are presented, before the preparation of clean metallic, semiconducting, oxidic and organic surfaces are introduced.

The atomic processes on surfaces are activated by the increase of the substrate temperature. They can be studied using scanning tunneling microscopy (STM) and atomic force microscopy (AFM). The combination with molecular beam epitaxy (MBE) allows determining the sizes of the critical nuclei and the other activated processes in a hierarchical fashion. The evolution of the surface morphology is characterized by the density and size distribution of the nanostructures that could be quantified by means of the rate equation analysis, the mean-field nucleation theory, as well as the scaling theory. The surface morphology is further characterized by defects and nanostructure's shapes, which are based on the strain relieving mechanisms and kinetic growth processes.

High-resolution electron diffraction is complementary to scanning probe techniques and provides exact mean values. Some phenomena are quantitatively described by the kinematic theory and perfectly understood by means of the Ewald construction. Other phenomena need to be described by the more complex dynamical theory. Electron diffraction is not only associated with elastic scattering but also inelastic excitation mechanisms that reflect the electronic structure of the surfaces studied. Low-energy electrons lead to phonon and high-energy electrons to plasmon excitations. Both effects are perfectly described by dipole and impact scattering.

Thin-films of rather complex organic materials are often quantitatively characterized by photons with a broad range of wavelengths from ultraviolet to infrared light. The high-brilliance and high-coherence of third generation synchrotron radiation facilities allow quantitative, three-dimensional imaging at the micro and nanometer scale and extend the traditional absorption imaging technique to edge-enhanced and phase-sensitive measurements, which are particularly suited for investigating biological samples.

The lecture includes a general introduction to the principles of tomographic imaging from image formation to image reconstruction. It provides the physical and engineering basics to understand how imaging beamlines at synchrotron facilities work, looks into the recently developed phase contrast methods, and explores the first applications of X-ray nano-tomographic experiments.

The course finally provides the necessary background to understand the quantitative evaluation of tomographic data, from basic image analysis to complex morphometrical computations and 3D visualization, keeping the focus on biomedical applications.

### Major in Bioengineering

#### Core Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>227-0965-00L</td>
<td>Micro and Nano-Tomography of Biological Tissues</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>M. Stampanoni, P. A. Kaestner</td>
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<td>Objective</td>
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<tr>
<td></td>
<td>Introduction to the basic concepts of X-ray tomographic imaging, image analysis and data quantification at the micro and nano scale with particular emphasis on biological applications</td>
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<td></td>
<td>Content</td>
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<td>Synchrontron-based X-ray micro- and nano-tomography is today a powerful technique for non-destructive, high-resolution investigations of a broad variety of materials. The high-brilliance and high-coherence of third generation synchrotron radiation facilities allow quantitative, three-dimensional imaging at the micro and nanometer scale and extend the traditional absorption imaging technique to edge-enhanced and phase-sensitive measurements, which are particularly suited for investigating biological samples.</td>
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<tr>
<td></td>
<td>Lecture notes</td>
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<td></td>
<td>Available online</td>
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<tr>
<td>Literature</td>
<td>Will be indicated during the lecture.</td>
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<tr>
<td>376-1103-00L</td>
<td>Frontiers in Nanotechnology</td>
<td>W</td>
<td>4 credits</td>
<td>4V</td>
<td>V. Vogel, further lecturers</td>
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<td>Objective</td>
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<td>Many disciplines are meeting at the nanoscale, from physics, chemistry to engineering, from the life sciences to medicine. The course will prepare students to communicate more effectively across disciplinary boundaries, and will provide them with deep insights into the various frontiers.</td>
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<td>Content</td>
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<td></td>
<td>Building upon advanced technologies to create, visualize, analyze and manipulate nano-structures, as well as to probe their nano-chemistry, nano-mechanics and other properties within manmade and living systems, many exciting discoveries are currently made. They change the way we do science and result in so many new technologies.</td>
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<td>The goal of the course is to give Master and Graduate students from all interested departments an overview of what nanotechnology is all about, from analytical techniques to nanosystems, from physics to biology. Students will start to appreciate the extent to which scientific communities are meeting at the nanoscale. They will learn about the specific challenges and what is currently sizzling in the respective fields, and learn the vocabulary that is necessary to communicate effectively across departmental boundaries.</td>
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<td>Each lecturer will first give an overview of the state-of-the art in his/her field, and then describe the research highlights in his/her own research group. While preparing their Final Projects and discussing them in front of the class, the students will deepen their understanding of how to apply a range of new technologies to solve specific scientific problems and technical challenges. Exposure to the different frontiers will also improve their ability to conduct effective nanoscale research, recognize the broader significance of their work and to start collaborations.</td>
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<td>Content</td>
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<td>Starting with the fabrication and analysis of nanoparticles and nanostructured materials that enable a variety of scientific and technical applications, we will transition to discussing biological nanosystems, how they work and what bioinspired engineering principles can be derived, to finally discussing biomedical applications and potential health risk issues. Scientific aspects as well as the many of the emerging technologies will be covered that start impacting so many aspects of our lives. This includes new phenomena in physics, advanced materials, novel technologies and new methods to address major medical challenges.</td>
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<tr>
<td></td>
<td>Lecture notes</td>
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<td>All the enrolled students will get access to a password protected website where they can find pdf files of the lecture notes, and typically 1-2 journal articles per lecture that cover selected topics.</td>
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<tr>
<td>376-1714-00L</td>
<td>Biocompatible Materials</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>K. Maniura, J. Möller, M. Zenobi-Wong</td>
</tr>
</tbody>
</table>
Abstract

Introduction to molecules used for biomaterials, molecular interactions between different materials and biological systems (molecules, cells, tissues). The concept of biocompatibility is discussed and important techniques from biomaterials research and development are introduced.

Objective

The class consists of three parts:
1. Introduction into molecular characteristics of molecules involved in the materials-to-biology interface. Molecular design of biomaterials.
2. The concept of biocompatibility.
3. Introduction into methodology used in biomaterials research and application.

Content

Introduction into native and polymeric biomaterials used for medical applications. The concepts of biocompatibility, biodegradation and the consequences of degradation products are discussed on the molecular level. Different classes of materials with respect to potential applications in tissue engineering and drug delivery are introduced. Strong focus lies on the molecular interactions between materials having very different bulk and/or surface chemistry with living cells, tissues and organs. In particular the interface between the materials surfaces and the eukaryotic cell surface and possible reactions of the cells with an implant material are elucidated. Techniques to design, produce and characterize materials in vitro as well as in vivo analysis of implanted and explanted materials are discussed.

In addition, a link between academic research and industrial entrepreneurship is established by external guest speakers.

Lecture notes

Handouts can be accessed online.

Literature


(available online via ETH library)

Handouts provided during the classes and references therin.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>636-0003-00L</td>
<td>Biological Engineering and Biotechnology</td>
<td>W</td>
<td>6</td>
<td></td>
<td>M. Fussenegger</td>
</tr>
</tbody>
</table>

Abstract

Biological Engineering and Biotechnology will cover the latest biotechnological advances as well as their industrial implementation to engineer mammalian cells for use in human therapy. This lecture will provide forefront insights into key scientific aspects and the main points in industrial decision-making to bring a therapeutic from target to market.

Objective

1. Insight Into The Mammalian Cell Cycle. Cycling, The Balance Between Proliferation and Cancer - Implications For Biopharmaceutical Manufacturing.
2. The Licence To Kill. Apoptosis Regulatory Networks - Engineering of Survival Pathways To Increase Robustness of Production Cell Lines.
5. From Target To Market. An Antibody's Journey From Cell Culture to Production.
6. Biology and Malign Applications. Do Life Sciences Enable the Development of Biological Weapons?
7. Functional Food. Enjoy your Meal!

Lecture notes

Handouts during the course.

Practical Work

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>465-0800-00L</td>
<td>Practical Work</td>
<td>O</td>
<td>4</td>
<td></td>
<td>external organisers</td>
</tr>
</tbody>
</table>

Abstract

The practical work is designed to train the students in the solution of a specific problem and provides insights in the field of the selected MAS specialization. Tutors propose the subject of the project, the project plan, and the roadmap together with the student, as well as monitor the overall execution.

Objective

The practical work is aimed at training the学生’s capability to apply and connect specific skills acquired during the MAS specialization program towards the solution of a focused problem.

Electives

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0604-00L</td>
<td>Micro robotics</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>B. Nelson</td>
</tr>
</tbody>
</table>

Abstract

Micro robotics is an interdisciplinary field that combines aspects of robotics, micro and nanotechnology, biomedical engineering, and materials science. The aim of this course is to expose students to the fundamentals of this emerging field. Throughout the course students are expected to submit assignments. The course concludes with an end-of-semester examination.

Objective

The objective of this course is to expose students to the fundamental aspects of the emerging field of micro robotics. This includes a focus on physical laws that predominate at the microscale, technologies for fabricating small devices, bio-inspired design, and applications of the field.

Content

Main topics of the course include:
- Scaling laws at micro/nano scales
- Electrostatics
- Electromagnetism
- Low Reynolds number flows
- Observation tools
- Materials and fabrication methods
- Applications of biomedical micro robotics

Lecture notes

The powerpoint slides presented in the lectures will be made available in hardcopy and as pdf files. Several readings will also be made available electronically.

Prerequisites / notice

The lecture will be taught in English.

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>227-0386-00L</td>
<td>Biomedical Engineering</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>J. Vörös, S. J. Ferguson, S. Kozerke, U. Moser, M. Rudin, M. P. Wolf, M. Zenobi-Wong</td>
</tr>
</tbody>
</table>

Abstract

Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The focus is on learning the concepts that govern common medical instruments and the most important organs from an engineering point of view. In addition, the most recent achievements and trends of the field of biomedical engineering are also outlined.

Objective

Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The course provides an overview of the various topics of the different tracks of the biomedical engineering master course and helps orienting the students in selecting their specialized classes and project locations.
**Content**


**Lecture notes**

Introduction to Biomedical Engineering by Enderle, Banchard, and Bronzino

AND

https://www1.ethz.ch/lbb/Education/BME

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Lecture Hours</th>
<th>Coordinators</th>
</tr>
</thead>
<tbody>
<tr>
<td>327-1101-00L</td>
<td>Biomineralization</td>
<td>2</td>
<td>W</td>
<td>K.H. Ernst</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>The course addresses undergraduate and graduate students interested in getting introduced into the basic concepts of biomineralization. The course aims to introduce the basic concepts of biomineralization and the underlying principles, such as supersaturation, nucleation and growth of minerals, the interaction of biomolecules with mineral surfaces, and cell biology of inorganic materials creation. An important part of this class is the independent study and the presentation of original literature from the field.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>Biomineralization is a multidisciplinary field. Topics dealing with biology, molecular and cell biology, solid state physics, mineralogy, crystallography, organic and physical chemistry, biochemistry, dentistry, oceanography, geology, etc. are addressed. The course covers definition and general concepts of biomineralization (BM), types of biominerals and their function, crystal nucleation and growth, biological induction of BM, control of crystal morphology, habit, shape and orientation by organisms, strategies of compartmentalization, the interface between biomolecules (peptides, polysaccharides) and the mineral phase, modern experimental methods for studying BM phenomena, and organic templates and matrices for BM, structure of bone, teeth (vertebrates and invertebrates) and mollusk shells, calcification, silification in diatoms, radiolaria and plants, calcium and iron storage, impact of BM on lithosphere and atmosphere, evolution, and taxonomy of organisms.</td>
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</tbody>
</table>
| **Content** | 1. Introduction and overview  
2. Biominerals and their functions  
3. Chemical control of biomineralization  
4. Control of morphology: Organic templates and additives  
5. Modern methods of investigation of BM  
6. BM in matrices: bone and nacre  
7. Vertebrate teeth  
8. Invertebrate teeth  
9. BM within vesicles: calcite of coccoliths  
10. Silica  
11. Iron storage and mineralization |
| **Lecture notes** | Script with more than 600 pages with many illustrations will be distributed free of charge. |
| **Literature** | 1) S. Mann, Biomineralization, Oxford University Press, 2001, Oxford, New York  
3) P. M. Dove, J. J. DeYoreo, S. Weiner (Eds.) Biomineralization, Reviews in Mineralogy & Geochemistry Vol. 54, 2003 |
| **Prerequisites / notice** | Each attendee is required to present a publication from the field. The selection of key papers is provided by the lecturer. No special requirements are needed for attending. Basic knowledge in chemistry and cell biology is expected. |
| 376-1622-00L | Practical Methods in Tissue Engineering | 5 | 4P | K. Würtz-Kozak, M. Zenobi-Wong |
| **Abstract** | The goal of this course is to teach MSc students the necessary skills for doing research in the fields of tissue engineering and regenerative medicine. Practical exercises and demonstrations on topics including sterile cell culture, light microscopy and histology, protein and gene expression analysis, and viability assays are covered. The advantages of 3D cell cultures will be discussed and practical work on manufacturing and evaluating hydrogels and scaffolds for tissue engineering will be performed in small groups. In addition to practical lab work, the course will teach skills in data acquisition and analysis. |
| 402-0674-00L | Physics in Medical Research: From Atoms to Cells | 6 | 2V+1U | B. K. R. Müller |
| **Abstract** | Scanning probe and diffraction techniques allow studying activated atomic processes during early stages of epitaxial growth. For quantitative description, rate equation analysis, mean-field nucleation and scaling theories are applied on systems ranging from simple metallic to complex organic materials. The knowledge is expanded to optical and electronic properties as well as to proteins and cells. |
The lecture series is motivated by an overview covering the skin of the crystals, roughness analysis, contact angle measurements, protein absorption/activity and monocyte behaviour.

As the first step, real structures on clean surfaces including surface reconstructions and surface relaxations, defects in crystals are presented, before the preparation of clean metallic, semiconducting, oxidic and organic surfaces are introduced.

The atomic processes on surfaces are activated by the increase of the substrate temperature. They can be studied using scanning tunneling microscopy (STM) and atomic force microscopy (AFM). The combination with molecular beam epitaxy (MBE) allows determining the size of the critical nuclei and the other activated processes in a hierarchical fashion. The evolution of the surface morphology is characterized by the density and size distribution of the nanostructures that could be quantified by means of the rate equation analysis, the mean-field nucleation theory, as well as the scaling theory. The surface morphology is further characterized by defects and nanostructure's shapes, which are based on the strain relieving mechanisms and kinetic growth processes.

High-resolution electron diffraction is complementary to scanning probe techniques and provides exact mean values. Some phenomena are quantitatively described by the kinematic theory and perfectly understood by means of the Ewald construction. Other phenomena need to be described by the more complex dynamical theory. Electron diffraction is not only associated with elastic scattering but also inelastic excitation mechanisms that reflect the electronic structure of the surfaces studied. Low-energy electrons lead to phonon and high-energy electrons to plasmon excitations. Both effects are perfectly described by dipole and impact scattering.

Thin-films of rather complex organic materials are often quantitatively characterized by photons with a broad range of wavelengths from ultra-violet to infra-red light. Asymmetries and preferential orientations of the (anisotropic) molecules are verified using the optical dichroism and second harmonic generation measurements. These characterization techniques are vital for optimizing the preparation of medical implants and the determination of tissue's anisotropies within the human body.

Cell-surface interactions are related to the cell adhesion and the contractile cellular forces. Physical means have been developed to quantify these interactions. Other physical techniques are introduced in cell biology, namely to count and sort cells, to study cell proliferation and metabolism and to determine the relation between cell morphology and function.

3D scaffolds are important for tissue augmentation and engineering. Design, preparation methods, and characterization of these highly porous 3D microstructures are also presented.

Visiting clinical research in a leading university hospital will show the usefulness of the lecture series.

535-0423-00L Drug Delivery and Drug Targeting W 2 credits 2V J.C. Leroux, D. Brambilla

Objective The students gain an overview on current principles, methodologies and systems for controlled delivery and targeting of drugs. This enables the students to understand and evaluate the field in terms of scientific criteria.

Abstract The students dispose of an overview on current principles and systems for the controlled delivery and targeting of drugs. The focus of the course lies on developing a capacity to understand the involved technologies and methods, as well as an appreciation of the chances and constraints of their therapeutic usage, with prime attention on antitumor drugs, therapeutic peptides, proteins, nucleic acids and vaccines.

Content The course covers the following topics: drug targeting and delivery principles, radiopharmaceuticals, macromolecular drug carriers, liposomes, micelles, micro/nanoparticles, gels and implants, administration of vaccines, delivery of active agents in tissue engineering, targeting at the gastrointestinal level, synthetic carriers for nucleic acid drugs, opthalmic devices and novel trends in transdermal and nasal drug delivery.

Lecture notes Selected lecture notes, documents and supporting material will be directly provided or may be downloaded using

http://www.galenik.ethz.ch/teaching/drug_del_drug_targ

The website also displays additional information on peroral delivery systems, transdermal systems and systems for alternative routes (nasal, pulmonary) of delivery. These fields are covered in detail in the course Galenische Pharmazie II (Galenical Pharmacy II).

Further references will be provided in the course.


Abstract Storage, handling and analysis of large datasets have become essential in biological research. The course will introduce students to a number of applications of bioinformatics in biology. Freely accessible software tools and databases will be explained and explored in theory and praxis.

Objective Introduction to Bioinformatics I: Concepts and Applications (formerly Bioinformatics I) will provide students with the theoretical background of approaches to store and retrieve information from large databases. Concepts will be developed how DNA sequence information can be used to understand phylogentic relationships, how RNA sequence relates to structure, and how protein sequence information can be used for genome annotation and to predict protein folding and structure. Students will be introduced to quantitative methods for measuring gene expression and how this information can be used to model gene networks. Methods will be discussed to construct protein interaction maps and how this information can be used to simulate dynamic molecular networks.

In addition to the theoretical background, the students will develop hands-on experiences with the bioinformatics methods through guided exercises. The course provides students from different backgrounds with basic training in bioinformatics approaches that have impact on biological, chemical and physics experimentation. Bioinformatics approaches draw significant expertise from mathematics, statistics and computational science.

Although "Introduction to Bioinformatics I" will focus on theory and praxis of bioinformatics approaches, the course provides an important foundation for the course "Introduction to Bioinformatics II: Fundamentals of computer science, modeling and algorithms" that will be offered in the following semester.

Content Bioinformatics I will cover the following topics:

- From genes to databases and information
- BLAST searches
- Prediction of gene function and regulation
- RNA structure prediction
- Gene expression analysis using microarrays
- Protein sequence and structure databases
- Web applications for bioinformatics
- Protein sequence comparisons
- Proteomics and de novo protein sequencing
- Protein structure prediction
- Cellular and protein interaction networks
- Molecular dynamics simulation
### Major in Bioelectronics

#### Core Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>151-0604-00L</td>
<td>MicroRobotics</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>B. Nelson</td>
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<tr>
<td></td>
<td><em>Does not take place this semester.</em></td>
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<tr>
<td>Abstract</td>
<td>MicroRobotics is an interdisciplinary field that combines aspects of robotics, micro and nanotechnology, biomedical engineering, and materials science. The aim of this course is to expose students to the fundamentals of this emerging field. Throughout the course students are expected to submit assignments. The course concludes with an end-of-semester examination.</td>
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<tr>
<td>Objective</td>
<td>The objective of this course is to expose students to the fundamental aspects of the emerging field of microrobotics. This includes a focus on physical laws that predominate at the microscale, technologies for fabricating small devices, bio-inspired design, and applications of the field.</td>
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</tbody>
</table>
| Content       | Main topics of the course include:  
- Scaling laws at micro/nano scales  
- Electrostatics  
- Electromagnetism  
- Low Reynolds number flows  
- Observation tools  
- Materials and fabrication methods  
- Applications of biomedical microrobots |
| Lecture notes | The powerpoint slides presented in the lectures will be made available in hardcopy and as pdf files. Several readings will also be made available electronically. |
| Prerequisites / Notice | The lecture will be taught in English. |

| 227-0386-00L  | Biomedical Engineering     | W    | 4    | 3G    | J. Vörös, S. J. Ferguson, S. Kozerke, U. Moser, M. Rudin, M. P. Wolf, M. Zenobi-Wong |
| Abstract      | Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The focus is on learning the concepts that govern common medical instruments and the most important organs from an engineering point of view. In addition, the most recent achievements and trends of the field of biomedical engineering are also outlined. |
| Objective     | Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The course provides an overview of the various topics of the different tracks of the biomedical engineering master course and helps orienting the students in selecting their specialized classes and project locations. |
| Lecture notes | Introduction to Biomedical Engineering by Enderle, Banchard, and Bronzino  
AND  
https://www1.ethz.ch/lbb/Education/BME |

| 227-1037-00L  | Introduction to Neuroinformatics | W    | 6    | 2V+1U | K. A. Martin, M. Cook, V. Mante, M. Pfeiffer |
| Abstract      | The course provides an introduction to the functional properties of neurons. Particularly the description of membrane electrical properties (action potentials, channels), neuronal anatomy, synaptic structures, and neuronal networks. Simple models of computation, learning, and behavior will be explained. Some artificial systems (robot, chip) are presented. |
| Objective     | Understanding computation by neurons and neuronal circuits is one of the great challenges of science. Many different disciplines can contribute their tools and concepts to solving mysteries of neural computation. The goal of this introductory course is to introduce the monocultures of physics, maths, computer science, engineering, biology, psychology, and even philosophy and history, to discover the enchantments and challenges that we all face in taking on this major 21st century problem and how each discipline can contribute to discovering solutions. |
| Content       | This course considers the structure and function of biological neural networks at different levels. The function of neural networks lies fundamentally in their wiring and in the electro-chemical properties of nerve cell membranes. Thus, the biological structure of the nerve cell needs to be understood if biologically-realistic models are to be constructed. These simpler models are used to estimate the electrical current flow through dendritic cables and explore how a more complex geometry of neurons influences this current flow. The active properties of nerves are studied to understand both sensory transduction and the generation and transmission of nerve impulses along axons. The concept of local neuronal circuits arises in the context of the rules governing the formation of nerve connections and topographic projections within the nervous system. Communication between neurons in the network can be thought of as information flow across synapses, which can be modified by experience. We need an understanding of the action of inhibitory and excitatory neurotransmitters and neuromodulators, so that the dynamics and logic of synapses can be interpreted. Finally, the neural architectures of feedforward and recurrent networks will be discussed in the context of co-ordination, control, and integration of sensory and motor information in neural networks. |

| 376-1714-00L  | Biocompatible Materials      | W    | 4    | 3G    | K. Maniura, J. Möller, M. Zenobi-Wong |
| Abstract      | Introduction to molecules used for biomaterials, molecular interactions between different materials and biological systems (molecules, cells, tissues). The concept of biocompatibility is discussed and important techniques from biomaterials research and development are introduced. |
| Objective     | The class consists of three parts:  
1. Introduction into molecular characteristics of molecules involved in the materials-to-biology interface. Molecular design of biomaterials.  
2. The concept of biocompatibility.  
3. Introduction into methodology used in biomaterials research and application. |
Introduction into native and polymeric biomaterials used for medical applications. The concepts of biocompatibility, biodegradation and the consequences of degradation products are discussed on the molecular level. Different classes of materials with respect to potential applications in tissue engineering and drug delivery are introduced. Strong focus lies on the molecular interactions between materials having very different bulk and/or surface chemistry with living cells, tissues and organs. In particular the interface between the materials surfaces and the eukaryotic cell surface and possible reactions of the cells with an implant material are elucidated. Techniques to design, produce and characterize materials in vitro as well as in vivo analysis of implanted and explanted materials are discussed.

In addition, a link between academic research and industrial entrepreneurship is established by external guest speakers.

**Practical Work**

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>465-0800-00L</td>
<td>Practical Work Only for MAS in Medical Physics</td>
<td>O</td>
<td>4 credits</td>
<td>external organisers</td>
<td></td>
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</tbody>
</table>

**Objective**

The practical work is designed to train the students in the solution of a specific problem and provides insights in the field of the selected MAS specialization. Tutors propose the subject of the project, the project plan, and the roadmap together with the student, as well as monitor the overall execution.

**Abstract**

The practical work is provided during the classes and references therein.

**Electives**

<table>
<thead>
<tr>
<th>Number</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>227-1033-00L</td>
<td>Neuromorphic Engineering I</td>
<td>W</td>
<td>6 credits</td>
<td>2V+3U</td>
<td>T. Delbrück, G. Indiveri, S.C. Liu</td>
</tr>
</tbody>
</table>

**Objective**

The practical work is aimed at training the student’s capability to apply and connect specific skills acquired during the MAS specialization program towards the solution of a focused problem.

**Abstract**

This course covers analog circuits with emphasis on neuromorphic engineering: MOS transistors in CMOS technology, static circuits, dynamic circuits, systems (silicon neuron, silicon retina, silicon cochlea) with an introduction to multi-chip systems. The lectures are accompanied by weekly laboratory sessions.

**Literature**


(available online via ETH library)

**Prerequisites / notice**

- Particular: The course is highly recommended for those who intend to take the spring semester course ‘Neuromorphic Engineering II’, that teaches the conception, simulation, and physical layout of such circuits with chip design tools.

- Prerequisites: Background in basics of semiconductor physics helpful, but not required.

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<th>Number</th>
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<tbody>
<tr>
<td>227-2037-00L</td>
<td>Physical Modelling and Simulation</td>
<td>W</td>
<td>5 credits</td>
<td>4G</td>
<td>Hafner, J. Leuthold, J. Smajic</td>
</tr>
</tbody>
</table>

**Objective**

This module consists of (a) an introduction to fundamental equations of electromagnetics, mechanics and heat transfer, (b) a detailed overview of numerical methods for field simulations, and (c) practical examples solved in form of small projects.

**Abstract**

Basic knowledge of the fundamental equations and effects of electromagnetics, mechanics, and heat transfer. Knowledge of the main concepts of numerical methods for physical modelling and simulation. Ability (a) to develop own simple field simulation programs, (b) to select an appropriate field solver for a given problem, (c) to perform field simulations, (d) to evaluate the obtained results, and (e) to interactively improve the models until sufficiently accurate results are obtained.

**Content**

- The module begins with an introduction to the fundamental equations and effects of electromagnetics, mechanics, and heat transfer. After the introduction follows a detailed overview of the available numerical methods for solving electromagnetic, thermal and mechanical boundary value problems. This part of the course contains a general introduction into numerical methods, differential and integral forms, linear equation systems, Finite Difference Method (FDM), Boundary Element Method (BEM), Method of Moments (MoM), Multiple Multipole Program (MMP) and Finite Element Method (FEM). The theoretical part of the course finishes with a presentation of multiphysics simulations through several practical examples of HF-engineering such as coupled electromagnetic-mechanical and electromagnetic-thermal analysis of MEMS.

- In the second part of the course the students will work in small groups on practical simulation problems. For solving practical problems the students can develop and use own simulation programs or chose an appropriate commercial field solver for their specific problem. This practical simulation work of the students is supervised by the lecturers.

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<thead>
<tr>
<th>Number</th>
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<tbody>
<tr>
<td>376-1103-00L</td>
<td>Frontiers in Nanotechnology</td>
<td>W</td>
<td>4 credits</td>
<td>4V</td>
<td>Vogel, further lecturers</td>
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</table>

Many disciplines are meeting at the nanoscale, from physics, chemistry to engineering, from the life sciences to medicine. The course will prepare students to communicate more effectively across disciplinary boundaries, and will provide them with deep insights into the various frontiers.
Building upon advanced technologies to create, visualize, analyze and manipulate nano-structures, as well as to probe their nano-chemistry, nano-mechanics and other properties within manmade and living systems, many exciting discoveries are currently made. They change the way we do science and result in so many new technologies.

The goal of the course is to give Master and Graduate students from all interested departments an overview of what nanotechnology is all about, from analytical techniques to nanosystems, from physics to biology. Students will start to appreciate the extent to which scientific communities are meeting at the nanoscale. They will learn about the specific challenges and what is currently sizzling in the respective fields, and learn the vocabulary that is necessary to communicate effectively across departmental boundaries.

Each lecturer will first give an overview of the state-of-the art in his/her field, and then describe the research highlights in his/her own research group. While preparing their Final Projects and discussing them in front of the class, the students will deepen their understanding of how to apply a range of new technologies to solve specific scientific problems and technical challenges. Exposure to the different frontiers will also improve their ability to conduct effective nanoscale research, recognize the broader significance of their work and to start collaborations.

Starting with the fabrication and analysis of nanoparticles and nanostructured materials that enable a variety of scientific and technical applications, we will transition to discussing biological nanosystems, how they work and what bioinspired engineering principles can be obtained by thoroughly discussing medical applications and potential scientific aspects as well as the many of the emerging technologies will be covered that start impacting so many aspects of our lives. This includes new phenomena in physics, advanced materials, novel technologies and new methods to address major medical challenges.

All the enrolled students will get access to a password protected website where they can find pdf files of the lecture notes, and typically 1-2 journal articles per lecture that cover selected topics.

Objective

Abstract

Content

Lecture notes

402-0674-00L Physics in Medical Research: From Atoms to Cells W 6 credits 2V+1U B. K. R. Müller

Objective

The lecture series is motivated by an overview covering the skin of the crystals, roughness analysis, contact angle measurements, protein absorption/activity and monocyte behaviour.

As the first step, real structures on clean surfaces including surface reconstructions and surface relaxations, defects in crystals are presented, before the preparation of clean metallic, semiconducting, oxidic and organic surfaces are introduced.

The atomic processes on surfaces are activated by the increase of the substrate temperature. They can be studied using scanning tunneling microscopy (STM) and atomic force microscopy (AFM). The combination with molecular beam epitaxy (MBE) allows determining the sizes of the critical nuclei and the other activated processes in a hierarchical fashion. The evolution of the surface morphology is characterized by the density and size distribution of the nanostructures that could be quantified by means of the rate equation analysis, the mean-field nucleation theory, as well as the scaling theory. The surface morphology is further characterized by defects and nanostructure's shapes, which are based on the strain relieving mechanisms and kinetic growth processes.

High-resolution electron diffraction is complementary to scanning probe techniques and provides exact mean values. Some phenomena are quantitatively described by the kinematic theory and perfectly understood by means of the Ewald construction. Other phenomena need to be described by using complex dynamical theory. Electron diffraction is not only associated with elastic scattering but also inelastic excitation mechanisms that reflect the electronic structure of the surfaces studied. Low-energy electrons lead to phonon and high-energy electrons to plasmon excitations. Both effects are perfectly described by dipole and impact scattering.

Thin-films of rather complex organic materials are often quantitatively characterized by photons with a broad range of wavelengths from ultra-violet to infra-red light. Asymmetries and preferential orientations of the (anisotropic) molecules are verified using the optical dichroism and second harmonic generation measurements. These characterization techniques are vital for optimizing the preparation of medical implants and the determination of tissue's anisotropies within the human body.

Cell-surface interactions are related to the cell adhesion and the contractile cellular forces. Physical means have been developed to quantify these interactions. Other physical techniques are introduced in cell biology, namely to count and sort cells, to study cell proliferation and metabolism and to determine the relation between cell morphology and function.

3D scaffolds are important for tissue augmentation and engineering. Design, preparation methods, and characterization of these highly porous 3D microstructures are also presented.

Visiting clinical research in a leading university hospital will show the usefulness of the lecture series.

529-0837-00L Biomicrofluidic Engineering W 7 credits 3G A. de Mello

Objective

Number of participants limited to 30.

Abstract

Microfluidics describes the behavior, control and manipulation of fluids that are geometrically constrained within sub-microliter environments. The use of microfluidic devices offers an opportunity to control physical and chemical processes with unrivalled precision, and in turn provides a route to performing chemistry and biology in an ultra-fast and high-efficiency manner.

In the course students will investigate the theoretical concepts behind microfluidic device operation, the methods of microfluidic device manufacture and the application of microfluidic architectures to important problems faced in modern day chemical and biological analysis. A design workshop will allow students to develop new microscale flow processes by appreciating the dominant physics at the microscale. The application of these basic ideas will primarily focus on biological problems and will include a treatment of diagnostic devices for use at the point-of-care, advanced functional material synthesis, DNA analysis, proteomics and cell-based assays. Lectures, assignments and the design workshop will acquaint students with the state-of-the-art in applied microfluidics.

Autumn Semester 2016
Lecturers Storage, handling and analysis of large datasets have become essential in biological research. The course will introduce students to a

Introduction to Bioinformatics: Concepts and

ECTS W K. Bärenfaller, M. Cook, V. Mante,

Type 4G

Lecture handouts, background literature, problem sheets and notes will be provided electronically.

W. Fussenegger

Handsout during the course.

Title The course provides an introduction to the functional properties of neurons. Particularly the description of membrane electrical properties

2V+1U Introduction to Neuroinformatics

Understanding computation by neurons and neuronal circuits is one of the great challenges of science. Many different disciplines can

3V This course considers the structure and function of biological neural networks at different levels. The function of neural networks lies

6 credits W 6 credits 3V M. Fussenegger

M. Pfeiffer

Lecture notes Handouts during the course.

636-0003-00L Biological Engineering and Biotechnology W 6 credits 3V M. Fussenegger

Biological Engineering and Biotechnology will cover the latest biotechnological advances as well as their industrial implementation to

train mammalian cells for use in human therapy. This lecture will provide forefront insights into key scientific aspects and the main

points in industrial decision-making to bring a therapeutic from target to market.

Objective 1. Insight Into The Mammalian Cell Cycle. Cycling, The Balance Between Proliferation and Cancer - Implications For Biopharmaceutical

Manufacturing. 2. The Licence To Kill. Apoptosis Regulatory Networks - Engineering of Survival Pathways To Increase Robustness of Production Cell Lines.


5. From Target To Market. An Antibody's Journey From Cell Culture to The Clinic. 6. Biology and Malign Applications. Do Life Sciences Enable the


Lecture notes Handouts during the course.

Major in Neuroinformatics

Core Courses

Number Title Type ECTS Hours Lecturers

227-1037-00L Introduction to Neuroinformatics W 6 credits 2V+1U K. A. Martin, M. Cook, V. Mante, M. Pfeiffer

Abstract The course provides an introduction to the functional properties of neurons. Particularly the description of membrane electrical properties

(action potentials, channels), neuronal anatomy, synaptic structures, and neuronal networks. Simple models of computation, learning, and

behavior will be explained. Some artificial systems (robot, chip) are presented.

Objective Understanding computation by neurons and neuronal circuits is one of the great challenges of science. Many different disciplines can

contribute their tools and concepts to solving mysteries of neural computation. The goal of this introductory course is to introduce the

monocultures of physics, maths, computer science, engineering, biology, psychology, and even philosophy and history, to discover the

enchantments and challenges that we all face in taking on this major 21st century problem and how each discipline can contribute to

discovering solutions.

Content This course considers the structure and function of biological neural networks at different levels. The function of neural networks lies

fundamentally in their wiring and in the electro-chemical properties of nerve cell membranes. Thus, the biological structure of the nerve cell

needs to be understood if biologically-realistic models are to be constructed. These simpler models are used to estimate the electrical

current flow through dendritic cables and explore how a more complex geometry of neurons influences this current flow. The active

properties of nerves are studied to understand both sensory transduction and the generation and transmission of nerve impulses along

axons. The concept of local neuronal circuits arises in the context of the rules governing the formation of nerve connections and

topographic projections within the nervous system. Communication between neurons in the network can be thought of as information flow

across synapses, which can be modified by experience. We need an understanding of the action of inhibitory and excitatory

neurotransmitters and neuromodulators, so that the dynamics and logic of synapses can be interpreted. Finally, the neural architectures of

feedforward and recurrent networks will be discussed in the context of co-ordination, control, and integration of sensory and motor

information in neural networks.


Abstract Storage, handling and analysis of large datasets have become essential in biological research. The course will introduce students to a

number of applications of bioinformatics in biology. Freely accessible software tools and databases will be explained and explored in

theory and praxis.
Introduction to Bioinformatics I: Concepts and Applications (formerly Bioinformatics I) will provide students with the theoretical background of approaches to store and retrieve information from large databases. Concepts will be developed how DNA sequence information can be used to understand phylogenetic relationships, how RNA sequence relates to structure, and how protein sequence information can be used for genome annotation and to predict protein folding and structure. Students will be introduced to quantitative methods for measuring gene expression and how this information can be used to model gene networks. Methods will be discussed to construct protein interaction maps and how this information can be used to simulate dynamic molecular networks.

In addition to the theoretical background, the students will develop hands-on experiences with the bioinformatics methods through guided exercises. The course provides students from different backgrounds with basic training in bioinformatics approaches that have impact on biological, chemical and physics experimentation. Bioinformatics approaches draw significant expertise from mathematics, statistics and computational science.

Although "Introduction to Bioinformatics I" will focus on theory and praxis of bioinformatics approaches, the course provides an important foundation for the course "Introduction to Bioinformatics II: Fundamentals of computer science, modeling and algorithms" that will be offered in the following semester.

Bioinformatics I will cover the following topics:

- From genes to databases and information
- BLAST searches
- Prediction of gene function and regulation
- RNA structure prediction
- Gene expression analysis using microarrays
- Protein sequence and structure databases
- WWW for bioinformatics
- Protein sequence comparisons
- Proteomics and de novo protein sequencing
- Protein structure prediction
- Cellular and protein interaction networks
- Molecular dynamics simulation

### Practical Work

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<tr>
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<td>465-0800-00L</td>
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<td>O</td>
<td>4</td>
<td></td>
<td>external organisers</td>
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**Abstract**

The practical work is designed to train the students in the solution of a specific problem and provides insights in the field of the selected MAS specialization. Tutors propose the subject of the project, the project plan, and the roadmap together with the student, as well as monitor the overall execution.

**Objective**

The practical work is aimed at training the student's capability to apply and connect specific skills acquired during the MAS specialization program towards the solution of a focused problem.

### Electives

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<tbody>
<tr>
<td>227-1033-00L</td>
<td>Neuromorphic Engineering I</td>
<td>W</td>
<td>6</td>
<td>2V+3U</td>
<td>T. Delbrück, G. Indiveri, S.C. Liu</td>
</tr>
</tbody>
</table>

**Registration in this class requires the permission of the instructors. Class size will be limited to available lab spots. Preference is given to students that require this class as part of their major.**

**Abstract**

This course covers analog circuits with emphasis on neuromorphic engineering: MOS transistors in CMOS technology, static circuits, dynamic circuits, systems (silicon neuron, silicon retina, silicon cochlea) with an introduction to multi-chip systems. The lectures are accompanied by weekly laboratory sessions.

**Objective**

Understanding of the characteristics of neuromorphic circuit elements.

**Content**

Neuromorphic circuits are inspired by the organizing principles of biological neural circuits. Their computational primitives are based on physics of semiconductor devices. Neuromorphic architectures often rely on collective computation in parallel networks. Adaptation, learning and memory are implemented locally within the individual computational elements. Transistors are often operated in weak inversion (below threshold), where they exhibit exponential I-V characteristics and low currents. These properties lead to the feasibility of high-density, low-power implementations of functions that are computationally intensive in other paradigms. Application domains of neuromorphic circuits include silicon retinas and cochleas for machine vision and audition, real-time emulations of networks of biological neurons, and the development of autonomous robotic systems. This course covers devices in CMOS technology (MOS transistor below and above threshold, floating-gate MOS transistor, phototransducers), static circuits (differential pair, current mirror, transconductance amplifiers, etc.), dynamic circuits (linear and nonlinear filters, adaptive circuits), systems (silicon neuron, silicon retina and cochlea) and an introduction to multi-chip systems that communicate events analogous to spikes. The lectures are accompanied by weekly laboratory sessions on the characterization of neuromorphic circuits, from elementary devices to systems.

**Literature**

S.-C. Liu et al.: Analog VLSI Circuits and Principles; various publications.

**Prerequisites / notice**

Particular: The course is highly recommended for those who intend to take the spring semester course "Neuromorphic Engineering II", that teaches the conception, simulation, and physical layout of such circuits with chip design tools.

Prerequisites: Background in basics of semiconductor physics helpful, but not required.

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<tbody>
<tr>
<td>376-1795-00L</td>
<td>Advanced Course in Neurobiology I (Functional Anatomy of the Rodent Brain) (University of Zurich)</td>
<td>W</td>
<td>2</td>
<td></td>
<td>J.M. Fritschi, H. U. Zeilhofer</td>
</tr>
</tbody>
</table>

**No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.**

**UZH Module Code:** SPV0Y009

**Mind the enrolment deadlines at UZH:**

http://www.uzh.ch/studies/application/mobilitaet_en.html

**Abstract**

The goal of this Advanced Course in Neurobiology is to provide students with a broader knowledge in several important areas of neurobiology. The course consists of four parts: Part I deals with various topics in developmental neurobiology. Part II is devoted to aspects of signal transduction. Part III focuses on synaptic transmission. Part IV gives deeper insights into systems neuroscience.

**Objective**

This credit point course is designed for doctoral students who have successfully completed the Introductory Course in Neuroscience at the Neuroscience Center Zurich. The goal is to provide students with a broader and deeper knowledge in several important areas of neurobiology.
376-1791-00L Introductory Course in Neuroscience I (University of Zurich)  

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.  

UZH Module Code: SPV0Y005  

Mind the enrolment deadlines at UZH:  
http://www.uzh.ch/studies/application/mobilitaet_en.html  

Abstract  
The course gives an introduction to human and comparative neuroanatomy, molecular, cellular and systems neuroscience.  

Objective  
The course provides an introduction to the basic concepts of X-ray tomographic imaging, image analysis and data quantification at the micro and nano scale with particular emphasis on biological applications  

Content  
1) Human Neuroanatomy I&II  
2) Comparative Neuroanatomy  
3) Development I&II  
4) Membran and Action Potential  
5) Synaptic Transmission & Plasticity I&II  
6) Glia and Blood-Brain-BARRIER  
7) Somatosensory and Motor System  
8) Visual System  
9) Auditory System  
10) Circuits underlying Emotion  
11) Modeling of Neural Circuits  

Prerequisites / notice  
For doctoral students of the Neuroscience Center Zurich (ZNZ).

重大生物相容性材料

核心课程

<table>
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<tr>
<th>数量</th>
<th>题目</th>
<th>种类</th>
<th>ECTS</th>
<th>小时</th>
<th>讲师</th>
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<tbody>
<tr>
<td>227-0965-00L</td>
<td>Micro and Nano-Tomography of Biological Tissues</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>M. Stampanoni, P. A. Kaestner</td>
</tr>
</tbody>
</table>

摘要  
这门课程介绍了X射线显微镜的物理和技术知识。各种X射线成像技术（吸收率-面-暗场对比）将在日常研究中被讨论和使用，特别是在生物医学领域。该课程讨论了成像数据的定性以及成像数据的定性与统计学。

目的  
该课程介绍了X射线成像的基本概念，如成像分析和数据量化。

内容  
X射线成像在广义上是一个强有力的工具，用于非破坏性、高分辨率的成像。

主题  
X射线成像的高分辨率和高共焦度是第三代同步辐射辐射实验的允许量，三种三维成像在微米和纳米尺度上扩展传统的吸收成像技术，包括增强和相位敏感测量，这些特别适合于生物样本。

课程最终提供了必要的背景，以便理解成像数据的定量评估，从基本图像分析到复杂形态测量和3D可视化，始终保持在生物医学应用。

讲座笔记  
讲座笔记将被注明。

2016秋季学期

376-1622-00L Practical Methods in Tissue Engineering  

Number of participants limited to 12.  

Abstract  
The goal of this course is to teach MSc students the necessary skills for doing research in the fields of tissue engineering and regenerative medicine.

Objective  
Practical exercises and demonstrations on topics including sterile cell culture, light microscopy and histology, protein and gene expression analysis, and viability assays are covered. The advantages of 3D cell cultures will be discussed and practical work on manufacturing and evaluating hydrogels and scaffolds for tissue engineering will be performed in small groups. In addition to practical work, the course will teach skills in data acquisition/analysis.

内容  
实践练习和演示包括无菌细胞培养、光学显微镜和显微解剖学、蛋白质和基因表达分析，以及活细胞检测。3D细胞培养的优势将被讨论，并进行制造和评价水凝胶和支架的实践工作。在实践工作之外，本课程还将教授数据采集/分析的技能。

讲座笔记  
讲座笔记将被注明。

376-1714-00L Biocompatible Materials  

Abstract  
Introduction to molecules used for biomaterials, molecular interactions between different materials and biological systems (molecules, cells, tissues). The concept of biocompatibility is discussed and important techniques from biomaterials research and development are introduced.

Objective  
The class consists of three parts:  
1. Introduction into molecular characteristics of molecules involved in the materials-to-biology interface. Molecular design of biomaterials.  
2. The concept of biocompatibility.  
3. Introduction into methodology used in biomaterials research and application.

内容  
介绍用于生物材料的分子，不同材料和生物系统的分子（分子，细胞，组织）。生物相容性的概念被讨论，并介绍生物材料研究和发展的关键技术。

讲座笔记  
手册可以访问。

文献  

(可在线访问ETH图书馆)

Handouts provided during the classes and references therein.
Practical Work

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<tr>
<td>465-0800-00L</td>
<td>Practical Work</td>
<td>O</td>
<td>4</td>
<td></td>
<td>external organisers</td>
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</tbody>
</table>

**Abstract**
The practical work is designed to train the students in the solution of a specific problem and provides insights into the field of the selected MAS specializations. Tutors propose the subject of the project, the project plan, and the roadmap together with the student, as well as monitor the overall execution.

**Objective**
The practical work is aimed at training the student's capability to apply and connect specific skills acquired during the MAS specialization program towards the solution of a focused problem.

Electives

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>151-0255-00L</td>
<td>Energy Conversion and Transport in Biosystems</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>D. Poulikakos, A. Ferrari</td>
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</table>

**Abstract**
The theory and application of thermodynamics and energy conversion in biological systems with focus on the cellular level. Understanding of the basic features governing solutes transport in the principal systems of the human cell. Connection of characteristics and patterns from other fields of engineering to biofluidics. Heat and mass transport processes in the cell, generation of forces, work and relation to biomedical technologies.

**Objective**
Mass transfer models for the transport of chemical species in the human cell. Organization and function of the cell membrane and of the cell cytoskeleton. The role of molecular motors in cellular force generation and their function in cell migration. Description of the functionality of these systems and of analytical experimental and computational techniques for understanding of their operation.

**Content**
Introduction to cell metabolism, cellular energy transport and cellular thermodynamics.

**Lecture notes**
Material in the form of hand-outs will be distributed.

**Literature**
Lecture notes and references therein.

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<tr>
<th>Number</th>
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<th>Hours</th>
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<tbody>
<tr>
<td>327-1101-00L</td>
<td>Biomineralization</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>K.H. Ernst</td>
</tr>
</tbody>
</table>

**Abstract**
The course addresses undergraduate and graduate students interested in getting introduced into the basic concepts of biomineralization.

**Objective**
The course aims to introduce the basic concepts of biomineralization and the underlying principles, such as supersaturation, nucleation and growth of minerals, the interaction of biomolecules with mineral surfaces, and cell biology of inorganic materials creation. An important part of this class is the independent study and the presentation of original literature from the field.

**Content**
Biomineralization is a multidisciplinary field. Topics dealing with biomineralization and multifaceted biology, solid state physics, mineralogy, crystallography, organic and physical chemistry, biochemistry, dentistry, oceanography, geology, etc. are addressed. The course covers definition and general concepts of biomineralization (BM) types of biominerals and their function. Biological induction of BM. Control of crystal morphology, habit, shape and orientation by organisms. Strategies of compartmentalization. The interface between biomolecules (peptides, polysaccharides) and the mineral phase. Modern experimental methods for studying BM phenomena. Inter- and intra- and epicellular BM. Organic templates and matrices for BM. Structure of bone, teeth (vertebrate and invertebrates) and mollusk shells. Calcification. Silification. Diatoms, radiolarians and other BM: Calcium and iron storage and impact of BM on lithosphere and atmosphere evolution. Taxonomy of organisms.

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<th>Number</th>
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<tr>
<td>376-1103-00L</td>
<td>Frontiers in Nanotechnology</td>
<td>W</td>
<td>4</td>
<td>4V</td>
<td>V. Vogel, further lecturers</td>
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</table>

**Abstract**
Many disciplines are meeting at the nanoscale, from physics, chemistry to engineering, from the life sciences to medicine. The course will prepare students to communicate more effectively across disciplinary boundaries, and will provide them with deep insights into the various frontiers.

**Objective**
Building upon advanced technologies to create, visualize, analyze and manipulate nanomaterials, as well as to probe their nanochemistry, nano-mechanics and other properties within mammal and living systems, many exciting discoveries are currently made. They change the way we do science and result in many new technologies.

**Content**
The goal of the course is to give Master and Graduate students from all interested departments an overview of what nanotechnology is all about, from analytical techniques to nanosystems, from physics to biology. Students will start to appreciate the extent to which scientific communities are meeting at the nanoscale. They will learn about the specific challenges and what is currently sizzling in the respective fields, and learn the vocabulary that is necessary to communicate effectively across departmental boundaries.

**Lecture notes**
Each attendee is required to present a publication from the field. The selection of key papers is provided by the lecturer. No special requirements are needed for attending. Basic knowledge in chemistry and cell biology is expected.

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<tr>
<th>Number</th>
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<tr>
<td>402-0674-00L</td>
<td>Physics in Medical Research: From Atoms to Cells</td>
<td>W</td>
<td>6</td>
<td>2V+1U</td>
<td>B. K. R. Müller</td>
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</table>
Scanning probe and diffraction techniques allow studying activated atomic processes during early stages of epitaxial growth. For quantitative description, rate equation analysis, mean-field nucleation and scaling theories are applied on systems ranging from simple metallic to complex organic materials. The knowledge is expanded to optical and electronic properties as well as to proteins and cells.

The lecture series is motivated by an overview covering the skin of the crystals, roughness analysis, contact angle measurements, protein absorption/activity and monocyte behaviour.

As the first step, real structures on clean surfaces including surface reconstructions and surface relaxations, defects in crystals are presented, before the preparation of clean metallic, semiconducting, oxidic and organic surfaces are introduced.

The atomic processes on surfaces are activated by the increase of the substrate temperature. They can be studied using scanning tunneling microscopy (STM) and atomic force microscopy (AFM). The combination with molecular beam epitaxy (MBE) allows determining the sizes of the critical nuclei and the other activated processes in a hierarchical fashion. The evolution of the surface morphology is characterized by the density and size distribution of the nanostructures that could be quantified by means of the rate equation analysis, the mean-field nucleation theory, as well as the scaling theory. The surface morphology is further characterized by defects and nanostructure's shapes, which are based on the strain relieving mechanisms and kinetic growth processes.

High-resolution electron diffraction is complementary to scanning probe techniques and provides exact mean values. Some phenomena are quantitatively described by the kinematic theory and perfectly understood by means of the Ewald construction. Other phenomena need to be described by the more complex dynamical theory. Electron diffraction is not only associated with elastic scattering but also inelastic excitation mechanisms that reflect the electronic structure of the surfaces studied. Low-energy electrons lead to phonon and high-energy electrons to plasmon excitations. Both effects are perfectly described by dipole and impact scattering.

Thin-films of rather complex organic materials are often quantitatively characterized by photons with a broad range of wavelengths from ultra-violet to infra-red light. Asymmetries and preferential orientations of the (anisotropic) molecules are verified using the optical dichroism and second harmonic generation measurements. These characterization techniques are vital for optimizing the preparation of medical implants and the determination of tissue's anisotropies within the human body.

Cell-surface interactions are related to the cell adhesion and the contractile cellular forces. Physical means have been developed to quantify these interactions. Other physical techniques are introduced in cell biology, namely to count and sort cells, to study cell proliferation and metabolism and to determine the relation between cell morphology and function.

3D scaffolds are important for tissue augmentation and engineering. Design, preparation methods, and characterization of these highly porous 3D microstructures are also presented.

Visiting clinical research in a leading university hospital will show the usefulness of the lecture series.

### Major in Molecular Biology and Biophysics

#### Core Courses

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<tr>
<th>Number</th>
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<tbody>
<tr>
<td>227-0945-00L</td>
<td>Cell and Molecular Biology for Engineers I</td>
<td>W</td>
<td>3</td>
<td>3G</td>
<td>C. Frei</td>
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<td></td>
<td><em>This course is part I of a two-semester course.</em></td>
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<tr>
<td>Abstract</td>
<td>The course gives an introduction into cellular and molecular biology, specifically for students with a background in engineering. The focus will be on the basic organization of eukaryotic cells, molecular mechanisms and cellular functions. Textbook knowledge will be combined with results from recent research and technological innovations in biology.</td>
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<tr>
<td>Objective</td>
<td>After completing this course, engineering students will be able to apply their previous training in the quantitative and physical sciences to modern biology. Students will also learn the principles how biological models are established, and how these models can be tested.</td>
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<tr>
<td>Content</td>
<td>Lectures will include the following topics: DNA, chromosomes, RNA, protein, genetics, gene expression, membrane structure and function, vesicular traffic, cellular communication, energy conversion, cytoskeleton, cell cycle, cellular growth, apoptosis, autophagy, cancer, development and stem cells.</td>
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<tr>
<td>Lecture notes</td>
<td>Scripts of all lectures will be available.</td>
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<td></td>
<td><em>Introduction to Bioinformatics I: Concepts and Applications (formerly Bioinformatics I) will provide students with the theoretical background of approaches to store and retrieve information from large databases. Concepts will be developed how DNA sequence information can be used to understand phylogenetic relationships, how RNA sequence relates to structure, and how protein sequence information can be used for genome annotation and to predict protein folding and structure. Students will be introduced to quantitative methods for measuring gene expression and how this information can be used to model gene networks. Methods will be discussed to construct protein interaction maps and how this information can be used to simulate dynamic molecular networks. In addition to the theoretical background, the students will develop hands-on experiences with the bioinformatics methods through guided exercises. The course provides students from different backgrounds with basic training in bioinformatics approaches that have impact on biological, chemical and physics experimentation. Bioinformatics approaches draw significant expertise from mathematics, statistics and computational science.</em></td>
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<tr>
<td>Abstract</td>
<td>Storage, handling and analysis of large datasets have become essential in biological research. The course will introduce students to a number of applications of bioinformatics in biology. Freely accessible software tools and databases will be explained and explored in theory and praxis.</td>
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<tr>
<td>Objective</td>
<td>Introduction to Bioinformatics I: Concepts and Applications (formerly Bioinformatics I) will provide students with the theoretical background of approaches to store and retrieve information from large databases. Concepts will be developed how DNA sequence information can be used to understand phylogenetic relationships, how RNA sequence relates to structure, and how protein sequence information can be used for genome annotation and to predict protein folding and structure. Students will be introduced to quantitative methods for measuring gene expression and how this information can be used to model gene networks. Methods will be discussed to construct protein interaction maps and how this information can be used to simulate dynamic molecular networks. In addition to the theoretical background, the students will develop hands-on experiences with the bioinformatics methods through guided exercises. The course provides students from different backgrounds with basic training in bioinformatics approaches that have impact on biological, chemical and physics experimentation. Bioinformatics approaches draw significant expertise from mathematics, statistics and computational science.*</td>
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<tr>
<td>Literature</td>
<td>&quot;Introduction to Bioinformatics II: Fundamentals of computer science, modeling and algorithms&quot; that will be offered in the following semester.</td>
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</table>
Bioinformatics I will cover the following topics:

- From genes to databases and information
- BLAST searches
- Prediction of gene function and regulation
- RNA structure prediction
- Gene expression analysis using microarrays
- Protein sequence and structure databases
- WWW for bioinformatics
- Protein sequence comparisons
- Proteomics and de novo protein sequencing
- Protein structure prediction
- Cellular and protein interaction networks
- Molecular dynamics simulation

### Practical Work

**Number** | **Title** | **Type** | **ECTS** | **Hours** | **Lecturers**
--- | --- | --- | --- | --- | ---
465-0800-00L | Practical Work Only for MAS in Medical Physics | O | 4 credits | | external organisers

**Abstract**
The practical work is designed to train the students in the solution of a specific problem and provides insights in the field of the selected MAS specialization. Tutors propose the subject of the project, the project plan, and the roadmap together with the student, as well as monitor the overall execution.

**Objective**
The practical work is aimed at training the student’s capability to apply and connect specific skills acquired during the MAS specialization program towards the solution of a focused problem.

### Electives

**Number** | **Title** | **Type** | **ECTS** | **Hours** | **Lecturers**
--- | --- | --- | --- | --- | ---
327-1101-00L | Biomineralization | W | 2 credits | 2G | K.H. Ernst

**Abstract**
The course addresses undergraduate and graduate students interested in getting introduced into the basic concepts of biomineralization.

**Objective**
The course aims to introduce the basic concepts of biomineralization and the underlying principles, such as supersaturation, nucleation and growth of minerals, the interaction of biomolecules with mineral surfaces, and cell biology of inorganic materials creation. An important part of this class is the independent study and the presentation of original literature from the field.

**Content**
Biomineralization is a multidisciplinary field. Topics dealing with biology, molecular and cell biology, solid state physics, mineralogy, crystallography, organic and physical chemistry, biochemistry, dentistry, oceanography, geology, etc. are addressed. The course covers definition and general concepts of biomineralization (BM)/ types of biominerals and their function / crystal nucleation and growth / biological induction of BM / control of crystal morphology, habit, shape and orientation by organisms / strategies of compartmentalization / the interface between biomolecules (peptides, polysaccharides) and the mineral phase / modern experimental methods for studying BM phenomena / inter-, intra, extra- and epicellular BM / organic templates and matrices for BM / structure of bone, teeth (vertebrates and invertebrates) and mollusk shells / calcification / siltification in diatoms, radiolaria and plants / calcium and iron storage / impact of BM on lithosphere and atmosphere/ evolution / taxonomy of organisms.

1. Introduction and overview
2. Biominerals and their functions
3. Chemical control of biomineralization
4. Control of morphology: Organic templates and additives
5. Modern methods of investigation of BM
6. BM in matrices: bone and nacre
7. Vertebrate teeth
8. Invertebrate teeth
9. BM within vesicles: calcite of coccoliths
10. Silica
11. Iron storage and mineralization

**Lecture notes** Script with more than 600 pages with many illustrations will be distributed free of charge.

**Literature**
3) P. M. Dove, J. J. DeYoreo, S. Weiner (Eds.) Biomineralization, Reviews in Mineralogy & Geochemistry Vol. 54, 2003

**Prerequisites / notice** Each attendee is required to present a publication from the field. The selection of key papers is provided by the lecturer. No special requirements are needed for attending. Basic knowledge in chemistry and cell biology is expected.

**Number** | **Title** | **Type** | **ECTS** | **Hours** | **Lecturers**
--- | --- | --- | --- | --- | ---
376-1103-00L | Frontiers in Nanotechnology | W | 4 credits | 4V | V. Vogel, further lecturers

**Abstract** Many disciplines are meeting at the nanoscale, from physics, chemistry to engineering, from the life sciences to medicine. The course will prepare students to communicate more effectively across disciplinary boundaries, and will provide them with deep insights into the various frontiers.
Starting with the fabrication and analysis of nanoparticles and nanostructured materials that enable a variety of scientific and technical applications, we will transition to discussing biological nanosystems, how they work and what bioinspired engineering principles can be derived from them. Finally discussing biomedical applications and potential health risk issues, scientific aspects as well as the many of the emerging technologies will be covered that start impacting so many aspects of our lives. This includes new phenomena in physics, advanced materials, novel technologies and new methods to address major medical challenges.

Each lecturer will first give an overview of the state-of-the art in his/her field, and then describe the research highlights in his/her own research group. While preparing their Final Projects and discussing them in front of the class, the students will deepen their understanding of how to apply a range of new technologies to solve specific scientific problems and technical challenges. Exposure to the different frontiers will also improve their ability to conduct effective nanoscale research, recognize the broader significance of their work and to start collaborations.

Content
Starting with the fabrication and analysis of nanoparticles and nanostructured materials that enable a variety of scientific and technical applications, we will transition to discussing biological nanosystems, how they work and what bioinspired engineering principles can be derived from them. Finally discussing biomedical applications and potential health risk issues, scientific aspects as well as the many of the emerging technologies will be covered that start impacting so many aspects of our lives. This includes new phenomena in physics, advanced materials, novel technologies and new methods to address major medical challenges.

The course covers the following topics: drug targeting and delivery principles, radiopharmaceuticals, macromolecular drug carriers, and delivery of vaccines.

Objective
The students gain an overview on current principles, methodologies and systems for controlled delivery and targeting of drugs. This enables the students to understand and evaluate the field in terms of scientific criteria.

Lecture notes
All enrolled students will get access to a password protected website where they can find pdf files of the lecture notes, and typically 1-2 journal articles per lecture that cover selected topics.
The course consists of a series of research seminars on Structural Biology, Biochemistry and Biophysics, given by both scientists of the National Center of Competence in Research (NCCR) in Structural Biology and external speakers. Information on the individual seminars is provided on the following websites:
http://www.structuralbiology.uzh.ch/educ002.asp
http://www.biol.ethz.ch/dbiol-cal/index

The goal of this course is to provide doctoral and postdoctoral students with a broad overview on the most recent developments in biochemistry, structural biology and biophysics.

Abstract

Molecular and Structural Biology I: Protein Structure and Function
D-BIOL BSc students are obliged to take part I and part II (next semester) as a two-semester course

Abstract

Biophysics of protein folding, membrane proteins and biophysics of membranes, enzymatic catalysis, catalytic RNA and RNAi, current topics in protein biophysics and structural biology.

Objective

Understanding of structure-function relationships in proteins and in protein folding, detailed understanding of biophysics and physical methods as well as modern methods for protein purification and microanalytics.

Literature

Scripts on the individual topics can be found under http://www.mol.biol.ethz.ch/teaching.

Basics:
- Creighton, T.E., Proteins, Freeman, (1993)
- Fersht, A., Enzyme, Structure and Mechanism in Protein Science (1999), Freeman.

Current topics: References will be given during the lectures.

Biological Engineering and Biotechnology

1. Insight Into The Mammalian Cell Cycle. Cycling, The Balance Between Proliferation and Cancer - Implications For Biopharmaceutical Manufacturing.
2. The Licence To Kill. Apoptosis Regulatory Networks - Engineering of Survival Pathways To Increase Robustness of Production Cell Lines.
5. From Target To Market. An Antibody's Journey From Cell Culture to The Clinics.
6. Biology and Malign Applications. Do Life Sciences Enable the Development of Biological Weapons?
7. Functional Food. Enjoy your Meal!

Lecture notes

Handsout during the course.

MAS in Medical Physics - Key for Type

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<th>Key for Type</th>
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<td>P</td>
<td>practical/laboratory course</td>
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<td>independent project</td>
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<td>revision course / private study</td>
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Special students and auditors need special permission from the lecturers.
MAS in Spatial Planning

Four-semester, part-time MAS programme.
Start of the next course: Autumn Semester 2017.

Lectures and Seminars

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
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<tr>
<td>115-0511-00L</td>
<td>Lecture Week 11: Introduction Study Project 2 W</td>
<td>W</td>
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<td>A. Grams Dietziker</td>
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<td>Only for MAS in Spatial Planning.</td>
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<td>The topic of the study project of the second year</td>
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<td>areas in the Lake of Constance region. Typical</td>
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<td>problems in such a kind of spaces are the</td>
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<td>complexity of content and institutions; two days</td>
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<td>excursion in the project area; consolidation of</td>
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<td>the methodology for interdisciplinary team work.</td>
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<td>The aim of the first course in the second year of</td>
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<td>the program is an individual setting up of the</td>
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<td>further education; developing an overview</td>
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<td>on the second Study Project as well as reviewing</td>
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<td>the basic knowledge about team work gathered in</td>
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<td>the first year and adapting it if necessary in</td>
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<tr>
<td>115-0512-00L</td>
<td>Lecture Week 12: Spatial Development W</td>
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<td>B. Scholl</td>
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<td>Only for MAS, DAS and CAS in Spatial Planning.</td>
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<td>Abstract</td>
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<td>In this course, the fundamental methods in spatial</td>
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<td>planning taught in the second week will be</td>
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<td>consolidated. In particular additional</td>
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<td>knowledge and practice in the fields of spatial</td>
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<td>planning methodology, spatial design and</td>
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<td>Lecture Week 13: Urban Planning and Urban Design II W</td>
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<td>1G</td>
<td>K. Christiaanse, S. Kretz</td>
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<td>focuses on a case study in the field of strategic</td>
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<td>discussions with actors from the planning and</td>
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<td>analyse and discuss a real life problem and</td>
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<td>W. Schönwandt, A. Grams Dietziker</td>
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<td>Impart thinking patterns and active application of</td>
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<td>Lecture Week 15: Academic Working in Spatial W</td>
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<td>What means a scientific method in spatial planning?</td>
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<td>knowledge of scientific working and writing;</td>
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<td>various case studies and exercises.</td>
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<td>Introduction to European planning systems and their</td>
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Projects and Individual Work

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<td>115-0702-00L</td>
<td>Study Project 2 (part 1) O</td>
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<td>10U</td>
<td>S. Gatti-Sauter, F. Günther,</td>
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<td>P. J. Noser, R. Tremp</td>
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<td>Development of strategies for sustainable</td>
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<td>planning analysis of the situation (goals and</td>
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<td>priorities); preparation for implementation</td>
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<td>(instruments and procedures); independent group</td>
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<td>Detect, assess and classify the main conflicts of</td>
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<td>spatial development and define the need for</td>
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<td>planning action. Concentrate resources and</td>
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<td>design; evaluate different solutions and</td>
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<td>demonstrate their feasibility exemplarily.</td>
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<td>Recognize possibilities and limits of formal and</td>
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<td>informal planning and apply them in practice.</td>
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<td>Efficient and interdisciplinary group work.</td>
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<th>Key for Hours</th>
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<td>revision course / private study</td>
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ECTS | European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
**Compulsory Courses**

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<td>Water Resources Seminars</td>
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<td>3</td>
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<td>P. Molnar, P. Burlando, further speakers</td>
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**Abstract**
The Seminar Series features invited experts from a wide range of disciplines, who will present their experiences working with water related topics in international settings. The students will be exposed to many different perspectives, and will be asked to apply the information they learn to specific case studies.

**Objective**
The Seminar Series will provide students with background information on the wide range of topics related to water resources. The lectures will challenge the students to evaluate water resources and water resource management in new ways, using tools that have been successfully implemented in real case scenarios. The seminars will include theory, interactive discussions, and the assessment of methodologies. Student participation will be highly encouraged.

**Content**
The Seminar Series is aimed at offering students the opportunity to learn about water resources in a multi-disciplinary fashion, with a focus on international examples. Selected topics will include: Water & Sanitation, Urban Water Management, Politics & International Water Management, Water Resources & Agriculture, Water Hazards (floods), Water Resources & Ecosystem Services, Integrated Water Resource Management, and Adaptation to Climate Change. For additional details see the course website [http://www.mas-swr.ethz.ch/education/courses/core-courses/water-resources-seminars.html](http://www.mas-swr.ethz.ch/education/courses/core-courses/water-resources-seminars.html).

**Prerequisites / notice**
For further information, contact the MAS coordinator, Darcy Molnar (darcy.molnar@ifi.baug.ethz.ch).

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<td>102-0287-00L</td>
<td>Fluvial Systems</td>
<td>O</td>
<td>3</td>
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<td>P. Molnar</td>
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**Abstract**
The course presents a view of the processes acting on and shaping the landscape and the fluvial landforms that result. The fluvial system is viewed in terms of the production and transport of sediment on hillslopes, the structure of the river network and channel morphology, fluvial processes in the river, riparian zone and floodplain, and basics of catchment and river management.

**Objective**
The course has two fundamental aims: (1) it aims to provide environmental engineers with the physical process basis of fluvial system change, using the right language and terminology to describe landforms; and (2) it aims to provide quantifiable skills in making simple and more complex predictions of change and the data and models required.

**Content**
The course consists of three sections: (1) Introduction to fluvial forms and processes and geomorphic concepts of landscape change, including climatic and human activities acting on the system. (2) The processes of sediment production, upland sheet-rill-gully erosion, basin sediment yield, rainfall-triggered landsliding, sediment budgets, and the modelling of the individual processes involved. (3) Processes in the river, floodplain and riparian zone, including river network topology, channel geometry, aquatic habitat, role of riparian vegetation, including basics of fluvial system management. The main focus of the course is hydrological and the scales of interest are field and catchment scales.

**Lecture notes**
There is no script.

**Literature**
The course materials consist of a series of 13 lecture presentations and notes to each lecture. The lectures were developed from textbooks, professional papers, and ongoing research activities of the instructor. All material is on the course webpage.

**Prerequisites / notice**
Prerequisites: Hydrology 1 and Hydrology 2 (or contact instructor).

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<tr>
<td>102-0237-00L</td>
<td>Hydrology II</td>
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<td>3</td>
<td>2G</td>
<td>P. Burlando, S. Fatichi</td>
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</table>

**Abstract**
The course presents advanced hydrological analyses of rainfall-runoff processes. The course is given in English.

**Objective**
Tools for hydrological modelling are discussed at the event and continuous scale. The focus is on the description of physical processes and their modelling with practical examples.

**Content**

**Lecture notes**
Parts of the script for "Hydrology II" are used. Also available are the overhead transparencies used in the lectures. The semester project consists of a two part instruction manual.

**Literature**
Additional literature is presented during the course.

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<td>Numerical Hydraulics</td>
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<td>M. Holzner</td>
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**Abstract**
In the course Numerical Hydraulics the basics of numerical modelling of flows are presented.

**Objective**
The goal of the course is to develop the understanding of the students for numerical simulation of flows to an extent that they can later use commercial software in a responsible and critical way.

**Content**
The basic equations are derived from first principles. Possible simplifications relevant for practical problems are shown and their applicability is discussed. Using the example of non-steady state pipe flow numerical methods such as the method of characteristics and finite difference methods are introduced. The finite volume method as well as the method of characteristics are used for the solution of the shallow water equations. Special aspects such as wave propagation and turbulence modelling are also treated.

All methods discussed are applied practically in exercises. This is done using programs in MATLAB which partially are programmed by the students themselves. Further, some generally available softwares such as Hydraulic Systems and HEC RAS for non-steady flows are used.

**Lecture notes**
Lecture notes, powerpoints shown in the lecture and programs used can be downloaded. They are also available in German.

**Literature**
Given in lecture.

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<td>O</td>
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<td>3G</td>
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**Abstract**
The course deals with advanced topics in GIS; GIS project lifecycle, Managing GIS, Legal issues, GIS assets & constraints; Geospatial Web Services; technical basics, architecture, functions, interoperability, standards, mashups, portals, applications; Geostatistics; Sensor Web Enablement; Human-Computer Interaction; Cognitive Issues in GIS.

**Objective**
Students will get a detailed overview of advanced GIS topics. They will go through all steps of setting up a Web-GIS application in the labs and perform other practical tasks relating to Sensor Web Enablement, Human-Computer Interaction, Geostatistics, and Web Processing Services.

**Lecture notes**
Lecture slides will be made available in digital form.
Implementation of Environmental and other Sustainability Goals
Master students in Environmental Engineering choosing module Ecological Systems Design are not allowed to...
How to make sustainability operational - in industry, services and other organizations: You will learn how to put sustainability into practice by integrating environmental, social and economic aspects into organisations' management and processes. The course contains both a management view, as well as a sustainability view - and how to combine them.

Objective
To provide understanding of how sustainability can be made operational in an organisation. To do so, students will understand how to integrate sustainability thinking into the typical current organisational environment and processes, such as planning, implementing and controlling.

Content
We meet for five 3-hour-lectures, with discussions and case studies during course time. Additionally, small case studies in-between courses will be given at most course days.

Course topics are:
- Sustainable Development and its meaning for Management
- Management Standards for Sustainability (ISO and others)
- Sustainability Opportunities and Innovation
- Organisation and Implementation
- The concept of ‘Continuous Improvement’
- Environmental Performance Measurement (Concepts, Standards, Methods)
- Life Cycle Costing, Life Cycle Management
- (Sustainable) Supply Chain Management
- Communication of Sustainability Issues

Literature
There are two ways to approach the course's issues:


c) We will touch upon the hotel sustainable scheme and label "ibex" see: http://www.e2mc.com/images/stories/e2_bilder/downloads/Umweltfocus_d.pdf (for an english version, pls contact the lecturer at arthurb@ethz.ch)

Prerequisites / notice
If you have specific interests or questions, let me know at arthurb@ethz.ch. Maybe I can include your issues - or I can't :-)

701-0015-00L Seminar on Transdisciplinary Research for Sustainable Development

Abstract
The seminar is designed for students and researchers (MA, PhD, PostDoc) who use inter- and transdisciplinary elements in their projects. It addresses the challenges of this research: How to integrate disciplines? How (and in what role) to include societal actors? How to bring results to fruition? We discuss these questions based on case studies and theories and on the participant's projects.

Objective
The participants understand the specific challenges of inter- and transdisciplinary research in general and in the context of sustainable development in particular. They know methods and concepts to address these challenges and apply them to their research projects.

Content
The seminar covers the following topics:
(1) Theories and concepts of inter- and transdisciplinary research
(2) The specific challenges of inter- and transdisciplinary research
(3) Involving stakeholders
(4) Collaborating disciplines
(5) Exploration of tools and methods
(6) Analysing participants' projects to improve inter- and transdisciplinary elements

Literature
Literature will be made available to the participants

Prerequisites / notice
The seminar is specifically suitable for PhD or PostDoc researchers. It is open to master students (minor "global change and sustainability") and further interested people, who preferentially are preparing, or working on, a project/thesis.

E Electives

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>102-0215-00L</td>
<td>Urban Water Management II</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>M. Maurer, P. Staufer</td>
</tr>
<tr>
<td>Objective</td>
<td>Consolidation of the basic procedures for design and operation of technical networks in water engineering.</td>
<td></td>
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</tr>
<tr>
<td>Lecture notes</td>
<td>Written material and copies of the overheads will be available.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prerequisites / notice</td>
<td>Prerequisite: Introduction to Urban Water Management</td>
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</tbody>
</table>

401-6215-00L Using R for Data Analysis and Graphics (Part I)

Abstract
The course provides the first part an introduction to the statistical software R for scientists. Topics covered are data generation and selection, graphical and basic statistical functions, creating simple functions, basic types of objects.

Objective
The students will be able to use the software R for simple data analysis.
The course provides the first part of an introduction to the statistical software R for scientists. R is free software that contains a huge collection of functions with focus on statistics and graphics. If one wants to use R one has to learn the programming language R - on very rudimentary level. The course aims to facilitate this by providing a basic introduction to R.

Part I of the course covers the following topics:
- What is R?
- R Basics: reading and writing data from/to files, creating vectors & matrices, selecting elements of dataframes, vectors and matrices, arithmetics;
- Types of data: numeric, character, logical and categorical data, missing values;
- Simple (statistical) functions: summary, mean, var, etc., simple statistical tests;
- Writing simple functions;
- Introduction to graphics: scatter-, boxplots and other high-level plotting functions, embellishing plots by title, axis labels, etc., adding elements (lines, points) to existing plots.

The course focuses on practical work at the computer. We will make use of the graphical user interface RStudio: www.rstudio.org

Note: Part I of UsingR is complemented and extended by Part II, which is offered during the second part of the semester and which can be taken independently from Part I.

Lecture notes
An Introduction to R. http://stat.ethz.ch/CRAN/doc/contrib/Lam-IntroductionToR_LHL.pdf

Prerequisites / notice
The course resources will be provided via the Moodle web learning platform. Please login (with your ETH (or other University) username+password) at https://moodle-app2.let.ethz.ch/enrol/users.php?id=1145

Choose the course "Using R for Data Analysis and Graphics" and follow the instructions for registration.

651-4077-00L Quantification and Modeling of the Cryosphere: Dynamic Processes (University of Zurich)

W 3 credits 1V University lecturers

Content
Overview of the most important earth surface processes and landforms in cold regions (regions with glaciers and intense frost) with emphasis on high-mountain aspects. Discussion of present research challenges.

Abstract
Knowledge of the most prominent climate-related geomorphological processes and phenomena in high-mountain regions, understanding of primary research challenges.

Objective
Erosion and sedimentation by glaciers as a function of topography, englacial temperature, sediment balance, sliding and melt water runoff. Processes and landforms in regions of seasonal and perennial frost (frost weathering, rock falls, debris cones/talus, solification, permafrost creep/rock glaciers, debris flows).

Content
Glacial and periglacial geomorphodynamics in high-mountain regions. Ca. 100 pages.

Literature
references in script

Prerequisites / notice
Basic knowledge about geomorphology and glaciers/permafrost from corresponding courses at ETH/UZH or from the related lecture notes

701-1341-00L Water Resources and Drinking Water


Content
The course covers qualitative (chemistry and microbiology) and quantitative aspects of drinking water from the resource to the tap. Natural processes, anthropogenic pollution, legislation of groundwater and surface water and of drinking water as well as water treatment will be discussed for industrialized and developing countries.

Objective
The goal of this lecture is to give an overview over the whole path of drinking water from the source to the tap and understand the involved physical, chemical and biological processes which determine the drinking water quality.

Content
The course covers qualitative (chemistry and microbiology) and quantitative aspects of drinking water from the resource to the tap. The various water resources, particularly groundwater and surface water, are discussed as part of the natural water cycle influenced by anthropogenic activities such as agriculture, industry, urban water systems. Furthermore legislation related to water resources and drinking water will be discussed. The lecture is focused on industrialized countries, but also addresses global water issues and problems in the developing world. Finally unit processes for drinking water treatment (filtration, adsorption, oxidation, disinfection etc.) will be presented and discussed.

Lecture notes
Handouts will be distributed

Literature
Will be mentioned in handouts

701-1253-00L Analysis of Climate and Weather Data

W 3 credits 2G C. Frei

Content
Topics: exploratory methods, hypothesis tests, analysis of climate trends, measuring the skill of climate and forecasting models, analysis of extreme events, principal component analysis and maximum covariance analysis.

Objective
Observation networks and numerical climate and forcasting models deliver large primary datasets. The use of this data in practice and in research requires specific techniques of statistical data analysis. This lecture introduces a range of frequently used techniques, and enables students to apply them and to properly interpret their results.

Abstract
Introduction into the theoretical background and the practical application of methods of data analysis in meteorology and climatology.

Content
The lecture also provides an introduction into R, a programming language and graphics tool frequently used for data analysis in meteorology and climatology. During hands-on computer exercises the student will become familiar with the practical application of the methods.

Lecture notes
Documentation and supporting material include:
- documented view graphs used during the lecture
- exercise sets and solutions
- R-packages with software and example datasets for exercise sessions

All material is made available via the lecture web-page.

Literature
Suggested literature:
### 701-1251-00L Land-Climate Dynamics

<table>
<thead>
<tr>
<th>Objective</th>
<th>The students can understand the role of land processes and associated feedbacks for the climate system.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecture notes</td>
<td>Powerpoint slides will be made available</td>
</tr>
<tr>
<td>Prerequisites / notice</td>
<td>Prerequisites: Introductory lectures in atmospheric and climate science</td>
</tr>
</tbody>
</table>

#### Content
- Understanding glaciers and ice sheets with simple physical concepts. Topics include the reaction of glaciers to the climate, ice rheology, temperature in glaciers and ice sheets, glacier hydrology, glacier seismology, basal motion and calving glaciers. A special focus is the current development of Greenland and Antarctica.
- After the course the students are able understand and interpret measurements of ice flow, subglacial water pressure and ice temperature. They will have an understanding of glaciology-related physical concepts sufficient to understand most of the contemporary literature on the topic. The students will be well equipped to work on glacier-related problems by numerical modeling, remote sensing, and field work.
- The dynamics of glaciers and polar ice sheets is the key requisite to understand their history and their future evolution. We will take a closer look at ice deformation, basal motion, heat flow and glacier hydraulics. The specific dynamics of tide water and calving glaciers is investigated, as is the reaction of glaciers to changes in mass balance (and therefore climate).

#### Lecture notes
- [Atmospheric physics](http://www.vvz.ethz.ch/Vorlesungsverzeichnis/lerneinheitPre.do?lerneinheitId=61924&semkez=2009W&lang=en)
- [Climate systems](http://www.vvz.ethz.ch/Vorlesungsverzeichnis/lerneinheitPre.do?lerneinheitId=57794&semkez=2009S&lang=en)

#### Literature
- A list of relevant literature is available on the class web site.

### 651-4101-00L Physics of Glaciers

| Objective | After the course the students are able understand and interpret measurements of ice flow, subglacial water pressure and ice temperature. They will have an understanding of glaciology-related physical concepts sufficient to understand most of the contemporary literature on the topic. The students will be well equipped to work on glacier-related problems by numerical modeling, remote sensing, and field work. |
| Lecture notes | Powerpoint slides will be made available |
| Literature | http://people.ee.ethz.ch/~luethim/teaching.html |

#### Content
- Understanding glaciers and ice sheets with simple physical concepts. Topics include the reaction of glaciers to the climate, ice rheology, temperature in glaciers and ice sheets, glacier hydrology, glacier seismology, basal motion and calving glaciers. A special focus is the current development of Greenland and Antarctica.
- After the course the students are able understand and interpret measurements of ice flow, subglacial water pressure and ice temperature. They will have an understanding of glaciology-related physical concepts sufficient to understand most of the contemporary literature on the topic. The students will be well equipped to work on glacier-related problems by numerical modeling, remote sensing, and field work.
- The dynamics of glaciers and polar ice sheets is the key requisite to understand their history and their future evolution. We will take a closer look at ice deformation, basal motion, heat flow and glacier hydraulics. The specific dynamics of tide water and calving glaciers is investigated, as is the reaction of glaciers to changes in mass balance (and therefore climate).

### 701-1437-00L Limnoecology

| Objective | During this course you will get an overview of the world's typical freshwater ecosystems. After this course you will be able to understand how aquatic organisms have adapted to their habitat and how the interactions (e.g. food web) between organisms work. During the experimental part of this course you will learn the principles of doing research to observe interrelations in aquatic ecosystems. You will measure and interpret biological and physical data (e.g. during experiments, field work) and present the collected knowledge. In short: apply the theoretical / lecture knowledge to field situations in a lake and river. |
| Lecture notes | Course notes and power point presentations provided during the course. |

#### Content
- The course contains a lecture part, an experimental part and field excursions.
- The lecture part covers ecology and evolution of aquatic organisms in lentic and lotic waters. Topics include: Adaptations, distribution patterns, biotic interactions, and conceptual paradigms in freshwater ecosystems. Important aspects regarding ecosystem metabolism and habitat properties of freshwaters. Applied case studies and experiments testing ecological and evolutionary processes in freshwaters.
- The lectures are given by Piet Spaak (Eawag), Florian Altermatt (UNI, Eawag), Tom Gonser (Eawag), Katja Räsänän (Eawag) and Chris Robinson (Eawag), specialists from the Aquatic Ecology department of Eawag and University of Zurich.

### 701-1631-00L Foundations of Ecosystem Management

| Objective | Students should be able to a) propose appropriate and realistic solutions to ecosystem management problems that integrate ecological, economic and social dimensions across relevant temporal and spatial scales. b) identify important stakeholders, their needs and interests, and the main conflicts that exist among them in the context of land and resource management. |

#### Literature
- [Bestimmungskurs aquatische Makroinvertebraten](http://www.vvz.ethz.ch/Vorlesungsverzeichnis/lerneinheitPre.do?lerneinheitId=61924&semkez=2009W&lang=en)
- [Bestimmungskurs aquatische Mikroinvertebraten und Kryptogamen](http://www.vvz.ethz.ch/Vorlesungsverzeichnis/lerneinheitPre.do?lerneinheitId=61924&semkez=2009W&lang=en)
- [Atmospheric physics](http://www.vvz.ethz.ch/Vorlesungsverzeichnis/lerneinheitPre.do?lerneinheitId=61924&semkez=2009W&lang=en)
- [Climate systems](http://www.vvz.ethz.ch/Vorlesungsverzeichnis/lerneinheitPre.do?lerneinheitId=57794&semkez=2009S&lang=en)
Traditional management systems focus on extraction of natural resources, and their manipulation and governance. However, traditional management has frequently resulted in catastrophic failures such as, for example, the collapse of fish stocks and biodiversity loss. These failures have stimulated the development of alternative ecosystem management approaches that emphasise the functionality of human-dominated systems. Inherent to such approaches are system-wide perspectives and a focus on ecological processes and services, multiple spatial and temporal scales, as well as the need to incorporate diverse stakeholder interests in decision making. Thus, ecosystem management is the science and practice of managing natural resources, biodiversity and ecological processes, to meet multiple demands of society. It can be local, regional or global in scope, and addresses critical issues in developed and developing countries relating to economic and environmental security and sustainability.

This course provides an introduction to ecosystem management, and in particular the importance of integrating ecology into management systems to meet multiple societal demands. The course explores the extent to which human-managed terrestrial systems depend on underlying ecological processes, and the consequences of degradation of these processes for human welfare and environmental well-being. Building upon a theoretical foundation, the course will tackle issues in resource ecology and management, notably forests, agriculture and wild resources within the broader context of sustainability, biodiversity conservation and poverty alleviation or economic development. Case studies from tropical and temperate regions will be used to explore these issues. Dealing with ecological and economic uncertainty, and how this affects decision making, will be discussed. Strategies for conservation and management of terrestrial ecosystems will give consideration to landscape ecology, and community management, paying particular attention to alternative livelihood options and marketing strategies of common pool resources.

Objectives

After completion of the module, students will be able to:
- Identify and appraise ecological aspects in development cooperation, development policies and developing countries' realities
- Analyze the forces, components and processes, which influence the destiny, the implementation and the outcome of ecological measures
- Characterize concepts, instruments and drivers of environmental politics and understand, how policies are shaped, both at national level and in multilateral negotiations
- Study changes (improvements) in environmental politics over time as the result of the interaction of processes and actors, including international development organizations
- Analyze politics and design approaches to influence them, looking among others at governance, social organization, legal issues and institutions

Different cases not only deal with different environmental problems, but also focus on different levels and degrees of formality. This ranges from local interventions with resource user groups as key stakeholders, to country level policies, to multi- and international initiatives and conventions. Linkages and interaction of the different system levels are highlighted. Special emphasis is given to natural resources management.

The cases address the following issues:
- Land use and soil fertility enhancement: From degradation to sustainable use
- Common property resource management (forest and pasture): Collective action and property rights, community-based management
- Ecosystem health (integrated pest management, soil and water conservation)
- Payment for environmental services: Successes in natural resources management
- Climate change and agriculture: Adaptation and mitigation possibilities
- Biodiversity Convention: Implications for conservations and access to genetic resources
- Biodiversity as a means for more secure livelihoods: Agroforestry and intercropping
- The Millennium Development Goals: Interactions between poverty and the environment
- Poverty and natural resources management: Poverty reduction strategies, the view of the poor themselves
- Food security: Policies, causes for insecurity, the role of land grabbing
- Biofuels and food security: Did politics misfire?
- International development at global level: IAASTD and World Development Report 2008
- Strategy development at global level: Does politics misfire?

Prerequisites / notice

The performance assessment will consist of an individual essay to be written by each student based on at least five references in addition to the sources provided in the course. Students can choose from a list of topics. Criteria for assessment will be communicated at the beginning of the course.

701-0535-00L Environmental Soil Physics/Vadose Zone Hydrology

The course provides theoretical and practical foundations for understanding and characterizing physical and transport properties of soils/near-surface earth materials, and quantifying hydrological processes and fluxes of mass and energy at multiple scales. Emphasis is given to land-atmosphere interactions, the role of plants on hydrological cycles, and biophysical processes in soils.

Objective

Students are able to:
- characterize quantitative knowledge needed to measure and parameterize structural, flow and transport properties of partially-saturated porous media,
- quantify driving forces and resulting fluxes of water, solute, and heat in soils,
- apply modern measurement methods and analytical tools for hydrological data collection
- conduct and interpret a limited number of experimental studies
- explain links between physical processes in the vadose-zone and major societal and environmental challenges
Weeks 1 to 3: Physical Properties of Soils and Other Porous Media  Units and dimensions, definitions and basic mass-volume relationships between the solid, liquid and gaseous phases; soil texture; particle size distributions; surface area; soil structure. Soil colloids and clay behavior

Soil Water Content and its Measurement - Definitions; measurement methods - gravimetric, neutron scattering, gamma attenuation; and time domain reflectometry; soil water storage and water balance.

Weeks 4 to 5: Soil Water Retention and Potential (Hydrostatics) - The energy state of soil water; total water potential and its components; properties of water (molecular, surface tension, and capillary rise); modern aspects of capillarity in porous media; units and calculations and measurement of equilibrium soil water potential components; soil water characteristic curves definitions and measurements; parametric models; hysteresis. Modern aspects of capillarity

Demo-Lab: Laboratory methods for determination of soil water characteristic curve (SWC), sensor pairing

Weeks 6 to 9: Water Flow in Soil - Hydrodynamics:
Part 1 - Laminar flow in tubes (Poiseuille's Law); Darcy's Law, conditions and states of flow; saturated flow; hydraulic conductivity and its measurement.
Part 2 - Unsaturated steady state flow; unsaturated hydraulic conductivity models and applications; non-steady flow and Richards Eq.; approximate solutions to infiltration (Green-Ampt, Philip); field methods for estimating soil hydraulic properties.
Midterm exam
Part 3 - Use of Hydrus model for simulation of unsaturated flow

Week 10 to 11: Energy Balance and Land Atmosphere Interactions - Radiation and energy balance; evapotranspiration definitions and estimation; transpiration, plant development and transpiration coefficients small and large scale influences on hydrological cycle; surface evaporation.

Week 12 to 13: Solute Transport in Soils  Transport mechanisms of solutes in porous media; breakthrough curves; convection-dispersion eq.; solutions for pulse and step solute application; parameter estimation; salt balance.
Lab #3: Miscible displacement and breakthrough curves for a conservative tracer through a column; data analysis and transport parameter estimation.

Additional topics:
Temperature and Heat Flow in Porous Media - Soil thermal properties; steady state heat flow; nonsteady heat flow; estimation of thermal properties; engineering applications.

Biological Processes in the Vadose Zone  An overview of below-ground biological activity (plant roots, microbial, etc.); interplay between physical and biological processes. Focus on soil-atmosphere gaseous exchange; and challenges for bio- and phytoremediation.

Content

Lecture notes

Classnotes on website: Vadose Zone Hydrology, by Or D., J.M. Wraith, and M. Tuller (available at the beginning of the semester) http://www.step.ethz.ch/education/active-courses/vadose-zone-hydrology

Literature

Supplemental textbook (not mandatory) - Environmental Soil Physics, by: D. Hillel

102-0617-00L Basics and Principles of Radar Remote Sensing for Environmental Applications

Abstract

The course will provide the basics and principles of Radar Remote Sensing (specifically Synthetic Aperture Radar (SAR)) and its imaging techniques for the use of environmental parameter estimation.

Objective

The course should provide an understanding of SAR techniques and the use of the imaging tools for bio/geophysical parameter estimation. At the end of the course the student has the understanding of
1. SAR basics and principles,
2. SAR polarimetry,
3. SAR interferometry and
4. environmental parameter estimation from multi-parametric SAR data

Content

The course is giving an introduction into SAR techniques, the interpretation of SAR imaging responses and the use of SAR for different environmental applications. The outline of the course is the following:
1. Introduction into SAR basics and principles
2. Introduction into electromagnetic wave theory
3. Introduction into scattering theory and decomposition techniques
4. Introduction into SAR interferometry
5. Introduction into polarimetric SAR interferometry
6. Introduction into bio/geophysical parameter estimation (classification/segmentation, soil moisture estimation, earth quake and volcano monitoring, forest height inversion, wood biomass estimation etc.)

Lecture notes

Handouts for each topic will be provided

Literature

First readings for the course:
Complete literature listing will be provided during the course.

401-0649-00L Applied Statistical Regression

Abstract

This course offers a practically oriented introduction into regression modeling methods. The basic concepts and some mathematical background are included, with the emphasis lying in learning "good practice" that can be applied in every student's own projects and daily work life. A special focus will be laid in the use of the statistical software package R for regression analysis.

Objective

The students acquire advanced practical skills in linear regression analysis and are also familiar with its extensions to generalized linear modeling.
The course starts with the basics of linear modeling, and then proceeds to parameter estimation, tests, confidence intervals, residual analysis, model choice, and prediction. More rarely touched but practically relevant topics that will be covered include variable transformations, multicollinearity problems and model interpretation, as well as general modeling strategies.

The last third of the course is dedicated to an introduction to generalized linear models: this includes the generalized additive model, logistic regression for binary response variables, binomial regression for grouped data and poisson regression for count data.

Lecturers Streams are integrated monitors of the health and functioning of their surrounding landscapes. Streams integrate the fluxes of water, solutes, and sediment from their contributing catchment area; thus they reflect the spatially integrated hydrological, ecophysiological, biogeochemical, and geomorphological processes in the surrounding landscape. At a practical level, there is a significant public interest in managing forested upland landscapes to provide a reliable supply of high-quality surface water and to minimize the risk of catastrophic flooding and debris flows, but the scientific background for such management advice is still evolving.

Using a combination of lectures, field exercises, and data analysis, we explore the processes controlling the delivery of water, solutes, and sediment to streams, and how those processes are affected by changes in land cover, land use, and climate. We review the connections between process understanding and predictive modeling in these complex environmental systems. How well can we understand the processes controlling watershed-scale phenomena, and what uncertainties are unavoidable? What are the relative advantages of top-down versus bottom-up approaches? How much can “black box” analyses reveal about what is happening inside the black box? Conversely, can small-scale, micro-mechanistic approaches be successfully “scaled up” to predict whole-watershed behavior? Practical problems to be considered include the effects of land use, atmospheric deposition, and climate on streamflow, water quality, and sediment dynamics, illustrated with data from experimental watersheds in North America, Scandinavia, and Europe.

Conversely, can small-scale, micro-mechanistic approaches be successfully "scaled up" to predict whole-watershed behavior? Practical problems to be considered include the effects of land use, atmospheric deposition, and climate on streamflow, water quality, and sediment dynamics, illustrated with data from experimental watersheds in North America, Scandinavia, and Europe.

Students will practice using data and models to frame and test hypotheses about connections between streams and landscapes.

### Literature
- Faraway (2005): Linear Models with R
- Faraway (2006): Extending the Linear Model with R
- Draper & Smith (1998): Applied Regression Analysis
- Fox (2008): Applied Regression Analysis and GLMs
- Montgomery et al. (2006): Introduction to Linear Regression Analysis
- Montgomery et al. (2006): Applied Statistical Regression Analysis

### Prerequisites / notice
The exercises, but also the classes will be based on procedures from the freely available, open-source statistical software package R, for which an introduction will be held.

In the Mathematics Bachelor and Master programmes, the two course units 401-0649-00L "Applied Statistical Regression" and 401-3622-00L "Regression" are mutually exclusive. Registration for the examination of one of these two course units is only allowed if you have not registered for the examination of the other course unit.

### Master's Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>118-0121-00L</td>
<td>Master's Thesis</td>
<td>O</td>
<td>24 credits</td>
<td>51D</td>
<td>Lecturers</td>
</tr>
</tbody>
</table>

Students propose relevant research topics from their home countries, or from Latin American research projects, around which individual study programmes are devised, and on which they write their thesis. The Master thesis is supervised by scientific staff at ETH and collaborating institutions, and is based on the student’s academic or professional experience.

### Key for Hours
- V: lecture
- G: lecture with exercise
- U: exercise
- S: seminar
- K: colloquium
- E: course outside the curriculum
- Z: suitable for doctorate

### Key for Hours
- P: practical/laboratory course
- A: independent project
- D: diploma thesis
- R: revision course / private study

### ECTS
- European Credit Transfer and Accumulation System
- Special students and auditors need special permission from the lecturers.
MAS in Urban Design

Courses Offered

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>065-0070-00L</td>
<td>MAS Programme “Urban Transformation in Developing Territories”</td>
<td>E-</td>
<td>0</td>
<td>16S</td>
<td>M. Angélil</td>
</tr>
</tbody>
</table>

After successful completion the students achieve 65 Creditpoints.

Abstract

The MAS programme is structured around an investigation of transforming urban conditions as they pertain to global phenomena, and the development of practical tools for operating within such domains.

Objective

The programme aims at developing a culture of urban research and design that will enable the participant to actively engage in envisioning future urban scenarios. Secondly, a strong emphasis is put on methodology, process design and communication in order to prepare for the interdisciplinary negotiating agenda of the urban designer as future member of professional design offices, academic research teams, public services or communication agencies.

Content

Each year, the MAS studio will focus on two specific topics of urban research and two existing sites on which to intervene in the form of two design research studios. The sites are preferably territories under development pressure with existing groups of urban actors to engage with.

MAS in Urban Design - Key for Type

| O  | Compulsory                                           | E-   | Recommended, not eligible for credits |
| W+ | Eligible for credits and recommended                 | Z    | Courses outside the curriculum        |
| W  | Eligible for credits                                 | Dr   | Suitable for doctorate                |

Key for Hours

| V  | lecture                                              | P    | practical/laboratory course           |
| G  | lecture with exercise                               | A    | independent project                   |
| U  | exercise                                             | D    | diploma thesis                        |
| S  | seminar                                              | R    | revision course / private study       |
| K  | colloquium                                           |      |                                      |

ECTS

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Management, Technology and Economics (General Courses)

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>351-0778-00L</td>
<td>Discovering Management</td>
<td>Z</td>
<td>3</td>
<td>3G</td>
<td>B. Clarysse, M. Ambühl, S. Brusoni, E. Fleisch, G. Grote, V. Hoffmann, P. Schönleben, G. von Krogh, V. von Wangenheim</td>
</tr>
<tr>
<td>351-0778-01L</td>
<td>Discovering Management (Exercises)</td>
<td>Z</td>
<td>1</td>
<td>1U</td>
<td>B. Clarysse, L. De Cuyper</td>
</tr>
<tr>
<td>351-0555-00L</td>
<td>Open- and User Innovation</td>
<td>Z</td>
<td>3</td>
<td>2G</td>
<td>S. Häfliger, S. Spaeth</td>
</tr>
<tr>
<td>363-0511-00L</td>
<td>Managerial Economics</td>
<td>Z</td>
<td>4</td>
<td>3V</td>
<td>S. Rausch, V. Hoffmann</td>
</tr>
</tbody>
</table>

**Discovering Management**

- **Entry level course in management for BSc, MSc and PhD students at all levels not belonging to D-MTEC.** This course can be complemented with Discovering Management (Exercises) 351-0778-01.
- **Abstract**
  - Discovering Management offers an introduction to the field of business management and entrepreneurship for engineers and natural scientists. The module provides an overview of the principles of management, teaches knowledge about management that is highly complementary to the students' technical knowledge, and provides a basis for advancing the knowledge of the various subjects offered at D-MTEC.
- **Objective**
  - Discovering Management combines in an innovative format a set of lectures and an advanced business game. The learning model for Discovering Management involves 'learning by doing'. The objective is to introduce the students to the relevant topics of the management literature and give them a good introduction in entrepreneurship topics too. The course is a series of lectures on the topics of strategy, innovation, corporate finance, leadership, design thinking and corporate social responsibility. While the 14 different lectures provide the theoretical and conceptual foundations, the experimental learning outcomes result from the interactive business game. The purpose of the business game is to analyse the innovative needs of a large multinational company and develop a business case for the company to grow. This business case is as relevant to someone exploring innovation within an organisation as it is if you are planning to start your own business. By discovering the key aspects of entrepreneurial management, the purpose of the course is to advance students' understanding of factors driving innovation, entrepreneurship, and company success.
- **Content**
  - Discovering Management aims to broaden the students' understanding of the principles of business management, emphasizing the interdependence of various topics in the development and management of a firm. The lectures introduce students not only to topics relevant for managing large corporations, but also touch upon the different aspects of starting up your own venture. The lectures will be presented by the respective area specialists at D-MTEC.
- **Prerequisites / notice**
  - Discovering Management is designed to suit the needs and expectations of Bachelor students at all levels as well as Master and PhD students not belonging to D-MTEC. By providing an overview of Business Management, this course is an ideal enrichment of the standard curriculum at ETH Zurich. No prior knowledge of business or economics is required to successfully complete this course.

**Open- and User Innovation**

- **Abstract**
  - This course is offered complementary to the basic course 351-0778-00L, "Discovering Management". The course offers additional exercises and case studies.
- **Objective**
  - This course is offered to complement the course 351-0778-00L. The course offers additional exercises and case studies.
- **Content**
  - The course introduces the students to the long-standing tradition of actively involving users of technology and other knowledge-intensive products in the development and production process, and through own cases they develop an entrepreneurial understanding of product development under distributed, user-centered, or open innovation strategies.
  - The students actively participate in discussions during the lectures and contribute presentations of case studies during the exercises. The combination should allow to compare theory with practical cases from various industries.
- **Prerequisites / notice**
  - The course presents and builds upon recent research and challenges the students to devise innovation strategies that take into account the availability of user expertise, free and public knowledge, and the interaction with communities that span beyond one organization.
- **Literature**
  - The slides of the lectures are made available and updated continuously through the SMI website.
  - Relevant literature for the exam includes the slides and the reading assignments. The corresponding papers are either available from the author online or distributed during class.

**Managerial Economics**

- **Abstract**
  - Not for MSc students belonging to D-MTEC! This course on user innovation extends courses on knowledge management and innovation as well as marketing. The students are introduced to the long-standing tradition of actively involving users of technology and other knowledge-intensive products in the development and production process, and through own cases they develop an entrepreneurial understanding of product development under distributed, user-centered, or open innovation strategies. Theoretical underpinnings taught in the course include models of innovation, the structuration of technology, and an introduction to entrepreneurship.

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Data: 06.03.2019 12:57  Autumn Semester 2016  Page 973 of 1571
Abstract
Managerial Economics applies economic theory and methods to business and economic decision-making. Economic ideas related to optimization, the theory of consumer demand, the theory of the firm, industrial organization and decision making under uncertainty are studied using methods of numerical analysis, statistical estimation, game theory and constrained optimization.

Objective
The objective of the course is to provide undergraduate and graduate students in MAVT with an understanding of the use of economic concepts for firm-level management decisions. The course covers a number of models and methods of analysis which are commonly employed in business decisions. The course covers the economic theory of choice, models of oligopoly and industrial organization, applications of game theory to contract design and agency theory, and the theory of decision making under uncertainty focusing specifically on long-term investment decisions. The course will include three lectures by Professor Volker Hoffman focusing on related case-studies in management.

Literature
Mikroökonomie (Pearson Studium - Economic VWL) Gebundene Ausgabe, August 2013, Robert S. Pindyck, Dr. Daniel L. Rubinfeld.

Prerequisites / notice
The course acquaints students who have previous not studied economics to economic concepts and quantitative methods which can be used to solve management decision problems.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Type</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-1075-00L</td>
<td>Reflecting Leadership: Mutual Learning Via Shadowing</td>
<td>Z</td>
<td>0</td>
<td>2G</td>
</tr>
</tbody>
</table>

Does not take place this semester.
Student must have the status as ESOP-fellow. Please apply with letter of motivation and CV.

Abstract
This course introduces ESOP (Excellence Scholarship & Opportunity Programme) Fellows to leadership in the business world. After a preparatory seminar that builds foundations in theory and methods, the fellows 'shadow' top-managers and observe their work-routines for several days.

Objective
Observations are later analyzed amongst the students and in a personal debriefing with managers to allow for mutual reflections on leadership.

The participants develop deep insights into a company as they follow a senior manager or a member of the Board of Directors for several days as a 'shadow'. They learn by experiencing leadership in action and later offer their reflections to the executives, thereby creating opportunities for mutual learning. The course gives students an introduction to theories of leadership and methods to observe leadership practices. Students will record their impressions in field journals. The intensive shadowing phase is prepared in a two-day bloc seminar and de-briefed in a one-day reflection workshop. At a common event with ETH Foundation and participating companies, selected reflections by ESOP fellows are presented to a larger audience.

A central aim and learning objective of the course is that students reflect deeply about responsibilities and challenges in the practice of leadership and refine their critical thinking skills. The course is an innovative contribution to intergenerational learning and a stimulus to the development of the students' personalities towards becoming confident entrepreneurs of the next generation.

Management, Technology and Economics (General Courses) - Key for Type

<table>
<thead>
<tr>
<th>O</th>
<th>W+</th>
<th>W</th>
<th>Key for Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compulsory</td>
<td>Eligible for credits and recommended</td>
<td>Eligible for credits</td>
<td></td>
</tr>
<tr>
<td>Z</td>
<td>Dr</td>
<td>E-</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>Courses outside the curriculum</td>
<td>Suitable for doctorate</td>
<td>Recommended, not eligible for credits</td>
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</tr>
</tbody>
</table>

ECTS European Credit Transfer and Accumulation System
- Special students and auditors need special permission from the lecturers.
Core Courses

General Management and Human Resource Management

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>363-0341-00L</td>
<td>Introduction to Management</td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>S. Brusoni, P. Baschera</td>
</tr>
</tbody>
</table>

Abstract
We develop a 'systemic' view of organizations.

Objective
We look at organizations as part of an industry context, which is affected by different elements like strategy, culture, tasks, people and outputs.

Content
Further information is available on the Tim Group Chair's website:
http://www.timgroup.ethz.ch/en/courses

and on the Moodle of the course:
https://moodle-app2.let.ethz.ch/course/view.php?id=2209
(The Enrollment Key to Moodle will be provided during the course)

Prerequisites / notice
All the materials uploaded on Moodle must be considered as required readings.

Prerequisites / notice
The final exam of the present course is in written form.

Prerequisites / notice
The final exam is requested for all types of students (BSc, MSc, MA, PhD, and Exchange students).

Prerequisites / notice
It is not possible to retake the exam within the same term or academic year.

Prerequisites / notice
We strongly recommend Exchange students to take it into consideration when selecting the courses to attend.

Strategy, Technology and Innovation Management

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-0387-00L</td>
<td>Corporate Sustainability</td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>V. Hoffmann</td>
</tr>
</tbody>
</table>

Abstract
The lectures addresses the assessment of corporate sustainability and its links to strategy, technology, and finance. Students learn why sustainability matters for managers and how businesses can act towards it. E-modules allow students to train critical thinking skills. In the 2nd half of the semester, sustainability challenges on water, energy, mobility, and food are explored in group projects.

Objective
Understand the limits and the potential of corporate sustainability for sustainable development

Content
Overview of the key concepts of corporate sustainability and topics related to Water, Energy, Mobility, and Food

Business implications of sustainable development, in particular for the assessment of sustainability performance, strategic change towards sustainability, technological innovations and sustainability, and finance and corporate sustainability.

Critical thinking skills for corporate sustainability.

In-depth case studies of corporate sustainability challenges in the track phase: How to deal with environmental pressure groups? How to use the strengths of business to solve pressing sustainability problems? How to catalyze technological innovations for sustainability? How to invest money in a sustainable way?

Prerequisites / notice
The final exam of the present course is in written form.

Prerequisites / notice
The final exam is requested for all types of students (BSc, MSc, MA, PhD, and Exchange students).

Prerequisites / notice
It is not possible to retake the exam within the same term or academic year.

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Prerequisites / notice
It is not possible to retake the exam within the same term or academic year.

Prerequisites / notice
We strongly recommend Exchange students to take it into consideration when selecting the courses to attend.

Number of participants limited to 80.

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Number of participants limited to 80.
This course conveys concepts and methods in strategic management, with a focus on competitive strategy. Competitive strategy aims at improving and establishing position of firms within an industry.

The lecture “Strategic Management” is designed to teach relevant competences in strategic planning and -implementation, for both professional work-life and further scientific development. The course provides an overview of the basics of strategy and the most prevalent concepts and methods in strategic management. The course is given as a combination of lectures about concepts/methods, and case studies where the students solve strategic issues of the case companies. In two sessions, the students will also be addressing real-time strategic issues of firms that are represented by executives.

Contents:
- Introduction to strategy
- Industry dynamics I: Industry analysis
- Industry dynamics II: Analysis of technology and innovation
- The resource-based theory of the firm
- The knowledge-based theory of the firm

Prerequisites / notice
- Session #0: (September 19) Introductory Guest Lecture & Organizational Issues
- Session #1: (September 26) Introduction & How to Solve a Case
- Session #2: (October 3) Industry Dynamics I
- Session #3: (October 24) Guest Lecture
- Session #4: (October 31) Industry Dynamics II
- Session #5: (November 7) Resource-Based Theory
- Session #6: (November 14) Knowledge-Based Theory
- Session #7: (November 28) Guest Lecture

For more information please see:
http://www.smi.ethz.ch/education/practicing-strategy.html

**Information Management, Operations Management**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>363-0421-00L</td>
<td>Mastering Digital Business Models</td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>E. Fleisch</td>
</tr>
</tbody>
</table>

This lecture provides a theory- and practice-based understanding of how today’s information technologies enable new digital business models and disrupt existing markets.

A. After the lecture, the student is able to evaluate digital business models from different angels, including theory-based views:

- Definition and classification of business models
- Digital business model patterns
- Theoretical frameworks that explain why and how digital business models function
- Impact of digital business model patterns on P&L and balance sheet

Students know how to measure & evaluate investments into the digital space as strategic projects:

- a decision maker in an established company (should I invest in project A or B?)
- an entrepreneur (should I pursue this venture?)
- an investor (should I invest in start-up xy?)

B. The student knows different tools to design digital business model patterns.
Content

Uber, Airbnb, Nest and Jawbone - A wide range of innovative companies exist, which successfully implemented ICT enabled business models and continue to grow at a rapid pace. Examples, illustrating how digitalization, including the "Internet of Things" currently fosters business model innovation across various industries. This course is designed to help students to understand and critically assess such newly emerging (digital) business models.

For the lecture students will get access to one of the leading online teaching platforms (called edX) also offered by other top universities (incl. MIT, Harvard, Berkeley, etc.). Using the edX platform, will allow students to collaborate in online discussions, solve online exercises and present a short educational video as part of a group project.

Key Topics:

Business model innovation; (digital) business model patterns; business value of IT; the concept of integration; transaction cost perspective; network economics perspective; essentials and impact of web 2.0, internet of things, mobile computing, market places, social analytics and big data; IT governance and portfolio management; entrepreneurship in the digital space, etc.

363-0445-00L Production and Operations Management W+ 3 credits 2G T. Netland, P. Schönsleben

Abstract

This core course on Production and Operations Management provides the students insights into the basic theories, principles, concepts, and techniques used to design, analyze, and improve the operational capabilities of an organization.

Objective

Students learn why and how operations can be a competitive weapon; how to design, plan, control, and manage production and service processes; how to improve effectiveness and efficiency in operations; how to take advantage of new technological advancements; and how environmental and social concerns affect decisions in global production networks.

Content

The course covers the most fundamental strategic and tactical concepts in production and operations management. The lectures cover: Introduction to POM; Operations strategy; Capacity management; Production planning and control; Production philosophies; Lean management; Performance measurement; Problem solving; Service operations; New technologies in POM; Servitization; Global production; and Triple-bottom line.

Literature


363-0453-00L Strategic Supply Chain Management W 3 credits 2G S. Wagner

Abstract

The course offers an introduction to the theory and practice of supply chain management. Students will learn how to develop supply chain strategies and supply chain networks based on firms competitive strategies and marketing priorities.

Objective

The task of designing and managing supply chains requires that managers apply strategic, decision making and leadership skills in a supply chain context. The goal of this course is to develop and practice these skills.

Content

Effective supply chains ought to be aligned with and support the achievement of the firms corporate, business and product strategies, taking into account future opportunities and risks. This course will familiarize students with modern supply chain management theory and practice to develop and manage supply chains. The topics covered range from fundamental logistics and supply chain concepts (e.g. push vs. pull, postponement) to the development of supply chain strategies, relationships and networks.

Literature

The following textbook is mandatory:


The following textbook is supplementary:


Prerequisites / notice

The final course grade will be a weighted average of the following:

- Exam (semester end): 70%
- Case studies (during the semester): 30%

Lecture notes

Course material will be available for download from the homepage of the Chair of Logistics Management:

http://www.scm.ethz.ch/teaching/courses.html

Login will be provided in the first lecture or can be obtained from the Teaching Assistant Dagmar Reinerth (dreinerth@ethz.ch).

Quantitative and Qualitative Methods

Number Title Type ECTS Hours Lecturers
363-0305-00L Empirical Methods in Management W+ 3 credits 2G A. Scherer

Abstract

Evidence-based management requires valid empirical research. In this course, students will learn the basics of research design, fundamentals of data collection and statistical methods to analyze the data acquired in social science research. Students are expected to apply their knowledge in class discussions and out-of-class assignments.

Objective

- Ability to formulate research questions and designing an appropriate study
- Ability to collect and analyze data using a variety of methods
- Ability to critically assess the quality of empirical research in management
- Applied knowledge of empirical methods through out-of-class assignments

Content

1) Introduction to empirical management research
2) Research designs: exploratory, descriptive, experimental
3) Measurement and scaling
4) Data collection and sampling
5) Data analysis methods
6) Reporting and presenting empirical research

Prerequisites / notice

Assignments and projects: This course includes out-of-class assignments and projects to give students some hands-on experience in conducting empirical research in management. Projects will focus on one particular aspect of empirical research, like the formulation of a research question or the design of a study. Students will have at least one week to work on each assignment. Students are expected to work on these assignments individually. Duplicate answers will receive no credit and will be subject to a disciplinary review. Assignments will be graded and need to be turned-in on time.

Class participation: Class participation is encouraged and can greatly improve students' learning in this class. In this spirit, students are expected to attend class regularly and come to class prepared.

363-0541-00L Systems Dynamics and Complexity W+ 3 credits 3G F. Schweitzer, G. Casiraghi, V. Nanumyan

Abstract

Finding solutions: what is complexity, problem solving cycle.

Implementing solutions: project management, critical path method, quality control feedback loop.

Controlling solutions: Vensim software, feedback cycles, control parameters, instabilities, chaos, oscillations and cycles, supply and demand, production functions, investment and consumption

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Objective

A successful participant of the course is able to:
- understand why most real problems are not simple, but require solution methods that go beyond algorithmic and mathematical approaches
- apply the problem solving cycle as a systematic approach to identify problems and their solutions
- calculate project schedules according to the critical path method
- setup and run systems dynamics models by means of the Vensim software
- identify feedback cycles and reasons for unintended systems behavior
- analyse the stability of nonlinear systems and apply this to macroeconomic dynamics

Content

Why are problems not simple? Why do some systems behave in an unintended way? How can we model and control their dynamics? The course provides answers to these questions by using a broad range of methods encompassing systems oriented management, classical systems dynamics, nonlinear dynamics and macroeconomic modeling.

The course is structured along three main tasks:
1. Finding solutions
2. Implementing solutions
3. Controlling solutions

PART 1 introduces complexity as a system immanent property that cannot be simplified. It introduces the problem solving cycle, used in systems oriented management, as an approach to structure problems and to find solutions.

PART 2 discusses selected problems of project management when implementing solutions. Methods for identifying the critical path of subtasks in a project and for calculating the allocation of resources are provided. The role of quality control as an additional feedback loop and the consequences of small changes are discussed.

PART 3, by far the largest part of the course, provides more insight into the dynamics of existing systems. Examples come from biology (population dynamics), management (inventory modeling, technology adoption, production systems) and economics (supply and demand, investment and consumption). For systems dynamics models, the software program VENSIM is used to evaluate the dynamics. For economic models analytical approaches, also used in nonlinear dynamics and control theory, are applied. These together provide a systematic understanding of the role of feedback loops and instabilities in the dynamics of systems. Emphasis is on oscillating phenomena, such as business cycles and other life cycles.

Weekly self-study tasks are used to apply the concepts introduced in the lectures and to come to grips with the software program VENSIM.

Lecture notes

The lecture slides are provided as handouts - including notes and literature sources - to registered students only. All material is to be found on the Moodle platform. More details during the first lecture

Prerequisites / notice

Self-study tasks (discussion exercises, Vensim exercises) are provided as home work. Weekly exercise sessions (45 min) are used to discuss selected solutions. Regular participation in the exercises is an efficient way to understand the concepts relevant for the final exam.

363-1004-00L Operations Research

W+  3 credits  2G  M. Laumanns

Abstract

This course provides an introduction to operations research methods in the fields of management science and economics. Requisite mathematical concepts are introduced with a practical, problem-solving perspective.

Objective

- Introduction to building and using quantitative models in a business / industrial environment
- Introduction to basic optimization techniques (Linear Programming and extensions, network flows, integer programming, dynamic and stochastic optimization)
- Understanding the integration of quantitative models into the managerial decision process

Content

The following topics are covered: Systems and models, linear models and the importance of linear programming, duality theory and shadow prices, integer programming, optimization under uncertainty and applications in inventory management.

Lecture notes

A printed script will be made available.

Literature

Any standard textbook in Operations Research is a useful complement to the course.

Prerequisites / notice

Undergraduate calculus, linear algebra, probability and statistics are a prerequisite.

Economics

Number  Title  Type  ECTS  Hours  Lecturers
363-0503-00L Principles of Microeconomics  W+  3 credits  2G  M. Filippini

Abstract

The course introduces basic principles, problems and approaches of microeconomics.

Objective

The learning objectives of the course are:
1. Students must be able to discuss basic principles, problems and approaches in microeconomics. (1) Students must be able to discuss basic principles, problems and approaches in microeconomics. (2) Students can analyse and explain simple economic principles in a market using supply and demand graphs. (3) Students can contrast different market structures and describe firm and consumer behaviour. (4) Students can identify market failures such as externalities related to market activities and illustrate how these affect the economy as a whole. (5) Students can apply simple mathematical treatment of some basic concepts and can solve utility maximization and cost minimization problems.

Lecture notes

Lecture notes, exercises and reference material can be downloaded from Moodle.

Literature


For students taking only the course 'Principles of Microeconomics' there is a shorter version of the same book:

Complementary:

363-0537-00L Resource and Environmental Economics  W+  3 credits  2G  L. Bretschger, A. Brausmann

Abstract

Relationship between economy and environment, market failure, external effects and public goods, contingent valuation, internalisation of externalities; economics of non-renewable resources, economics of renewable resources, cost-benefit analysis, sustainability, and international aspects of resource and environmental economics.
Objective

Understanding of the basic issues and methods in resource and environmental economics; ability to solve typical problems in the field using the appropriate tools, which are concise verbal explanations, diagrams or mathematical expressions.

Topics are:
- Introduction to resource and environmental economics
- Importance of resource and environmental economics
- Main issues of resource and environmental economics
- Normative basis
  - Utilitarianism
  - Fairness according to Rawls
- Economic growth and environment
- Externalities in the environmental sphere
- Governmental internalisation of externalities
- Private internalisation of externalities: the Coase theorem
- Free rider problem and public goods
- Types of public policy
- Efficient level of pollution
- Tax vs. permits
- Command and Control Instruments
- Empirical data on non-renewable natural resources
- Optimal price development: the Hotelling-rule
- Effects of exploration and Backstop-technology
- Effects of different types of markets.
- Biological growth function
- Optimal depletion of renewable resources
- Social inefficiency as result of over-use of open-access resources
- Cost-benefit analysis and the environment
- Measuring environmental benefit
- Concept of sustainability
- Measuring costs
- Technological feasibility
- Conflict sustainability / optimality
- Indicators of sustainability
- Problem of climate change
- Cost and benefit of climate change
- Climate change as international ecological externality
- International climate policy: Kyoto protocol
- Implementation of the Kyoto protocol in Switzerland

Content

- Economy and natural environment, welfare concepts and market failure, external effects and public goods, measuring externalities and contingent valuation, internalising external effects and environmental policy, economics of non-renewable resources, renewable resources, cost-benefit-analysis, sustainability issues, international aspects of resource and environmental problems, selected examples and case studies.

Lecture notes

Learning material and script can be found here:
https://moodle-app2.let.ethz.ch/course/view.php?id=328

Literature


Abstract

This course examines the behaviour of macroeconomic variables, such as gross domestic product, unemployment and inflation rates. It tries to answer questions like: How can we explain fluctuations of national economic activity? What can economic policy do against unemployment and inflation? What significance do international economic relations have for Switzerland?

Objective

This lecture will introduce the fundamentals of macroeconomic theory and explain their relevance to everyday economic problems.

Content

This course helps you understand the world in which you live. There are many questions about the macroeconomy that might spark your curiosity. Why are living standards so meagre in many African countries? Why do some countries have high rates of inflation while others have stable prices? Why have some European countries adopted a common currency? These are just a few of the questions that this course will help you answer.

Furthermore, this course will give you a better understanding of the potential and limits of economic policy. As a voter, you help choose the policies that guide the allocation of society’s resources. When deciding which policies to support, you may find yourself asking various questions about economics. What are the burdens associated with alternative forms of taxation? What are the effects of free trade with other countries? What is the best way to protect the environment? How does the government budget deficit affect the economy? These and similar questions are always on the minds of policy makers.

Lecture notes

The course webpage (to be found at https://moodle-app2.let.ethz.ch/course/view.php?id=2467) contains announcements, course information and lecture slides.

Literature


We advise you to also buy access to Aplia. This internet platform will support you in learning for this course. To save money, you should buy the book together with Aplia. This is sold as a bundle (ISBN: 9781473715998).

Besides this textbook, the slides and lecture notes will cover the content of the lecture and the exam questions.

Financial Management

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-0561-00L</td>
<td>Financial Market Risks</td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>D. Sornette</td>
</tr>
</tbody>
</table>

Abstract

I aim to introduce students to the concepts and tools of modern finance and to make them understand the limits of these tools, and the many problems met by the theory in practice. I will put this course in the context of the on-going financial crises in the US, Europe, Japan and China, which provide fantastic opportunities to make the students question the status quo and develop novel solutions.
Objective

The course explains the key concepts and mechanisms of financial economics, their depth and then stresses how and why the theories and models fail and how this is impacting investment strategies and even a global view of citizenship, given the present developing crises in the US since 2007 and in Europe since 2010.

- Development of the concepts and tools to understand these risks and master them.
- Working knowledge of the main concepts and tools in finance (Portfolio theory, asset pricing, options, real options, bonds, interest rates, inflation, exchange rates)
- Strong emphasis on challenging assumptions and developing a systemic understanding of financial markets and their many dimensional risks

Content

1- The Financial Crises: what is really happening? Historical perspective and what can be expected in the next decade(s). Bubbles and crashes. The illusion of the perpetual money machine.

2- Risks in financial markets
- What is risk?
- Measuring risks of financial assets
- Introduction to three different concepts of probability
- History of financial markets, diversification, market risks

3- Introduction to financial risks and its management.
- Relationship between risk and return
- Portfolio theory: the concept of diversification and optimal allocation
- How to price assets: the Capital Asset Pricing Model
- How to price assets: the Arbitrage Pricing Theory, the factor models and beyond

4- Financial markets: role and efficiency
- What is an efficient market?
- Financial markets as valuation engines: exogeneity versus endogeneity (reflexivity)
- Deviations from efficiency, puzzles and anomalies in the financial markets
- Financial bubbles, crashes, systemic instabilities

5- An introduction to Options and derivatives
- Calls, Puts and Shares and other derivatives
- Financial alchemy with options (options are building blocks of any possible cash flow)
- Determination of option value; concept of risk hedging

6- Valuation and using options
- A first simple option valuation model
- The Binomial method for valuing options
- The Black-scholes model and formula
- Practical examples and implementation
- Realized prices deviate from these theories: volatility smile and real option trading
- How to imperfectly hedge with real markets?

7- Real options
- The value of follow-on investment opportunities
- The timing option
- The abandonment option
- Flexible production
- Conceptual aspects and extensions

8- Government bonds and their valuation
- Relationship between bonds and interest rates
- Real and nominal rates of interest
- Term structure and Yields to maturity
- Explaining the term structure
- Different models of the term structure

9- Managing international risks
- The foreign exchange market
- Relations between exchanges rates and interest rates, inflation, and other economic variables
- Hedging currency risks
- Currency speculation
- Exchange risk and international investment decisions

Lecture notes

Lecture slides will be available on the site of the lecture

Literature

Corporate finance
Brealey / Myers / Allen
Eight edition

+ additional paper reading provided during the lectures

Prerequisites / notice

none

363-0711-00L Accounting for Managers W+ 3 credits 2V M. Passardi

Overview of financial and managerial accounting
Accounting for current and fixed assets
Liabilities and owners equity
Recording change in balance sheet
Measuring financial performance
Managing financial reporting
Full and variable costing system
Using accounting information for decision making purposes
Objective
Understand the different procedures involved in the accounting system
Record change in financial position
Measure business income
Prepare final accounts
Understand the principles of cost accounting
Calculate the different product costs
Make decisions about the acceptance or rejection of a particular product

Content
Financial Accounting: Balance sheet, income statement, double-entry accounting, journal and ledger, accounting for merchandising activities, value-added tax, adjustments before final accounts, provisions, depreciation, valuation,

Managerial Accounting: Full costing, variable costing, cost-volume-profit, break-even analysis, activity-based costing

Prerequisites / notice
This course is a prerequisite for the course Financial Management.

Electives

Recommended Elective Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-0301-00L</td>
<td>Work Design and Organizational Change</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>G. Grote</td>
</tr>
<tr>
<td>Abstract</td>
<td>Good work design is crucial for individual and company effectiveness and a core element to be considered in organizational change. Meaning of work, organization-technology interaction, and uncertainty management are discussed with respect to work design and sustainable organizational change. As course project, students learn and apply a method for analyzing and designing work in business settings.</td>
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</tbody>
</table>
| Objective | - Know effects of work design on competence, motivation, and well-being  
- Understand links between design of individual jobs and work processes  
- Know basic processes involved in systematic organizational change  
- Understand the interaction between organization and technology and its impact on organizational change  
- Understand relevance of work design for company performance and strategy  
- Know and apply methods for analyzing and designing work |       |      |       |           |
| Content   | - Work design: From Adam Smith to job crafting  
- Effects of work design on performance and well-being  
- Approaches to analyzing and designing work  
- Modes of organizational change and change methods  
- Balancing stability and flexibility in organizations as design criterion  
- The organization-technology interaction and its impact on work design and organizational change  
- Example Flexible working arrangements  
- Strategic choices for work design |       |      |       |           |
| Literature | A list of required readings will be provided at the beginning of the course. |       |      |       |           |
| Prerequisites / notice | The course includes the completion of a course project to be conducted in groups of four students. The project entails applying a particular method for analyzing and designing work processes and is carried out by means of interviews and observations in companies chosen by the students. |       |      |       |           |
| 363-0311-00L | Psychological Aspects of Risk Management and Technology | W    | 3    | 2V    | G. Grote, J. Schmutz, R. Schneider, M. Zumbühl |
| Abstract  | Using uncertainty management by organizations and individuals as conceptual framework, risk management and risk implications of new technologies are treated. Three components of risk management (risk identification/evaluation, risk mitigation, risk communication) and underlying psychological and organizational processes are discussed, using company case studies to promote in-depth understanding. |       |      |       |           |
| Objective | - understand basic components of risk management in organizations  
- know and apply methods for risk identification/evaluation, risk mitigation, risk communication  
- know psychological foundations of risk perception, decision-making under risk, and risk communication  
- know organizational principles for managing uncertainty  
- apply theoretical foundations to applied issues such as safety management, regulatory activities, and technology design and implementation in different domains (e.g. transport systems, IT, insurance) |       |      |       |           |
| Content   | The syllabus includes the following topics:  
Elements of risk management  
- risk identification and evaluation  
- risk mitigation  
- risk communication  
Psychological and organizational concepts relevant in risk management  
- decision-making under uncertainty  
- risk perception  
- resilient organizational processes for managing uncertainty  
Case studies on different elements of risk management (e.g., rule making, training, managing project risks, automation)  
Group projects related to company case studies |       |      |       |           |
| Literature | There is no script, but slides will be made available before the lectures. |       |      |       |           |
| Prerequisites / notice | There are texts for each of the course topics made available before the lectures. |       |      |       |           |
| 363-0393-00L | Corporate Strategy | W    | 3    | 2V    | S. Ben-Menahem |
| Abstract  | Due to didactic considerations, the number of participants for this course is limited to 50. Please register through myStudies to enroll for the course. Slots are assigned on a first-come first-serve basis (in the order of the registration date on myStudies). We will confirm your registration by e-mail. If you have any inquiries about the course, please contact the course assistant. |       |      |       |           |
| Notice    | This course focuses on the challenges in managing multi-business corporations, and covers topics related to the vertical and horizontal scope of business activities.  
70% of the final grade consists of a final closed-book written exam and 30% of the final grade will consist of individual/group assignments. |       |      |       |           |
The lecture treats the main challenges of business transformation and the alignment of corporate development and IT activities. It presents

1. Introduction

There are three goals of the lecture. First, understanding how the world has developed over the last centuries and the proximate and practical causes of economic growth. Second, understanding and application of the basic models of economic growth. Third, design of policies to foster innovation and growth to reduce the large wealth differences in the world.

Format:

The course is a combination of lectures about concepts/methods, guest lectures, case studies/assignments, and group debates/assignments.

Content:

The course homepage can be found at: http://www.smi.ethz.ch/education/courses/corporatestrategy

Prerequisites / Notice:

Having participated in the course Strategic Management by Prof. Georg von Krogh/Dr. Zeynep Erden is an advantage but not a requirement.

<table>
<thead>
<tr>
<th>Objective</th>
<th>363-0425-00L Transformation: Corporate Development and IT</th>
<th>W</th>
<th>3 credits</th>
<th>2G</th>
<th>T. Gutzwiller</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>The lecture treats the main challenges of business transformation and the alignment of corporate development and IT activities. It presents a holistic approach to business transformation projects by introducing an integrated model dealing with three main design areas “strategy”, “processes” and “information systems” and applying this model to various case studies.</td>
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<tr>
<td>Content</td>
<td>The goal of the lecture is to understand the main challenges of corporate transformation and to demonstrate the application of a holistic project procedure model for corporate transformation projects with special emphasis on the alignment of business and IT.</td>
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<tr>
<td>363-0562-01L Economics of Innovation and Growth</td>
<td></td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>M.C. Riekhof</td>
</tr>
<tr>
<td>Abstract</td>
<td>Overview how the world has developed. Understanding the role of innovation for economic growth. Design of policies to foster innovation and growth.</td>
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<tr>
<td>Objective</td>
<td>There are three goals of the lecture. First, understanding how the world has developed over the last centuries and the proximate and fundamental causes of economic growth. Second, understanding and application of the basic models of economic growth. Third, design of policies to foster innovation and growth to reduce the large wealth differences in the world.</td>
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<tr>
<td>Content</td>
<td>1. Introduction</td>
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<tr>
<td>2. Neoclassical Growth Theory</td>
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<tr>
<td>3. Innovations and Growth (New Growth Theory)</td>
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<tr>
<td>4. Growth Policy</td>
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<tr>
<td>5. Institutions and Growth</td>
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</tr>
<tr>
<td>Lecture Notes</td>
<td>The transparencies used in the lectures will be distributed to the participants.</td>
<td></td>
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</tr>
</tbody>
</table>
Management Research
Z. Erden Özkol
M. Neuhaus

Introduction in theory and practical application of Corporate Finance, with a particular focus on financing of operations and transactions, Corporate Finance, investment management, business valuation, value based management and compensation, financial reporting today and in future, financial reporting value chain, reporting on non-financial measures, such as corporate sustainability reporting, mergers and acquisitions, legal aspects, taxes, corporate governance - risk management - internal controls & mgmt. information systems, turnaround.

Objective
I will provide STATA programs and show the execution thereof. After having participated in this course, students will be able to carry out simple research projects and understand the basics of intermediate econometrics. In particular, they will be able to write simple programs in STATA and to qualify their own and others' regression output relating to problems covered.

Literature

Prerequisites / notice
The course will be supported by the Chair of Entrepreneurial Risks. Please refer to the chair's website for more detailed information regarding the course (www.er.ethz.ch/teaching).

363-0585-00L
Intermediate Econometrics
W 3 credits 2V M. Kesina

Abstract
The idea of this course is to familiarize students with instrumental variables estimation of linear regression models and the estimation of models with limited dependent variables as well as of nonlinear regression models. While most of the material covered will pertain to cross-sectional data, we will also work on selected issues with panel data.

Objective
I will provide STATA programs and show the execution thereof. After having participated in this course, students will be able to carry out simple research projects and understand the basics of intermediate econometrics. In particular, they will be able to write simple programs in STATA and to qualify their own and others' regression output relating to problems covered.

Literature

363-0723-00L
Corporate Finance
W 3 credits 2G M. Neuhaus

Abstract
Corporate Finance, investment management, business valuation, value based management & compensation, financial reporting today & in future, financial reporting value chain, reporting on non-financial measures, such as corporate sustainability reporting, mergers and acquisitions, legal aspects, taxes, corporate governance - risk management - internal controls & mgmt. information systems, turnaround.

Objective
Introduction in theory and practical application of Corporate Finance, with a particular focus on financing of operations and transactions, analysed from multiple aspects, including legal and tax.

Content
Corporate Finance, investment management, business valuation, value based management and compensation, financial reporting today and in future, financial reporting value chain, reporting on non-financial measures, such as corporate sustainability reporting, mergers and acquisitions, legal aspects, taxes, corporate governance - risk management - internal controls and management information systems, turnaround.

Lecture notes

363-0887-00L
Management Research
W 1 credit 1S Z. Erden Özkol

Abstract
The course is mandatory for MSc students and recommended for MAS students who write their Master Thesis at the Chair of Strategic Management and Innovation. Participation to both sessions are mandatory to receive the credit, there will be no exceptions. If a student can't take part in one of the sessions, the course has to be taken the following semester.

Objective
This course teaches students about the basic principles of scientific work in the field of social sciences. The goal is to motivate students to develop an own thesis design and write scientific articles.

Content
This course teaches students about the basic principles of scientific work in the field of social sciences. It is an introduction into the fascinating field of research. The course shows the power of theory and literature, helps formulating intriguing research questions, provides an overview of scientific methods and data analysis, and gives hints on how to derive insightful conclusions out of results. The goal is to motivate students to find and read research papers relevant to their field, develop an own thesis design and write scientific articles.

Literature

Prerequisites / notice
The course is mandatory for MSc. students and recommended for MAS students who write their Master Thesis at the Chair of Strategic Management and Innovation - those will be served first. The course will be given once every semester by Dr. Zeynep Erden Özkol and the PhD students of the chair. The course takes two days, one for lecture, one for student paper presentations. Participation to both sessions are mandatory to receive the credit, there will be no exceptions.

- Students who participate in the lecture and present a paper receive 1 credit point. The course and the presentations will be given in English.
- Students might benefit more if they take this course towards the end of their studies, before writing their master thesis.
The following topics will be covered:


363-1037-00L Fiscal Competition and Multinational Firms

Abstract
The course enables students to understand how multinational firms respond to differential tax regimes in a global economy and how countries strategically use the tax system to host multinationals. In particular, the course covers transfer pricing issues, internal financing decisions and agency problems and their relation to tax policy.

Objective
Understanding how taxes influence decisions of multinational firms

Develop thinking about the strategic use of differential tax systems for multinational firms

Using theoretical models and empirical analysis to uncover regularities in how multinational firms respond to taxes

363-1044-00L Applied Negotiation Seminar

Due to didactics reasons, the number of participants is limited to 30.

Prerequisites: Successful completion of lectures "363-1039-00L Introduction to Negotiation".

Abstract
The block-seminar combines lectures introducing negotiation, negotiation engineering and specific aspects of successful negotiation with the respective application through in-class negotiation case studies and games.

Objective
Students obtain a concentrated insight into key aspects of the field of negotiations, negotiation engineering and specific aspects of successful negotiation. Multiple opportunities to apply that knowledge in different negotiation situations allow for an in-depth learning experience.

363-1049-00L Contemporary Conflict Management

The course provides students with theoretical background and practical insights in conflict management in the 3 areas international, business and interpersonal (legal) relations. Students are introduced into theoretical concepts related to the research field and real world case studies including examples of international conflicts, WWI, old and new regional conflicts, business and mediation.

Objective
Students will gain
- knowledge of history of conflict management;
- comprehension of major ideas in the theory and practice of conflict management, mediation, transformation and resolution;
- application of theoretical concepts to current conflict situations;
- evaluation of conflict situations in international relations and business.

Content
The following topics will be covered:
- history of international and regional conflicts;
- theoretical concepts of conflict management;
- theoretical models of arms races and conflict escalation;
- case studies in international conflicts, as well as in business.

Distinguished guest speakers will be invited.


363-1080-00L Power and Leadership

Abstract
Students learn about different leadership styles and how power and leadership play out in social interactions. Emphasis is placed on the importance of implementation and application to the workplace.

Objective
This course will enhance students' understanding of the complexity of hierarchical relationships in the workplace in weekly lessons that include lectures, analysis of leadership situations (e.g., case studies), exercises, and group discussions. More specifically, students will be informed about how power shapes people's behaviors and decision-making processes. They will learn to analyze the different elements that make a good leader including personality traits, behavior, and skills. With case studies and small group exercises, students will learn to evaluate different types of social and emotional skills related to leadership and will be encouraged to reflect upon their own communication skills and leadership potential. The course further addresses integrity and ethics in leadership.

Class presence is mandatory.

363-1081-00L Asset Liability Management and Treasury Risks

Number of participants limited to 30.

Abstract
Asset Liability Management (ALM) is the cornerstone of managing the balance sheet of any corporation. The goal of this course is to discuss the foundations and to develop a thorough understanding of the Treasury function, with a particular emphasis on managing the risks relating to ALM.

Objective
We attempt to develop an integrated perspective on financial risks materializing in impacts on capital, earnings, and liquidity. Even though the concepts are generally applicable, the course puts a focus on banking institutions.

The course comprises of three parts, Part 1 introducing the fundamental concepts, Part 2 discussing case studies allowing us to dive more deeply into specific real-world examples, focusing on cases where the risk management has failed, while Part 3 will look at hot topics such as new regulations relating to funding, liquidity, market risk, and capital management. We will also discuss whether regulations are fit for purpose or whether they might have unintended consequences.

This course is interactive and students' participation is an important aspect. To make the classes more lively and interactive, students are expected to complete group assignments and give an inclass presentation.
This part covers fundamental concepts for ALM and Treasury, balance sheet and off-balance sheet products, Basel III capital and liquidity rules, trading and hedging principles, interest rate and FX management, performance metrics (e.g. net interest income, net interest margin), operating model for Treasury and Treasury Risk, ALCOs, liquidity risk management, and funds transfer pricing (FTP).

Part 2: Case Studies
In the second part of the course we are using case studies to analyze real-world examples, allowing us to go into more detail with regards to the fundamental concepts. Particularly, we are focusing on cases of failure, where, for potentially different reasons, corporations have failed and in which ALM has been an important aspect.

Part 3: Hot Topics in ALM and Treasury Risk Management
The last part looks at selected hot topics such as new regulations relating to funding, liquidity, market risk, and capital management. We will also discuss whether regulations are fit for purpose, i.e. whether it contributes to systemic stability, or whether they might have unintended consequences.

Literature
No single textbook covers the course, below we list some useful references. Further materials will be made available to students prior to the lectures.


Prerequisites / notice
Basic knowledge in finance

First Semester

Enabling Entrepreneurship: From Science to Startup 1 W 3 credits 2V A. Sethi
Students should provide a brief overview (unto 1 page) of their business ideas that they would like to commercialise through the course. If they do not have an idea, they are required to provide a motivation letter stating why they would like to do this elective.

The total number of students in this first batch will be limited to 30. It is preferable that the students already form teams of at least two persons, where both the team-members would like to do the course. The names of the team-members should be provided together with the business idea or the motivation letter submitted by the students.

The students should submit the necessary information and apply before 21st September 2016 to anisethi@ethz.ch. They will be intimated by 23rd September 2016 to confirm if they have secured a place.

Once the application has been confirmed, a registration in myStudies is possible.

Participants form teams and identify an idea, which is then taken through the steps necessary to form a startup. The primary focus of the course is geared to technology startups that want to reach scale.

Participants want to become entrepreneurs. Participants can be from business or science & technology

The course will enable the students to identify an idea and take all necessary steps to convert it into a company, through the duration of the two semesters.

The participants will have constant exposure to investors and entrepreneurs (with a focus on ETH spin-offs) through the course, to gain an understanding of their vision and different perspectives.

Participants start from idea identification, forming team, technology and market size validation, assessing time-to-market, customer focus, IP strategy & financials, to become capable of starting the company and finally making the pitch to investors.

The seminar comprises lectures, talks from invited investors regarding the importance of the various elements being covered in content, workshops and teamwork. There is a particular emphasis on market validation on each step of the journey, to ensure the relevance of the idea, relevance to customers, time to market and customer value.

This course is only relevant for those students who aspire to become entrepreneurs.

Students applying for this course are requested to submit a 1 page business idea or, in case they don't have a business idea, a brief motivation letter stating why they would like to do this course.

This will be in two modules (autumn and spring), which will run in two consecutive semesters. Priority for the second semester will be given to those students who have attended the first semester.

Additional Electives Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-0345-01L</td>
<td>Lecture Cycle Purchasing</td>
<td>W</td>
<td>2</td>
<td>1V</td>
<td>S. Wagner</td>
</tr>
<tr>
<td>Abstract</td>
<td>This lecture is about practical and theoretical issues in the field of purchasing &amp; supply management. Purchasing managers from various industries examine the importance of purchasing for corporate success. Possible topics of the presentations could be: Corporate and purchasing strategy, supplier networks, innovations in purchasing, supply chain redesign, sustainability in purchasing.</td>
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</tr>
<tr>
<td>Objective</td>
<td>This lecture is about practical and theoretical issues in the field of purchasing &amp; supply management. Purchasing managers from various industries examine the importance of purchasing for corporate success. The speakers are executives form purchasing and supply chain management departments.</td>
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<tr>
<td>Content</td>
<td>The goal of this lecture is to get an overview about the challenges of purchasing managers, get to know the procurement department as an important corporate function and to understand the importance of purchasing &amp; supply management with regard to corporate success. The speakers are executives form purchasing and supply chain management departments as well as from general management. We will discuss recent issues in purchasing and supply management such as: Corporate and purchasing strategy, supplier networks, procurement organization, innovations in purchasing, supply chain redesign, sustainability in purchasing &amp; supply management</td>
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</table>

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-0445-02L</td>
<td>Production and Operations Management (Additional)</td>
<td>W</td>
<td>1</td>
<td>2A</td>
<td>T. Netland, P. Schönsleben</td>
</tr>
</tbody>
</table>

Data: 06.03.2019 12:57  Autumn Semester 2016  Page 985 of 1571
Abstract

With the aim of preparing the students to take on managerial responsibility, this 2x5 days-seminar teaches basic and practical management skills.

Objective

To convey management behaviour based on practical examples, own experiences and team discussions complemented by short theory sessions (subsidized from the donation for promotion and training in enterprise sciences at the ETHZ).

Content

1. Fundamentals of Communication Psychology
2. Communication in Business-Life
3. Fundamentals of Leadership
4. Self-Management and Life Balance
5. Leadership Tools
6. Problem Solving and Decision Making Techniques
7. Performance Coaching
8. Conflict Management
9. Personality
10. Summary-Day, Domino-Examination

Lecture notes

Will be provided as electronic version at www.entrepreneurship.ethz.ch at least one week before the seminar starts

Prerequisites / notice

Special permission from lecturers required

Limited number of participants: Mandatory registration required.

IMPORTANT NOTICE

Preliminary announcement: Seminar 2 is offered in Spring Semester 2017. Students can only register and participate in “Seminar 1” OR “Seminar 2”.

Seminar 1: 2 x 5 days

Limited number of participants: Mandatory registration required for “Seminar 1” until 30.06.2016 by E-Mail: bms@ethz.ch

Block I: 15.-19.08.2016, 9-17 h
Block II: 05.-09.09.2016, 9-17 h

where: tba

Seminar 2: 2 x 5 days

Limited number of participants: Mandatory registration required for “Seminar 2” until 26.09.2016 by E-Mail: bms@ethz.ch

Block I: 30.01.-03.02.2017, 9-17 h
Block II: 13.02.-17.02.2017, 9-17 h

where: tba

Abstract

Technology ventures are significantly changing the global economic picture. Technological skills increasingly need to be complemented by entrepreneurial understanding.

This course offers the fundamentals in theory and practice of entrepreneurship in new technology ventures. Main topics covered are success factors in the creation of new firms, including founding, financing and growing a venture.

Objective

This course provides theory-grounded knowledge and practice-driven skills for founding, financing, and growing new technology ventures.

A critical understanding of dos and don'ts is provided through highlighting and discussing real-life examples and cases.

Content

See course website: http://www.entrepreneurship.ethz.ch/sresources/courses/tech-entrepreneurship.html

Lecture notes

Lecture slides and case material

Abstract

The development of new business models coping with the constantly augmenting complexity of technologies and systems as well as the ever increasing global competition force organizations to focus on close collaboration with key partners. These alliances are key value creation opportunities and constitute the core part of this lecture.
Objective

Learning outcomes professional competence
- The students learn and understand the management basics of inter-firm cooperation and organizational networks (business models, incl. risk, communication, etc.)
- Realize the value creation potentials of alliances (added value)
- Understand underlying theoretical models (Transaction cost theory, principal agent, game theory)
- Identify and understand specific forms of collaboration (Strat. All., JV, Networks, M&A, etc.)
- Apply tools hands on in real companies (in coll. with companies)

Learning outcomes methodological competence
- Writing academic papers
- Developing structured documentation of interviews
- Transferring theory directly into application
- Contributing to the learning journey

Learning outcomes social competence
- Work together with industrial partners
- Improving communication skills as basics for collaboration
- Developing and applying team work skills
- Coping with conflicts resolution in teams

Content

The constantly augmenting complexity of technologies and systems, the increased pressure caused by competition, the need for shortening time-to-market and the thereby implied growing risks force organizations to increasingly focus on core competencies. Collaboration with external partners is a key value creation opportunity for successful ventures. This type of cooperation also has implications on daily management activities. This lecture will provide a better understanding of special requirements needed for management of cooperation issues.Content:
- Introduction to theory and management of inter-firm collaboration and networks.
- Description of the formation, management and evolution of collaborations and networks.
- Collaborations in marketing, development, manufacturing (e.g. NUMMI).
- Special forms of collaborations: mergers & acquisition (e.g. pre- and post-merger activities, joint venture, strategic alliances (e.g. Doz & Hamel, networks, virtual communities)

Learning journey:

In an introductory lecture we will give an overview of the theoretical framework and explain the concept of the lecture (Sept. 18, 2014). In weeks 2-5 you will work on a first assignment on six different aspects of the underlying framework: strategy and activities, structure and process, culture and people orientation, interaction and roles, risk and trust, knowledge and learning. This first assignment will give you the basics to participate in the second part (Oct.30-31.2014, 2014) of this seminar. There you will present the results of the first assignment and get additional theoretical input to perform the 2nd assignment. The second assignment will be to analyze real alliance projects in the partner companies. The final lesson will be used as a best practice exchange together with our industrial partners (Dec.18, 2014).

Lecture notes

- Lecture script
- Current course material
- Harvard Case Studies
- Reader with current papers

Literature

A list with recommended publications will be distributed in the lecture.

Additional Books:
- HBR Collaborating Effectively ISBN 978-1-4221-6264 4
- HBR on Mergers and Acquisitions: ISBN 1-57851-555-6

Prerequisites / notice

The number of students participating in the lecture is limited to 30.

363-0884-00L Industrial Engineering and Management Methodology for Theses in Companies W 1 credit 1G

Does not take place this semester.


Abstract

This course is a preparation course for theses in industry: Criteria of scientific work, writing the final report, using research resources at ETH. Using case studies, content of other lectures is discussed with regard to the special challenges during theses: Systems Engineering, Social science methods for empirical data collection and analysis, project management, presentation technique.

Objective

The objective of this course is to provide students with a practical toolset of techniques, procedures and hints for a successful scientific thesis (Bachelor/Master/MAS Thesis) in industry. The course is held by assistants of professorships at D-MTEC.

Content

Methodology: Systems Engineering, problem solving process, situation analysis, SWOT, objectives, solution finding, evaluation.


Project Management: tasks plan, milestones, roles, communication

Scientific work: research, resources, citation, argumentation

Presentation: techniques, procedure, handouts, significance

Final report: organization, layout, figures, formal requirements, appendix

Learning outcomes social competence

- Contributing to the learning journey

Learning outcomes methodological competence

- Writing academic papers
- Developing structured documentation of interviews
- Transferring theory directly into application
- Contributing to the learning journey

Learning outcomes professional competence

- The students learn and understand the management basics of inter-firm cooperation and organizational networks (business models, incl. risk, communication, etc.)
- Realize the value creation potentials of alliances (added value)
- Understand underlying theoretical models (Transaction cost theory, principal agent, game theory)
- Identify and understand specific forms of collaboration (Strat. All., JV, Networks, M&A, etc.)
- Apply tools hands on in real companies (in coll. with companies)

Learning outcomes social competence

- Work together with industrial partners
- Improving communication skills as basics for collaboration
- Developing and applying team work skills
- Coping with conflicts resolution in teams

Content

The constantly augmenting complexity of technologies and systems, the increased pressure caused by competition, the need for shortening time-to-market and the thereby implied growing risks force organizations to increasingly focus on core competencies. Collaboration with external partners is a key value creation opportunity for successful ventures. This type of cooperation also has implications on daily management activities. This lecture will provide a better understanding of special requirements needed for management of cooperation issues.Content:

- Introduction to theory and management of inter-firm collaboration and networks.
- Description of the formation, management and evolution of collaborations and networks.
- Collaborations in marketing, development, manufacturing (e.g. NUMMI).
- Special forms of collaborations: mergers & acquisition (e.g. pre- and post-merger activities, joint venture, strategic alliances (e.g. Doz & Hamel, networks, virtual communities)

Learning journey:

In an introductory lecture we will give an overview of the theoretical framework and explain the concept of the lecture (Sept. 18, 2014). In weeks 2-5 you will work on a first assignment on six different aspects of the underlying framework: strategy and activities, structure and process, culture and people orientation, interaction and roles, risk and trust, knowledge and learning. This first assignment will give you the basics to participate in the second part (Oct.30-31.2014, 2014) of this seminar. There you will present the results of the first assignment and get additional theoretical input to perform the 2nd assignment. The second assignment will be to analyze real alliance projects in the partner companies. The final lesson will be used as a best practice exchange together with our industrial partners (Dec.18, 2014).

Lecture notes

- Lecture script
- Current course material
- Harvard Case Studies
- Reader with current papers

Literature

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Additional Books:
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- HBR on Mergers and Acquisitions: ISBN 1-57851-555-6

Prerequisites / notice

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363-0884-00L Industrial Engineering and Management Methodology for Theses in Companies W 1 credit 1G

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Abstract

This course is a preparation course for theses in industry: Criteria of scientific work, writing the final report, using research resources at ETH. Using case studies, content of other lectures is discussed with regard to the special challenges during theses: Systems Engineering, Social science methods for empirical data collection and analysis, project management, presentation technique.

Objective

The objective of this course is to provide students with a practical toolset of techniques, procedures and hints for a successful scientific thesis (Bachelor/Master/MAS Thesis) in industry. The course is held by assistants of professorships at D-MTEC.

Content

Methodology: Systems Engineering, problem solving process, situation analysis, SWOT, objectives, solution finding, evaluation.


Project Management: tasks plan, milestones, roles, communication

Scientific work: research, resources, citation, argumentation

Presentation: techniques, procedure, handouts, significance

Final report: organization, layout, figures, formal requirements, appendix

Learning outcomes social competence

- Contributing to the learning journey

Learning outcomes methodological competence

- Writing academic papers
- Developing structured documentation of interviews
- Transferring theory directly into application
- Contributing to the learning journey

Learning outcomes professional competence

- The students learn and understand the management basics of inter-firm cooperation and organizational networks (business models, incl. risk, communication, etc.)
- Realize the value creation potentials of alliances (added value)
- Understand underlying theoretical models (Transaction cost theory, principal agent, game theory)
- Identify and understand specific forms of collaboration (Strat. All., JV, Networks, M&A, etc.)
- Apply tools hands on in real companies (in coll. with companies)
The semester project (180 hours) is designed to train the students in the solution of specific engineering problems. This makes use of the technical and social skills acquired during the master's program. Tutors propose the subject of the project, elaborate the project plan, and define the roadmap together with their students, as well as monitor the overall execution.

The course is intended for students who want to carry out a thesis in industry, in general these are:

1. MSc-students MTEC or MAVT with master thesis (MA) during the next term and supervised by MTEC, (corresponds to 3rd or 4th semester Master) and
2. BSc-students MAVT with bachelor thesis (BA) in industry and supervised by MTEC, as well as with full MTEC focus (corresponds to 5th or 6th semester Bachelor) or
3. MAS MTEC students in 3rd semester for MA during the next term.

Important note: Credits will only be awarded to students according to (1), (2) or (3). Prerequisites for obtaining the credit or "Testat": being present during the whole course (presence list) and prior study of documents provided on the Internet and of the book Züst, R.: Einstieg ins Systems Engineering. 3. Aufl., Verlag Industrielle Organisation, Zürich 2004.

Other students on request (limited places).

Important: the chair coaching your BA/MA defines whether the course is mandatory. Please contact your chair!

Electronic enrollment until 08.09.2015 required. Without electronic enrollment participation in the course can't be confirmed. The course is held "en bloc" at the beginning of the semester.

Date: Friday 11.09.2015 (13:15-17:00), location: HG E33.1 (ETH main building) and Saturday, 12.09.2015 (09:15-17:00), location: HG E33.1 (ETH main building). Participation at both days required (Friday afternoon and Saturday whole day).

The course is held in English; handouts are available in English.

Besonderes (deutsche Version):
Der Kurs richtet sich an Studierende, welche an einer Professur des D-MTEC eine Arbeit in der Wirtschaft schreiben werden. Im Allgemeinen sind dies:

1. MSc-Studierende MTEC oder MAVT mit Masterarbeit (MA) im kommenden Semester, die vom MTEC betreut wird, (entspricht 3. oder 4. Semester Master) sowie
2. BSc-Studierende MAVT mit Bachelorarbeit (BA) in der Wirtschaft, die vom MTEC betreut wird, sowie mit vollem MTEC Fokus (entspricht 5. oder 6. Semester Bachelor) oder


Andere Studierende auf Anfrage (beschränkte Anzahl Plätze).

Wichtig: die Professur, welche die jeweilige BA/MA betreut, legt fest, ob der Besuch der Veranstaltung obligatorisch ist. Bitte informieren Sie sich dort!

Elektronische Einschreibung bis zum 08.09.2015 notwendig. Ohne elektronische Einschreibung kann Ihre Teilnahme am Kurs nicht bestätigt werden.

Der Kurs wird als Blockkurs zu Beginn des Semesters gehalten.

Termin: Freitag, den 11.09.2015 (13:15-17:00) im HG E33.1 und Samstag, 12.09.2015 (09:15- ca. 17:00) im HG E33.1 (ETH Hauptgebäude). Anwesenheitspflicht an beiden Tagen (Freitagnachmittag und Samstag ganztag).

Die Veranstaltung wird auf Englisch gehalten; Handouts sind in Englisch verfügbar.

### Abstract

**Semester Project Small**

- W 3 credits
- Professors

The semester project (90 hours) is designed to train the students in the solution of specific engineering problems. This makes use of the technical and social skills acquired during the master's program. Tutors propose the subject of the project, elaborate the project plan, and define the roadmap together with their students, as well as monitor the overall execution.

### Objective

The semester project (90 hours) is designed to train the students in the solution of specific engineering problems. This makes use of the technical and social skills acquired during the master's program. Tutors propose the subject of the project, elaborate the project plan, and define the roadmap together with their students, as well as monitor the overall execution.

**Semester Project Large**

- W 6 credits
- Professors

The semester project (180 hours) is designed to train the students in the solution of specific engineering problems. This makes use of the technical and social skills acquired during the master's program. Tutors propose the subject of the project, elaborate the project plan, and define the roadmap together with their students, as well as monitor the overall execution.

### Monetary Policy

- W 3 credits
- J.E. Sturm, D. Kaufmann

The main aim of this course is to analyse the goals of monetary policy and to review the instruments available to central banks in order to pursue these goals. It will focus on the transmission mechanisms of monetary policy and the differences between monetary policy rules and discretionary policy. It will also make connections between theoretical economic concepts and current real world issues.
Health expenditures constitute about 10% of GDP in OECD countries. Extensive government intervention is a typical feature in health economics. W. Hu and P. Cettier have written extensively on the topic. The course provides students with the basic skills to understand and assess empirically the technological activities of firms and the consequences for their performance.

### Objective
- To deliver the general understanding about why and when regulations are needed; to make students familiar with common regulatory tools and their advantages and disadvantages of the alternatives will be discussed to provide a framework for analyzing specific types of health care systems.

### Content
- Market failure: the reason for regulation;
- The evolution of price regulation;
- Regulation against the monopoly power: the general idea;
- Regulation practices for the utilities (Electricity and energy, Telecommunications, Environmental regulation, Financial regulation);
- Cost-benefit analysis;
- Extended topics: the asymmetric information problem in regulation.

### Literature
Lodge, M., M. Cave and R. Baldwin (eds.), The Oxford Handbook of Regulation, Oxford University Press, 2010. (accessible online via the school network)


### Prerequisites / notice
Students are expected to have taken at least one basic microeconomics course. Knowledge about game theory, industrial organization and public economics will be useful. Knowledge about contract theory is a plus.

### Literature
- Cost-benefit analysis;
- Regulation practices for the utilities (Electricity and energy, Telecommunications, Environmental regulation, Financial regulation);
- Regulation against the monopoly power: the general idea;
- Regulation practices for the utilities (Electricity and energy, Telecommunications, Environmental regulation, Financial regulation);
- Cost-benefit analysis;
- Extended topics: the asymmetric information problem in regulation.

### Prerequisites / notice
Specific academic papers and cases will be studied during the lectures.

### Literature
Jay Bhattacharya, Timothy Hyde, Peter Tu, "Health Economics", Palgrave Macmillan.


### Prerequisites / notice
- Students are expected to have taken at least one basic microeconomics course.

### Literature

### Prerequisites / notice
Basic knowledge in international economics and a good background in macroeconomics. The course website can be found at: https://moodle-app2.let.ethz.ch/course/view.php?id=2457

### Literature
- The Fifty Most Important Papers in the Economics of Regulation" ACCC/AER Working paper

### Prerequisites / notice
- The course will be based on chapters of:

### Literature
- Basic knowledge in international economics and a good background in macroeconomics. The course website can be found at: https://moodle-app2.let.ethz.ch/course/view.php?id=2457

### Prerequisites / notice
- The course consists of two parts. Part I provides an introduction into important topics in the field of the economics of innovation. Part II consists of empirical exercises based on the KOF Innovation Data. In part I we will learn about ...a market conditions that encourage firms to invest in R&D (Research and Development) and develop new products. ...b) the role of universities for the technological activities of a firm (technology transfer), ...c) how technologies diffuse among firms. ...d) how the R&D activities of firms are affected by economic crises and how firms finance their R&D activities. ...e) how (environmental) policies affect the technological activities of a firm. In part II we will use the KOF Innovation Survey Data in order to assess empirically the technological activities of firms referring to the topics introduced in part I.

### Literature
- The course consists of two parts. Part I provides an introduction into important topics in the field of the economics of innovation. Part II consists of empirical exercises based on the KOF Innovation Data. In part I we will learn about ...a market conditions that encourage firms to invest in R&D (Research and Development) and develop new products. ...b) the role of universities for the technological activities of a firm (technology transfer), ...c) how technologies diffuse among firms. ...d) how the R&D activities of firms are affected by economic crises and how firms finance their R&D activities. ...e) how (environmental) policies affect the technological activities of a firm. In part II we will use the KOF Innovation Survey Data in order to assess empirically the technological activities of firms referring to the topics introduced in part I.

### Lecture notes
- Will be provided in the course

### Literature
- Will be provided in the course.

### Prerequisites / notice
- Strategic Career Development is directed to advanced Master-Students and PhD Students with an interest in empirical work.

### Literature
- The Fifty Most Important Papers in the Economics of Regulation" ACCC/AER Working paper

### Prerequisites / notice
- The course consists of two parts. Part I provides an introduction into important topics in the field of the economics of innovation. Part II consists of empirical exercises based on the KOF Innovation Data. In part I we will learn about ...a market conditions that encourage firms to invest in R&D (Research and Development) and develop new products. ...b) the role of universities for the technological activities of a firm (technology transfer), ...c) how technologies diffuse among firms. ...d) how the R&D activities of firms are affected by economic crises and how firms finance their R&D activities. ...e) how (environmental) policies affect the technological activities of a firm. In part II we will use the KOF Innovation Survey Data in order to assess empirically the technological activities of firms referring to the topics introduced in part I.

### Lecture notes
- Will be provided in the course.

### Literature
- Will be provided in the course.
Objective
We will discuss and develop answers to the following questions:

What do I want to achieve in my life?
Why is it to important to define goals?
What decision criteria can I use as a guide?
How do potential career paths look like? What are the possibilities?
How does the life cycle of a career look like? What are the alternatives?
How do I increase my chances of success/reaching my goals?
How did others do it? What kind of advice can experienced captains of industry give?
Why is a periodic check of my goals and my progress necessary?

Content
INTRODUCTION
Awareness building / Overview on the career life cycle / Examples from praxis / Exchange of experiences / Approach for goalsetting / Introduction to the success secrets of a career

ORIENTATION AND GOAL SETTING
Class discussion of the success secrets of a career / Orientation on career options / Discussion of possible decision criteria / Initial formulation of concrete goals

External guest speaker: Inspiring Start-up Entrepreneur

CAREER DEVELOPMENT PLANS
Exchange with representatives of industries / Personal Values & Norms vs Corporate Identity / Work-Life Balance Gender / Diversity / Summary of discussions / Best practice / Modification/Sharpening of goals

External guest speaker: Representatives from Hilti AG Switzerland

DETAILING OF INDIVIDUAL CAREER PLANS
Development of detailed individual career plans / Next steps / action plan / Tips & Tricks for careers in organizations and entrepreneurship

REVIEW & APPLICATION COUNSELING
Review/check of goals and career plans / Motivation letter / CV / Preparation for interviews

INTERVIEW TRAINING
In today’s world of everything is possible it becomes an every increasing challenge to find orientation, to define a goal for which it is worth to work for with focus and energy. But this is exactly what is so important in today’s work environment. Only with a definite goal one can decide if the taken path is right, one can develop enough motivation to go beyond the comfort zone. With a definite goal, one increases the chances of success of one’s education and career. The earlier one has defined what he/she wants to achieve, the bigger the effect.

Lecture notes
In today’s world of everything is possible it becomes an every increasing challenge to find orientation, to define a goal for which it is worth to work for with focus and energy. But this is exactly what is so important in today’s work environment. Only with a definite goal one can decide if the taken path is right, one can develop enough motivation to go beyond the comfort zone. With a definite goal, one increases the chances of success of one’s education and career. The earlier one has defined what he/she wants to achieve, the bigger the effect.

Prerequisites / notice
Motivation. Strategic long-term view.

Economics of Urban Transportation W 3 credits 2G A. Russo

Abstract
The first part of the course will present some basic principles of transportation economics, applied to the main issues in urban transport policy (e.g. road pricing, public transport tariffs, investment in infrastructure etc.). The second part of the course will consider some case studies where we will apply the tools acquired in the first part to actual policy issues.

Objective
The main objective of this course is to provide students with some basic tools to analyze transport policy decisions from an economic perspective. Can economics help us reduce road congestion problems? Should drivers be asked to pay for using urban roads? Should public transport tariffs depend on how roads are priced? How should the investment in transport infrastructure be financed? These are some of the questions that students should be able to tackle after completing the course.

Content
COURSE OUTLINE (preliminary):
1. Introduction
2. Travel demand :
   a. travel cost and value of time
   b. mode choice
3. Road congestion and first-best pricing
   a. Static congestion model
   b. Dynamic congestion models
   c. Examples: London Congestion Charge, Stockholm Congestion Charge
4. Second-best pricing
   a. Pricing roads with unpriced alternatives. Examples: tolled and toll-free highways
   b. Public transport: pricing with road congestion and with (or without) road tolls
5. Investment in infrastructure: public transport and roads
   a. Roads: Investment with and without pricing
   b. induced demand
   c. Economies of scale/density in public transport
6. Topics:
   a. Political economy of road pricing: why do we see road pricing in so few cities (London, Stockholm...) and not in many other cities (NYC, Manchester, Paris...)?
   b. What are the alternatives to road pricing to reduce congestion? Parking tariffs, traffic regulation (speed bumps, low emission zones), road space reduction. Examples: Zurich, San Francisco (SFPark), Paris.
   c. Transport and land use: value of housing and transport services. Road congestion, transport subsidies and urban sprawl.

Lecture notes
Course slides will be made available to students prior to each class.

Sustainable Supply Chain Management W 3 credits 2G C. Busse

Abstract
The course focuses on the establishment of sustainability in firm’s supply chains (that is, in their internal operations, in their logistics processes, and in their upstream supply chains). We will consider how supply chains can become more sustainable, as well as the extent to which firms are interested in such a development.
This course aims to equip students with an in-depth knowledge of the sustainability-related challenges and problems within supply chain management, and suggests some tools for managing these challenges. Equally importantly, the course seeks to capacitate students for understanding and analyzing the tradeoffs and conflicts of target within sustainable supply chain management. The content of the course is closely linked to the latest research in the field, meaning that the absence of simple solutions will be the rule, rather than the exception. Moreover, the course will be highly interactive, and there will be intensive coursework during the course.

### Content

The preliminary course outline is as follows:

**Module 1: Motivation for SusSCM**
- Introductory case study
- Basic terminology
- Sustainability issues
- Dilemmas for firms
- Motivation for firms to engage in SusSCM
- SusSCM and LCA
- Specificity of SusSCM

**Module 2: Sustainable operations management**
- Lean and green
- CO2 emissions: measurement and management
- Extended producer responsibility
- Recycling

**Module 3: Sustainable logistics**
- Closed-loop supply chain management and reverse logistics
- Sustainable transportation: foundations related to energy and CO2
- Sustainable transportation: improvement measures related to energy and CO2
- Sustainable transportation: other sustainability-related issues
- Sustainable warehousing: basics and sustainability-related benefits
- Sustainable warehousing: sustainability-related challenges

**Module 4: Sustainable purchasing and supply management**
- Introduction to sustainable purchasing and supply management
- Sustainable supply management
- Information processing prerequisites to sustainable supply management
- GRI supply chain issue reporting
- Sustainability-oriented supply chain risk management
- A buying firm’s self interest in suppliers’ sustainability-related conditions

**Lecture notes**

The course material will be available for download from the homepage of the Chair of Logistics Management:
http://www.scm.ethz.ch/teaching/Courses. The login will be announced in the first lecture. In addition, we will employ scientific publications and case studies as readings which are provided throughout the course. Supplementary textbooks are listed below in the literature section.

**Prerequisites / notice**

There are no formal prerequisites. However, to profit most from the course, it would be desirable if students attended the MTEC courses on Strategic Supply Chain Management (MTEC MSc course no. 363-0453-00L), on Purchasing and Supply Management (MTEC MSc course no. 363-0452-00L) and on Corporate Sustainability (MTEC MSc course no. 363-0387-00L) beforehand. Moreover, the course builds on and details lectures on Sustainable Supply Chain Management within the course LOS II: Manufacturing Strategies - From Supply Chain Design to Factory Planning II (MTEC MSc course no. 363-0448-00L).

### Literature

**Workshop & Lecture Series on the Law & Economics of Innovation**

- S. Bechtold, H. Gersbach, A. Heinemann

**Supplementary textbooks:**
- S. Brusoni, G. Grote, V. Hoffmann, A. Heinemann
- W. Hall / N. Rosenberg, Global Competition Law and Economics, 2007
- S. Schmitz, Innovation and Incubation, 2004
- Bronwyn Hall / Nathan Rosenberg (eds.), Handbook of the Economics of Innovation, 2 volumes, Amsterdam 2010
- Bronwyn Hall / Dietmar Harhoff, Recent Research on the Economics of Patents, 2011

**Supplementary textbooks:**
- S. Bechtold
- G. von Krogh
- P. Baschera

**Prerequisites / notice**

There are no formal prerequisites. However, to profit most from the course, it would be desirable if students attended the MTEC courses on Strategic Supply Chain Management (MTEC MSc course no. 363-0453-00L), on Purchasing and Supply Management (MTEC MSc course no. 363-0452-00L) and on Corporate Sustainability (MTEC MSc course no. 363-0387-00L) beforehand. Moreover, the course builds on and details lectures on Sustainable Supply Chain Management within the course LOS II: Manufacturing Strategies - From Supply Chain Design to Factory Planning II (MTEC MSc course no. 363-0448-00L).
The aim of this module is to introduce students to some key concepts in technology marketing and to familiarize them subsequently with the challenges that (marketing) managers face in technology intensive markets by using real life cases. Students will have to "solve" current and past managerial problems and will be enabled to compare their solutions with what has actually been done.

This module should enable students to deal with the uncertainty related to challenges in technology marketing by introducing them to some key concepts and letting them apply those concepts to real life cases. The competences acquired in this module are meant to go beyond the mere understanding of the study material by improving students' problem solving capabilities, analytical skills and capacity for teamwork. Furthermore, students will be exposed to decision-making styles and procedures in companies.

The goal of this course is to engage students in a multidisciplinary collaboration to tackle real world problems. Following a design thinking approach, students will work in teams to solve a set of design challenges that are organized as a one-week, a three-week, and a final six-week project in collaboration with an external project partner.

Students have to work on a specific assignment that flows from the current strategic agenda of the board. While gaining substantial insights into the structure, dynamics and challenges of the industry, you immerse into the business model and strategic landscape of the corporate partner. You visit their headquarter, conduct interviews with members of the management team as well as internal and external experts before you discuss your ideas with top executives. To secure impact, it is key that you formulate your recommendations from a deep understanding of the authentic leadership culture of the corporate partner.

Students have to organize the remaining phase of their studies in a way that they are able to participate in the workshops.

The number of participants is limited to 18.

ECTS: 4

Participants receive a certificate.
Objective

During the course, students will learn about different design thinking methods and tools. This will enable them to:
- Generate deep insights through the systematic observation and interaction of key stakeholders.
- Engage in collaborative ideation with a multidisciplinary (student) team.
- Rapidly prototype and iteratively test ideas and concepts by using various materials and techniques.

Content

The purpose of this course is to equip the students with methods and tools to tackle a broad range of problems. Following a Design Thinking approach, the students will learn how to observe and interact with key stakeholders in order to develop an in-depth understanding of what is truly important and emotionally meaningful to the people at the center of a problem. Based on these insights, the students ideate on possible solutions and immediately validated them through quick iterations of prototyping and testing using different tools and materials. The students will work in multidisciplinary teams on a set of challenges that are organized as a one-week, a three-week, and a final six-week project with an external project partner. In this course, the students will learn about the different Design Thinking methods and tools that are needed to generate deep insights, to engage in collaborative ideation, rapid prototyping and iterative testing.

Design Thinking is a deeply human process that taps into the creative abilities we all have, but that get often overlooked by more conventional problem solving practices. It relies on our ability to be intuitive, to recognize patterns, to construct ideas that are emotionally meaningful as well as functional, and to express ourselves through means beyond words or symbols. Design Thinking provides an integrated way by incorporating tools, processes and techniques from design, engineering, the humanities and social sciences to identify, define and address diverse challenges. This integration leads to a highly productive collaboration between different disciplines.

For more information and the application visit: http://sparklabs.ch/ethz

Prerequisites / notice

Class attendance and active participation is crucial as much of the learning occurs through the work in teams during class. Therefore, attendance is obligatory for every session. Please also note that the group work outside class is an essential element of this course, so that students must expect an above-average workload.

376-1177-00L Human Factors I

Abstract

Every day humans interact with various systems. Strategies of interaction, individual needs, physical & mental abilities, and system properties are important factors in controlling the quality and performance in interaction processes. In the lecture, factors are investigated by basic scientific approaches. Discussed topics are important for optimizing people's satisfaction & overall performance.

Objective

The goal of the lecture is to empower students in better understanding the applied theories, principles, and methods in various applications. Students are expected to learn about how to enable an efficient and qualitatively high standing interaction between human and the environment, considering costs, benefits, health, and safety as well. Thus, an ergonomic design and evaluation process of products, tasks, and environments may be promoted in different disciplines. The goal is achieved in addressing a broad variety of topics and embedding the discussion in macroscopic factors such as the behavior of consumers and objectives of economy.

Content

- Physiological, physical, and cognitive factors in sensation and perception
- Body spaces and functional anthropometry, Digital Human Models
- Experimental techniques in assessing human performance and well-being
- Human factors and ergonomics in system designs, product development and innovation
- Human information processing and biological cybernetics
- Interaction among consumers, environments, behavior, and tasks

Literature

- Gavriel Salvendy, Handbook of Human Factors and Ergonomics, 4th edition (2012), is available on NEBIS as electronic version and for free to ETH students
- Further textbooks are introduced in the lecture
- Brouchures, checklists, key articles etc. are uploaded in ILIAS

363-1050-00L Conference of Disarmament: Simulation of Negotiations

Abstract

The Global Studies Institute (University of Geneva) is organizing a simulation seminar on nuclear disarmament in collaboration with the Chair of Negotiation and Conflict Management (ETH), experts from the United Nations Institute for Disarmament Research and the Geneva Center for Security Policy.

Objective

The simulation is conducted in collaboration with experts and students during a two days seminar at the University of Geneva.

Students will have the possibility to participate in simulated diplomatic negotiations and to analyse and assess the negotiation logic behind the situations. They should gain insight in the basic information on disarmament issues and on the functioning of the Conference on Disarmament as well as on negotiation techniques in general.
The simulation project is intended for Master's or Doctoral students of the Global Studies Institute (GSI) of the University of Geneva, of the ETH and for interested students of the Geneva Centre for Security Policy (GCSP). The simulation will be in French and English and is conducted by Prof. Calmy-Rey, former President of Switzerland.

In the lectures, students will be provided with basic information on disarmament issues and on the functioning of the Conference on Disarmament as well as on negotiation techniques in general. Students will take the role of negotiators in the simulation (including the heads of the delegations), of keeper of the minutes or of observers and analysts. Students will co-develop their mandates for the negotiation and be assisted by experts that are specialized in international negotiations as well as in the topic of disarmament. The negotiation tables will be chaired by former diplomats. Representatives of diplomatic missions in Geneva will play the role of the "Capitals" to which the heads of delegations will have to give account of the ongoing negotiations.

More details on the program, timetable, reading lists and performance assessment will be published here: https://chamilo.unige.ch/home/courses/M165/?id_session=0

The simulation will take place on the 26 and 27 November 2015 at the University of Geneva.

Languages: English and French

Dates/Time/Location (GE = University of Geneva)

22 Sept. | ETH HG D 22 | 10:15-12:00 | Introduction
29 Sept. | GE Uni Mail Salle 1170 | 10:15-12:00 | Introduction to Negotiation Techniques (Dr. Vitalij Butenko and Dr. Sibylle Zürcher, ETH)
6 Oct. | ETH HG D 16.2 | 10:15-12:00 | Distribution of the roles, composition of the negotiation tables, preparation of mandates for the HA (humanitarian approach)
13 Oct. | ETH HG D 22 | 10:15-12:00 | Preparation of the mandates for the FMCT (Fissile Material Cut-off Treaty)
20 Oct. | GE Uni Mail Salle 1170 | 10:15-12:00 | No session; Students deepen and summarize their mandates on one page (A4)
27 Oct. | GE Uni Mail Salle 1170 | 10:15-12:00 | Discussion of the Mandates I (FMCT)
10 Nov. | GE Uni Mail Salle 1170 | 10:15-12:00 | Discussion of the Mandates II (HA)
17 Nov. | GE Uni Mail Salle 1170 | 10:15-12:00 | Preparation Meeting
26 & 27 Nov. | GE Salles 407 et 408 | 10:00-18:00 | Simulation at Uni Dufour
1 Dec. | GE Uni Mail Salle 1170 | 10:15-12:00 | Discussion of the results

Note:
The participation in the simulation on 26. and 27. November in Geneva is necessary.
The two hours lectures on the 22. September, 6. and 13. October have to be attended in Zürich via conference call (ETH HG D 16.2). The other lectures during the semester can be attended via Skype.

To get the 3 ECTS, students have to participate at the 2 days simulation in Geneva, attend the 3 mandatory lecture parts via conference call an Zürich and write a report of 5 pages at the end of the course.

(Technical note for registration: At this stage all registered students are on the waiting list)

Supplementary Courses

The students have to deepen their knowledge in the area(s) of engineering/natural sciences in consultation with the responsible professor (tutor). Core courses and electives of D-MTEC can not be used as supplementary courses.

Industrial Internship

Course Catalogue of ETH Zurich

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-0879-00L</td>
<td>Practical Training</td>
<td>O</td>
<td>6</td>
<td></td>
<td>external organisers</td>
</tr>
</tbody>
</table>

Abstract

The practical experience gained by the student completes the studies at the Swiss Federal Institute of Technology and prepares her/him for future activities in industry.

Objective

The practical experience gained by the student completes the studies at the Swiss Federal Institute of Technology and prepares her/him for future activities in industry.

Master's Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-0600-00L</td>
<td>Master's Thesis</td>
<td>O</td>
<td>30</td>
<td>57D</td>
<td>Professors</td>
</tr>
</tbody>
</table>

Abstract

Only students who fulfill the following criteria are allowed to begin with their master thesis:

a. successful completion of the bachelor programme;

b. fulfilling of any additional requirements necessary to gain admission to the master programme;

c. internship fulfilled;

d. academic writing course has been completed (students from Spring Semester 2015 onwards).

In the Master thesis students prove their ability to independent, structured and scientific working. The Master thesis is supervised by the tutor and normally deals with a subject contained in the major fields. The research will be performed normally within a private company or at the ETH Zurich.

Academic Writing Course

This course for MTEC master's students will focus on developing and refining students' English writing skills and their understanding of the requirements and conventions of academic writing.

Data: 06.03.2019 12:57 Autumn Semester 2016 Page 994 of 1571
Objective

The course develops a range of practical and transferrable writing skills. Its first aim is to improve the academic writing skills necessary for the successful completion of an MSc thesis. The course provides theoretical input, practical writing exercises, and detailed individual feedback. It is organized into an initial group lecture and four subsequent workshops in smaller tutorial groups.

The group lecture raises awareness about academic conduct, especially with regard to plagiarism. Afterwards, students take placement tests so that the areas where they need improvement can be identified. The following workshops concentrate on these highlighted areas, and feedback on placement tests is integrated into the input and practice during these sessions.

Students can use the skills developed on the course to improve the overall quality of their MSc theses and to produce their thesis more rapidly and efficiently. These skills can also be used beyond the MSc, whether students go on to complete a PhD or to produce reports and other documents in industry.

Content

Group lecture:
- an introduction to writing an MSc thesis in D-MTEC
- selecting topic and supervisor
- academic expectations
- avoiding plagiarism

Workshop 1:
- the writing process
- reading, note taking and planning
- overview of the thesis structure
- building academic vocabulary

Workshop 2:
- writing methods sections
- embedding figures and tables
- structuring sentences and paragraphs
- noun phrases and articles

Workshop 3:
- introductions; results and discussion sections
- analysis v description
- writing critically
- relative clauses

Workshop 4:
- abstracts and conclusions
- editing your own text
- punctuation, spelling, and grammar

Lecture notes

Notes will be available after registration.

Management, Technology and Economics Master - Key for Type

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
</tbody>
</table>

Key for Hours

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

ECTS

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
**Mechanical Engineering Bachelor**

**1. Semester**

**Registration for the exercises via the application [https://echo.ethz.ch/](https://echo.ethz.ch/) with your nETHz login (username, password).**

### First Year Examinations: Compulsory Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-0261-00L</td>
<td>Analysis I</td>
<td>O</td>
<td>8</td>
<td>5V+3U</td>
<td>A. Steiger</td>
</tr>
<tr>
<td>Abstract</td>
<td>Differential and integral calculus for functions of one and several variables; vector analysis; ordinary differential equations of first and of higher order, systems of ordinary differential equations; power series. The mathematical methods are applied in a large number of examples from mechanics, physics and other areas which are basic to engineering.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Objective</td>
<td>Introduction to the mathematical foundations of engineering sciences, as far as concerning differential and integral calculus.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Literature</td>
<td>U. Stammbach: Analysis I/II</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prerequisites / notice</td>
<td>Die Übungsaufgaben (inkl. Multiple Choice) sind ein wichtiger Bestandteil der Lehrveranstaltung. Es wird erwartet, dass Sie mindestens 75% der wöchentlichen Serien bearbeiten und zur Korrektur einreichen.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>401-0171-00L</td>
<td>Linear Algebra I</td>
<td>O</td>
<td>3</td>
<td>2V+1U</td>
<td>N. Hungerbüehler</td>
</tr>
<tr>
<td>Abstract</td>
<td>Linear algebra is an indispensable tool of engineering mathematics. The course offers an introduction into the theory with many applications. The new notions are practised in the accompanying exercise classes. The course will be continued as Linear algebra II.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Objective</td>
<td>Upon completion of this course, students will be able to recognize linear structures, and to solve corresponding problems in theory and in practice.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Content</td>
<td>Systems of linear equations, Gaussian elimination, solution space, matrices, LR decomposition, Determinants, structure of linear spaces, normed vector spaces, inner products, method of least squares, QR decomposition, introduction to MATLAB, applications</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
* K. Meyberg / P. Vachenauer, Höhere Mathematik 1, Springer 2003 |
| Prerequisites / notice | Active participation in the exercises is part of this course. It is expected, that students submit 3/4 of all exercises for control. |
| 151-0501-00L | Mechanics 1: Kinematics and Statics          | O    | 5     | 3V+2U | E. Mazza                |
| Abstract     | Basics: Position of a material point, velocity, kinematics of rigid bodies, forces, reaction principle, mechanical power |
| Content      | Statics: Groups of forces, moments, equilibrium of rigid bodies, reactions at supports, parallel forces, center of gravity, statics of systems, principle of virtual power, trusses, frames, forces in beams and cables, friction |
| Literature   | S. Ayer., M.B., Daul J., Kaufmann S., Ingenieurmechanik 1: Grundlagen und Statik, Teubner |
| Prerequisites / notice | Written session examination in "Mechanics 1" and "Mechanics 2" for D-MAVT Students, Students in Human Movement Sciences and Sport and all other Students, who take "Mechanics 1" and "Mechanics 2": |
| Lecture notes | Übungsbilder                                  |
| 151-0711-00L | Engineering Materials and Production I       | O    | 4     | 4G    | K. Wegener              |
| Abstract     | The lecture covers the structure and the properties of metallic materials. In the focus are the branches: microscopic structure; thermally activated processes; solidification; elastic, plastic deformation, creep. Generally the lecture also refers to manufacturing, to the processing, and application of the concerning materials. |
| Objective    | Understanding the basics of metallic materials for engineers who are confronted with material decisions in design and production. |
| Content      | The lecture covers the structure and the properties of metallic materials. In the focus are the branches: microscopic structure as ideal and real structure, alloying, thermally activated processes e.g. diffusion, recovery, recrystallisation, solidification, elastic and plastic deformation and creep. Generally the lecture also refers to manufacturing, to the processing, and application of the concerning materials. |
| Lecture notes | yes                                          |
| 151-0301-00L | Machine Elements                             | O    | 2     | 1V+1U | M. Meboldt, Q. Lohmeyer |
| Abstract     | Introduction to machine elements and mechanical systems as basics of product development. Case studies of their application in products and systems. |
| Objective    | The students get an overview of the main mechanical components (machine elements) which are used in mechanical engineering. Selected examples will demonstrate how these can be assembled into functional parts and complete systems such as machinery, tools or actuators. At the same time, also the problem of production (production-oriented design) is discussed. In concurrent lectures / exercises "technical drawing and CAD" the design implementation will be practiced. |
| Content      | - Innovation Process: A Quick Overview  
- Stages of the planning and design process  
- Requirements for a design and technical implementation  
- Choice of materials - Basic principles of a material-specific design  
- Manufacturing process - fundamentals of a production-oriented design  
- Connections, fuses, seals  
- Machine-standard elements  
- Storage & guides  
- Transmission and its components  
- Drives |
| Note          | The idea of machine elements is complemented by case studies and illustrated. |

Data: 06.03.2019 12:57  Autumn Semester 2016  Page 996 of 1571
The lecture slides will be published beforehand on the website of the pd|z.

For Bachelor studies in Mechanical and Process Engineering, the lecture "Maschinenelemente" (HS) is examined together with "Innovationsprozess" (FS) in the exam "Basisprüfung Maschinenelemente und Innovationsprozess".

529-0010-00L Chemistry

<table>
<thead>
<tr>
<th>Abstract</th>
<th>This is a general chemistry course aimed at first year undergraduate students in the Department of Mechanical and Process Engineering (D-MAVT).</th>
</tr>
</thead>
</table>
| Objective | The aims of the course are as follows:
1. To provide a thorough understanding of the basic principles of chemistry and its application.
2. To develop an understanding of the atomic and molecular nature of matter and of the chemical reactions that describe their transformations.
3. To emphasize areas considered most relevant in an engineering context. |
| Content  | Electronic structure of atoms, chemical bonding, molecular shape and bonding theory, gases, thermodynamics, chemical thermodynamics, chemical kinetics, equilibria, solutions and intermolecular forces, redox and electrochemistry. |
| Literature | The course is based on "Chemistry the Central Science" by Brown, LeMay, Bursten, Murphy and Woodward. Pearson, 12th Edition (international edition). |

Additional First Year Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0321-00L</td>
<td>Technical Drawing and CAD</td>
<td>O</td>
<td>4 credits</td>
<td>4G</td>
<td>K. Shea</td>
</tr>
</tbody>
</table>

Abstract


Objective

- The lecture and exercises teach the fundamentals of technical drawing and CAD. After taking the course students will be able to create accurate technical drawings of parts and assemblies as well as read them. Students will also be able to create models of parts and assemblies in a 3D, feature-based CAD system. They will understand the links with simulation, product data management (PDM) and additive manufacturing.

Content

- Technical Drawing:
  - projections and views
  - cuts
  - notations
  - primitives
  - ISO norm elements
  - dimensioning
  - tolerances
  - assemblies
  - documentation

- CAD:
  - CAD basics
  - CAD modeling methods
  - sketch modeling
  - modeling operations
  - feature-based modeling
  - assemblies
  - creating 2D drawings from 3D parts
  - links to simulation, e.g. kinematics
  - links to model variants and Product Data Management (PDM)
  - links to additive manufacturing (3D printing)

Lecture notes

Lecture slides and exercise handouts are available on the course Moodle website: https://moodle-app2.let.ethz.ch/course/index.php?categoryid=56

Literature

- TZ Technisches Zeichnen: selbstständig lernen und effektiv üben
  Susanna Labisch und Christian Weber
  2008 Vieweg
  eBook (accessible from the ETH domain): http://link.springer.com/book/10.1007/978-3-8348-9451-9/page/1

- VSM Normen-Auszugs 2010
  (kann in den Übungen bestellt und gekauft werden)

- CAD
  Marcel Schmid
  CAD mit NX: NX 8
  J.Schlembach Fachverlag
  ISBN: 978-3-935340-72-4

Prerequisites / notice

This course is given as a lecture (1h/week) and an exercise (3h/week). Students are split into working groups for the exercises with a maximum of 20 students per group.

Semester Fee

A fee is charged for printed copies of the course handouts.

First Year Optional Colloquia

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0501-02L</td>
<td>Mechanics 1: Kinematics and Statics (Colloquium)</td>
<td>Z</td>
<td>0 credits</td>
<td>1K</td>
<td>E. Mazza</td>
</tr>
</tbody>
</table>

Abstract

- Basics: Position of a material point, velocity, kinematics of rigid bodies, forces, reaction principle, mechanical power
- Statics: Groups of forces, moments, equilibrium of rigid bodies, reactions at supports, parallel forces, center of gravity, statics of systems, principle of virtual power, trusses, frames, forces in beams and cables, friction
Objective
The understanding of the fundamentals of Statics for engineers and their application in simple settings.

Content
Basics: Position of a material point; velocity; kinematics of rigid bodies; translation, rotation, planar motion; forces, action-reaction principle, internal and external forces, distributed forces; mechanical power.
Statics: equivalence and reduction of groups of forces; rest and equilibrium; basic theorem of statics; kinematic and static boundary conditions, applications to supports and clamps of rods and beams; procedures for determination of forces at supports and clamps; parallel forces and centre of gravity; statics of systems, solution using basic theorem and using the principle of virtual power, statically indeterminate systems; statically determinate truss structures, ideal truss structures, nodal point equilibrium, methods for truss force determination; friction, static friction, sliding friction, friction at joints and supports, rolling resistance; forces in cables; beam loading, force and moment vector.

Lecture notes
Übungsblätter

Literature
Sayir, M.B., Dual J., Kaufmann S., Ingenieurmechanik 1: Grundlagen und Statik, Teubner

3. Semester

Compulsory Courses

Examination Block 1

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-0363-10L</td>
<td>Analysis III</td>
<td>O</td>
<td>3 credits</td>
<td>2V+1U</td>
<td>M. Soner</td>
</tr>
</tbody>
</table>

Abstract
Introduction to partial differential equations. Differential equations which are important in applications are classified and solved. Elliptic, parabolic and hyperbolic differential equations are treated. The following mathematical tools are introduced: Laplace transforms, Fourier series, separation of variables, methods of characteristics.

Objective
Mathematical treatment of problems in science and engineering. To understand the properties of the different types of partial differential equations.

The first lecture is on Thursday, September 29 13-15 in HG F 7 and video transmitted into HG F 5.

The exercises Sheet are here: http://www.vvz.ethz.ch/Vorlesungsverzeichnis/lerneinheitPre.do?semkez=2016W&lang=de&ansicht=LERNMATERIALIEN&lerneinheitId=108855

The coordinator is Claudio Sibilia (see https://www.math.ethz.ch/the-department/people.html?u=sibilia)

The first exercise session is on Thursday, September 22 or resp. Friday, September 23. If you would like feedback on your work, please give it to your course assistant or leave it in the box of your course assistant in HG F 27. The due Date is one week later the assignment.

Office hour (Praesenz): Thursday 16-17, NO E 39.

Content
Laplace Transforms:
- Laplace Transform, Inverse Laplace Transform, Linearity, s-Shifting
- Transforms of Derivatives and Integrals, ODEs
- Unit Step Function, t-Shifting
- Short Impulses, Dirac's Delta Function, Partial Fractions
- Convolution, Integral Equations
- Differentiation and Integration of Transforms

Fourier Series, Integrals and Transforms:
- Fourier Series
- Functions of Any Period $p=2L$
- Even and Odd Functions, Half-Range Expansions
- Forced Oscillations
- Approximation by Trigonometric Polynomials
- Fourier Integral
- Fourier Cosine and Sine Transform

Partial Differential Equations:
- Basic Concepts
- Modeling: Vibrating String, Wave Equation
- Solution by separation of variables; use of Fourier series
- D'Alembert Solution of Wave Equation, Characteristics
- Heat Equation: Solution by Fourier Series
- Heat Equation: Solutions by Fourier Integrals and Transforms
- Modeling Membrane: Two Dimensional Wave Equation
- Laplacian in Polar Coordinates; Circular Membrane, Fourier-Bessel Series
- Solution of PDEs by Laplace Transform

Download the syllabus: https://polybox.ethz.ch/index.php/s/6nu5KYbWWMQhaA

Lecture notes
Alessandra Iozzi's Lecture notes: https://polybox.ethz.ch/index.php/s/9CFw703cHw

Errata: https://polybox.ethz.ch/index.php/s/VKIh86gyQRTwIE0w

Literature

For reference/complement of the Analysis I/II courses:
Christian Blatter: Ingenieur-Analysis (Download PDF)

Dynamics

Abstract
Kinematics, dynamics and oscillations: Motion of a single particle - Motion of systems of particles - 2D and 3D motion of rigid bodies - Vibrations

151-0503-00L

Abstract
Kinematics, dynamics and oscillations: Motion of a single particle - Motion of systems of particles - 2D and 3D motion of rigid bodies - Vibrations
Objective
This course provides Bachelor students of mechanical engineering with fundamental knowledge of kinematics and dynamics of mechanical systems. By studying motion of a single particle, systems of particles and rigid bodies, we introduce essential concepts such as work and energy, equations of motion, and forces and torques. Further topics include stability of equilibrium and vibrations. Examples presented in the lectures and weekly exercise lessons help students learn basic techniques that are necessary for advanced courses and work on engineering applications.

Content
1. Motion of a single particle // Kinematics: trajectory, velocity, acceleration, inertial frame, moving frames - Forces and torques. Active- and reaction forces. - Linear momentum principle, angular momentum principle, work-energy principle - Equations of motion;
2. Motion of systems of particles // Internal and external forces - Linear momentum principle, angular momentum principle, work-energy principle - Rigid body systems of particles; conservative systems
3. 3D motion of rigid bodies // Kinematics: angular velocity, velocity transport formula, instantaneous center of rotation - Linear momentum principle, angular momentum principle, work-energy principle - Parallel axis theorem. Angular momentum transport formula

Lecture notes
Hand-written slides will be downloadable after each lecture.

Literature
Typed course notes from the previous year

Prerequisites
Please log in to moodle (https://moodle-app2.let.ethz.ch/auth/shibboleth/login.php), search for "Dynamics", and join the course there. All exercises sheets, lecture materials etc. will be uploaded there.

402-0033-10L

Objective

Content
- Theoretical basics of engineering design
- Description of ductile and brittle material behavior
- Design of machine elements at static loading conditions
- Notch effects
- Axes and shafts
- Fatigue design
- Surface pressure
- Rotationally symmetric bodies, pressure vessels and cylindrical interference
- Dimensioning of permanent and separable joints

Lecture notes
The lecture bases on the books specified under "LITERATUR". The books 1) to 5) can be downloaded as pdf's. Additional documentation and handouts are available as PDFs on our website.

Literature
4) M. Meier and P. Erman, Dimensionieren 1, Zürich, 2012.

151-0051-00L

Objective
Introduction to the fundamentals of technical thermodynamics.

Content
1. Konzepte und Definitionen
2. Der erste Hauptsatz, der Begriff der Energie und Anwendungen für geschlossene Systeme
3. Eigenschaften reiner kompressibler Substanzen, quaistatische Zustandsänderungen
4. Elemente der kinetischen Gastheorie
5. Der erste Hauptsatz in offenen Systemen - Energieanalyse in einem Kontrollvolumen
6. Der zweite Hauptsatz - Der Begriff der Entropie
7) Nutzbarkeit der Energie - Exergie
8. Thermodynamische Beziehungen für einfache, kompressible Substanzen.

Lecture notes
available

Literature

151-0591-00L

Objective
Analysis and synthesis of linear systems with one input and one output signal (SISO); transition matrix; stability; controllability; observability; Laplace transform; transfer functions; transient and steady state responses. PID control; dynamic compensators; Nyquist theorem.

Content
Introduction to main ideas of linear systems analysis and synthesis. Transient and steady-state behavior, system engineering (input/output, static/dynamic behavior, feedforward and feedback loops, etc.), introduction of most important tools (solution of linear ODE, Laplace transformation, Nyquist/Abbildungstheorem). Elementary controller synthesis. Improve/describe.


Lecture notes

Prerequisites
Basic knowledge of (complex) analysis and linear algebra

Exam Block 2

Number Title Type ECTS Hours Lecturers
402-0033-10L Physics I O 6 credits 4V+2U W. Wegscheider

This is a two-semester course introducing students into the foundations of Modern Physics. Topics include electricity and magnetism, light, waves, quantum physics, solid state physics, and semiconductors. Selected topics with important applications in industry will also be considered.
Objective
The lecture is intended to promote critical, scientific thinking. Key concepts of Physics will be acquired, with a focus on technically relevant applications. At the end of the two semesters, students will have a good overview over the topics of classical and modern Physics.

Content
Electric and magnetic fields, current, magnetism, Maxwell's equations, concept of light, classical optics, waves.

Lecture notes
Notes from lectures will be available (in German).

Literature
Friedhelm Kuypers
Physik fuer Ingenieure und Naturwissenschaftler

Paul A. Tipler, Gene Mosca, Michael Basler und Renate Dohmen
Physik für Wissenschaftler und Ingenieure
Spektrum Akademischer Verlag, 2009, 1636 Seiten, ca. 80 Euro.

★★ Engineering Tools II
The participation at the Engineering Tools course is mandatory. If you miss any classes, no credit points will be awarded. For exemptions you have to contact the lecturer of the course.

Number Title Type ECTS Hours Lecturers
151-0021-00L Engineering Tool II: Introduction to MATLAB O 0.4 credits 1K B. Berisha, P. Hora

Abstract
Introduction to MATLAB; vectors and matrices; graphics in MATLAB; calculus, differential equations; programming with MATLAB; data analysis and statistics; interpolation and polynomials. Exercises with solutions: using MATLAB commands, technical applications.

Objective
Introduction to numerical calculations with MATLAB.

Content
Introduction to MATLAB; vectors and matrices; graphics in MATLAB; calculus, differential equations; programming with MATLAB; data analysis and statistics; interpolation and polynomials. Exercises with solutions: using MATLAB commands, technical applications.

Lecture notes
Web-based tutorial:
http://www.ivp.etzh.ch/studium/vorlesungen.html

Prerequisites / notice
Der Kurs findet in einem Hörsaal statt und es stehen keine Rechner zur Verfügung. Es wird empfohlen, dass pro zwei Studierenden mindestens ein Laptop mit installiertem Matlab mitgebracht wird.

Installation Matlab:
- es funktionieren alle Versionen
- netzunabhängige Node-Lizenz (z.B. zum Download auf IDES)
- folgende Toolboxes/Features müssen installiert sein: Simulink (wird für RT1 benutzt), Curve Fitting Toolbox, Optimization Toolbox, Symbolic Toolbox, Global Optimization Toolbox

5. Semester

★★ Compulsory Courses Examination Block 3

Number Title Type ECTS Hours Lecturers
151-0261-00L Thermodynamics III O 3 credits 2V+1U R. S. Abhari, A. Steinfeld

Abstract
Technical applications of engineering thermodynamics. Extension of thermodynamical fundamentals taught in Thermodynamics I and II.

Objective
Understand and apply thermodynamic principles and processes for use in a range of cycles used commonly in practice.

Content

151-0103-00L Fluid Dynamics II O 3 credits 2V+1U P. Jenny

Abstract

Objective
Expand basic knowledge of fluid dynamics. Concepts, phenomena and quantitative description of irrotational (potential), rotational, and one-dimensional compressible flows.

Content

Lecture notes
Lecture notes are available (in German). (See also info on literature below.)

Literature
(See also info on literature below.)


Prerequisites / notice
Analysis I/II, Knowledge of Fluid Dynamics I, thermodynamics of ideal gas

★★ Electives

Number Title Type ECTS Hours Lecturers
151-0917-00L Mass Transfer W 4 credits 2V+2U R. Büchel, S. E. Pratsinis

Abstract
This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore the application of these principles to important engineering problems is demonstrated.

Objective
This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore the application of these principles to important engineering problems is demonstrated.
To expound fundamentals in process engineering

Managerial Economics applies economic theory and methods to business and economic decision-making. Economic ideas related to managerial economics are used to solve management decision problems. The course acquaints students who have previous not studied economics to economic concepts and quantitative methods which can be used to solve management decision problems.

Stochastics (Probability and Statistics): This class covers the following concepts: random variables, probability, discrete and continuous distributions, joint and conditional probabilities and distributions, the law of large numbers, the central limit theorem, descriptive statistics, statistical inference, inference for normally distributed data, point estimation, and two-sample tests.


Fundamentals in Process Engineering: Overview of process engineering, reactions, balances and residence time analysis; overview of the thermal separation processes; equilibria for multiphase systems; introduction into mechanical process engineering and particle technology.

Signals and Systems: Signals arise in many engineering applications. They contain information about the behavior of physical systems. Systems respond to signals and produce other signals. In this course, we explore how signals can be represented and manipulated, and their effects on systems. We further explore how we can discover basic system properties by exciting a system with various types of signals.

Managerial Economics: Not for MSc students belonging to D-MTEC!

Electrical Engineering II: Signals and systems in the time and frequency domain, principle of operation and design of basic analog and digital circuits, analog-digital conversion. Basic power electronic circuits, design of magnetic components, electromechanical energy conversion, principle of operation and characteristics of transformers and selected rotating electrical machines.

Computational Methods for Engineering Applications: The course gives an introduction to the numerical methods for the solution of ordinary and partial differential equations that play a central role in engineering applications. Both basic theoretical concepts and implementation techniques necessary to understand and master the methods will be addressed.

At the end of the course the students should be able to:
- implement numerical methods for the solution of ODEs (= ordinary differential equations);
- identify features of a PDE (= partial differential equation) based model that are relevant for the selection and performance of a numerical algorithm;
- implement the finite difference, finite element and finite volume methods for the solution of simple PDEs using C++; read engineering research papers on numerical methods for ODEs or PDEs.
Content

Initial value problems for ODE: review of basic theory for ODEs, Forward and Backward Euler methods, Taylor series methods, Runge-Kutta methods, basic stability and consistency analysis, numerical solution of stiff ODEs.

Two-point boundary value problems: Green's function representation of solutions, Maximum principle, finite difference schemes, stability analysis.

Elliptic equations: Laplace's equation in one and two space dimensions, finite element methods, implementation of finite elements, error analysis.


Hyperbolic equations: Linear advection equation, method of characteristics, upwind schemes and their stability. Burgers equation, scalar conservation laws, shocks and rarefactions, Riemann problems, Godunov type schemes, TVD property.

Lecture notes

Script will be provided.

Literature

Chapters of the following book provide supplementary reading and are not meant as course material:


Prerequisites / notice

(Suggested) Prerequisites:

Analysis I-III (for D-MAVT), Linear Algebra, CMEA I, basic familiarity with programming in C++.

151-3207-00L Lightweight

Abstract

The elective course Lightweight includes numerical methods for the analysis of the load carrying and failure behavior of lightweight structures, as well as construction methods and design principles for lightweight design.

Objective

The goal of this course is to convey substantiated background for the understanding and the design and sizing of modern lightweight structures in mechanical engineering, vehicle and airplane design.

Content

Lightweight design
- Thin-walled beams and structures
- Instability behavior of thin walled structures
- Reinforced shell structures
- Load introduction in lightweight structures
- Joining technology
- Sandwich design

Lecture notes

Script, Handouts, Exercises

Focus Project

Focus Projects in Mechatronics

Number Title Type ECTS Hours Lecturers

151-0073-10L Amphibious Robot W 0 credits 15A R. Siegwart

Abstract

This course is part of a one-year course. The 14 credit points will be issued at the end of FS2017 with new enrolling for the same Focus-Project in FS2017.

Prerequisites for the focus projects:

a. Basis examination successfully passed
b. Block 1 and 2 successfully passed

Objective

- The various objectives of the Focus Project are:
- Synthesizing and deepening the theoretical knowledge from the basic courses of the 1. - 4. semester
- Team organization, work in teams, increase of interpersonal skills
- Independence, initiative, independent learning of new topic contents
- Problem structuring, solution identification in indistinct problem definitions, searches of information
- System description and simulation
- Presentation methods, writing of a document
- Ability to make decisions, implementation skills
- Workshop and industrial contacts
- Learning and recess of special knowledge
- Control of most modern engineering tools (Matlab, Simulink, CAD, CAE, PDM)
- Convert and experience technical solutions

Prerequisites / notice

This Focus-Project is supervised by the following lecturers:

Siegwart, R., ASL
Haas, R., ASL

151-0073-20L Mechanically-Actuated Cartoon Face

Does not take place this semester.

Abstract

This course is part of a one-year course. The 14 credit points will be issued at the end of FS2017 with new enrolling for the same Focus-Project in FS2017.

For MAVT BSc and ITET BSc only.

Prerequisites for the focus projects:

a. Basis examination successfully passed
b. Block 1 and 2 successfully passed

Objective

- The various objectives of the Focus Project are:
- Synthesizing and deepening the theoretical knowledge from the basic courses of the 1. - 4. semester
- Team organization, work in teams, increase of interpersonal skills
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Prerequisites / notice

This Focus-Project is supervised by the following lecturers:

Siegwart, R., ASL
Haas, R., ASL
Objective

The various objectives of the Focus Project are:
- Synthesizing and deepening the theoretical knowledge from the basic courses of the 1. - 4. semester
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- Control of most modern engineering tools (Matlab, Simulink, CAD, CAE, PDM)
- Convert and experience technical solutions

Prerequisites / notice

This Focus-Project is supervised by the following lecturers:
Siegwart, R., ASL
Haas, R., ASL
Beardsley P., Disney Research Zurich

Abstract

Students develop and build a product from A-Z! They work in teams and independently, learn to structure problems, to identify solutions, system analysis and simulations, as well as presentation and documentation techniques. They build the product with access to a machine shop and state of the art engineering tools (Matlab, Simulink, etc).

Objective

The various objectives of the Focus Project are:
- Synthesizing and deepening the theoretical knowledge from the basic courses of the 1. - 4. semester
- Team organization, work in teams, increase of interpersonal skills
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Siegwart, R., ASL
Haas, R., ASL
Beardsley P., Disney Research Zurich

Abstract

Students develop and build a product from A-Z! They work in teams and independently, learn to structure problems, to identify solutions, system analysis and simulations, as well as presentation and documentation techniques. They build the product with access to a machine shop and state of the art engineering tools (Matlab, Simulink, etc).

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- Learning and recess of special knowledge
- Control of most modern engineering tools (Matlab, Simulink, CAD, CAE, PDM)
- Convert and experience technical solutions

Content

Several teams of 4-8 students of the ETH as well as students from other universities realize a product during two semesters. On the basis of a vision and provocative problem definition, all processes of product development are beat down close-to-reality: conception, design, engineering, simulation, draft and production. The teams are coached by experienced staff who gives them the possibility of a unique learning experience.

Innovative ideas of the research labs of the ETH, of industrial partners or students are selected and realized by the teams.

Focus Projects in Manufacturing

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0073-30L</td>
<td>Robo-Racer</td>
<td>W</td>
<td>0</td>
<td>15A</td>
<td>R. Siegwart, M. Hutter</td>
</tr>
<tr>
<td>151-0073-40L</td>
<td>Adaptive Helicopter Landing Gear</td>
<td>W</td>
<td>0</td>
<td>15A</td>
<td>M. Hutter</td>
</tr>
</tbody>
</table>

For MAVT BSc and ITET BSc only.

Prerequisites for the focus projects:

a. Basis examination successfully passed
b. Block 1 and 2 successfully passed

For MAVT BSc and ITET BSc only.

Prerequisites for the focus projects:

a. Basis examination successfully passed
b. Block 1 and 2 successfully passed
Prerequisites for the focus projects:
1. Basis examination successfully passed
2. Block 1 and 2 successfully passed

<table>
<thead>
<tr>
<th>Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Type</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0075-20L</td>
<td>Formula Student Electric - Chassis and Suspension</td>
<td>0</td>
<td>W</td>
<td>Hora, P.</td>
</tr>
<tr>
<td>151-0075-30L</td>
<td>SUNCAR - iRoadster - Antrieb</td>
<td>0</td>
<td>W</td>
<td>Wegener, K.</td>
</tr>
<tr>
<td>151-0075-40L</td>
<td>Formula Student Electric - Drivetrain</td>
<td>0</td>
<td>W</td>
<td>Hora, P.</td>
</tr>
</tbody>
</table>

Abstract
Students develop and build a product from A-Z! They work in teams and independently, learn to structure problems, to identify solutions, system analysis and simulations, as well as presentation and documentation techniques. They build the product with access to a machine shop and state of the art engineering tools (Matlab, Simulink, etc).

Objective
The various objectives of the Focus Project are:
- Synthesizing and deepening the theoretical knowledge from the basic courses of the 1. - 4. semester
- Team organization, work in teams, increase of interpersonal skills
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- Problem structuring, solution identification in indistinct problem definitions, searches of information
- System description and simulation
- Presentation methods, writing of a document
- Ability to make decisions, implementation skills
- Workshop and industrial contacts
- Learning and recess of special knowledge
- Control of most modern engineering tools (Matlab, Simulink, CAD, CAE, PDM)
- Convert and experience technical solutions

For MAVT BSc and ITET BSc only.

Prerequisites for the focus projects:
1. Basis examination successfully passed
2. Block 1 and 2 successfully passed

151-0075-20L Formula Student Electric - Chassis and Suspension
This course is part of a one-year course. The 14 credit points will be issued at the end of FS2017 with new enrolling for the same Focus-Project in FS2017.

151-0075-30L SUNCAR - iRoadster - Antrieb
This course is part of a one-year course. The 14 credit points will be issued at the end of FS2017 with new enrolling for the same Focus-Project in FS2017.

151-0075-40L Formula Student Electric - Drivetrain
This course is part of a one-year course. The 14 credit points will be issued at the end of FS2017 with new enrolling for the same Focus-Project in FS2017.
Objective
The various objectives of the Focus Project are:
- Synthesizing and deepening the theoretical knowledge from the basic courses of the 1. - 4. semester
- Team organization, work in teams, increase of interpersonal skills
- Independence, initiative, independent learning of new topic contents
- Problem structuring, solution identification in indistinct problem definitions, searches of information
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Content
Several teams of 4-8 students of the ETH as well as students from other universities realize a product during two semesters. On the basis of a vision and provocative problem definition, all processes of product development are beat down close-to-reality: conception, design, engineering, simulation, draft and production. The teams are coached by experienced staff who gives them the possibility of a unique learning experience.

Innovative ideas of the research labs of the ETH, of industrial partners or students are selected and realized by the teams.

Prerequisites / notice
This Focus-Project is supervised by the following lecturers:
Hora, P.
Heingärtner, J.

151-0075-50L Sustainable Materials Concept
W 0 credits 15A K. Wegener
This course is part of a one-year course. The 14 credit points will be issued at the end of FS2017 with new enrolling for the same Focus-Project in FS2017.
For MAVT BSc and ITET BSc only.
Prerequisites for the focus projects:
- Basis examination successfully passed
- Block 1 and 2 successfully passed

Abstract
Students develop and build a product from A-Z! They work in teams and independently, learn to structure problems, to identify solutions, system analysis and simulations, as well as presentation and documentation techniques. They build the product with access to a machine shop and state of the art engineering tools (Matlab, Simulink, etc).

Objective
The various objectives of the Focus Project are:
- Synthesizing and deepening the theoretical knowledge from the basic courses of the 1. - 4. semester
- Team organization, work in teams, increase of interpersonal skills
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- Workshop and industrial contacts
- Learning and recess of special knowledge
- Control of most modern engineering tools (Matlab, Simulink, CAD, CAE, PDM)
- Convert and experience technical solutions

Focus Projects in Design, Mechanics and Materials

151-0079-20L SeatCase - An Innovative Airline Seat
W 0 credits 15A P. Ermanni
This course is part of a one-year course. The 14 credit points will be issued at the end of FS2017 with new enrolling for the same Focus-Project in FS2017.
For MAVT BSc and ITET BSc only.
Prerequisites for the focus projects:
- Basis examination successfully passed
- Block 1 and 2 successfully passed

Abstract
Students develop and build a product from A-Z! They work in teams and independently, learn to structure problems, to identify solutions, system analysis and simulations, as well as presentation and documentation techniques. They build the product with access to a machine shop and state of the art engineering tools (Matlab, Simulink, etc).

Objective
The various objectives of the Focus Project are:
- Synthesizing and deepening the theoretical knowledge from the basic courses of the 1. - 4. semester
- Team organization, work in teams, increase of interpersonal skills
- Independence, initiative, independent learning of new topic contents
- Problem structuring, solution identification in indistinct problem definitions, searches of information
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- Presentation methods, writing of a document
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- Control of most modern engineering tools (Matlab, Simulink, CAD, CAE, PDM)
- Convert and experience technical solutions

151-0079-30L Airborne Wind Energy System
W 0 credits 15A P. Ermanni
This course is part of a one-year course. The 14 credit points will be issued at the end of FS2017 with new enrolling for the same Focus-Project in FS2017.
For MAVT BSc and ITET BSc only.
Prerequisites for the focus projects:
- Basis examination successfully passed
- Block 1 and 2 successfully passed
**Abstract**

Students develop and build a product from A-Z! They work in teams and independently, learn to structure problems, to identify solutions, system analysis and simulations, as well as presentation and documentation techniques. They build the product with access to a machine shop and state of the art engineering tools (Matlab, Simulink, etc).

**Objective**

The various objectives of the Focus Project are:
- Synthesizing and deepening the theoretical knowledge from the basic courses of the 1. - 4. semester
- Team organization, work in teams, increase of interpersonal skills
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- Ability to make decisions, implementation skills
- Workshop and industrial contacts
- Learning and recess of special knowledge
- Control of most modern engineering tools (Matlab, Simulink, CAD, CAE, PDM)
- Convert and experience technical solutions

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**151-0079-40L**

**CFLF System: Free Form 3D Printing of Fibre Composite Structures**

This course is part of a one-year course. The 14 credit points will be issued at the end of FS2017 with new enrolling for the same Focus-Project in FS2017.

For MAVT BSc and ITET BSc only.

Prerequisites for the focus projects:
a. Basis examination successfully passed
b. Block 1 and 2 successfully passed

**Abstract**

Students develop and build a product from A-Z! They work in teams and independently, learn to structure problems, to identify solutions, system analysis and simulations, as well as presentation and documentation techniques. They build the product with access to a machine shop and state of the art engineering tools (Matlab, Simulink, etc).

**Objective**

The various objectives of the Focus Project are:
- Synthesizing and deepening the theoretical knowledge from the basic courses of the 1. - 4. semester
- Team organization, work in teams, increase of interpersonal skills
- Independence, initiative, independent learning of new topic contents
- Problem structuring, solution identification in indistinct problem definitions, searches of information
- System description and simulation
- Presentation methods, writing of a document
- Ability to make decisions, implementation skills
- Workshop and industrial contacts
- Learning and recess of special knowledge
- Control of most modern engineering tools (Matlab, Simulink, CAD, CAE, PDM)
- Convert and experience technical solutions

---

**151-0079-52L**

**Skinfactory BioReactor**

This course is part of a one-year course. The 14 credit points will be issued at the end of FS2017 with new enrolling for the same Focus-Project in FS2017.

For MAVT BSc and ITET BSc only.

Prerequisites for the focus projects:
a. Basis examination successfully passed
b. Block 1 and 2 successfully passed

**Abstract**

Students develop and build a product from A-Z! They work in teams and independently, learn to structure problems, to identify solutions, system analysis and simulations, as well as presentation and documentation techniques. They build the product with access to a machine shop and state of the art engineering tools (Matlab, Simulink, etc).

**Objective**

The various objectives of the Focus Project are:
- Synthesizing and deepening the theoretical knowledge from the basic courses of the 1. - 4. semester
- Team organization, work in teams, increase of interpersonal skills
- Independence, initiative, independent learning of new topic contents
- Problem structuring, solution identification in indistinct problem definitions, searches of information
- System description and simulation
- Presentation methods, writing of a document
- Ability to make decisions, implementation skills
- Workshop and industrial contacts
- Learning and recess of special knowledge
- Control of most modern engineering tools (Matlab, Simulink, CAD, CAE, PDM)
- Convert and experience technical solutions

---

**Courses Eligible for Focus Projects**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0141-00L</td>
<td>Leadership ■ ■</td>
<td>W</td>
<td>1</td>
<td>2G</td>
<td>K. Wegener, A. Halbleib</td>
</tr>
</tbody>
</table>

Only students for focus projects or doctoral students.

**Abstract**

Introduction in the topic of leading work forces. In the framework of scenarios competences and knowledge concerning leadership will be developed interactively with the students. Motivation, goal orientation and success will be discussed. The reliability of leaders is part of the course.

**Objective**

Culture of leading and corporate governance.

**Content**

Introduction in the topic of leading work forces.

**Prerequisites / notice**

Only students for focus projects or doctoral students.
Practice Course to Focus Projects on Product Development

**Abstract**
This course provides comprehensive input to ongoing focus project teams in the areas of project management, communication and presentation, as well as dealing with the media, coaches and patents and safety issues.

**Objective**
Participants will receive tips, hints and background information from experienced tutors applicable to current projects.

**Content**
- **Project Management**
  - Creating a solid project base
  - Project planning and controlling
  - Product validation and testing
  - Problem solving cycle and decision taking transparent for others
- **Communication**
  - Public Relations in a Nutshell
  - How to acquire and manage suppliers and sponsors
  - Technical reports
  - Review presentations
- **Handling of and guidance to**
  - Expectation management and dealing with conflicts
  - Safety issues
  - Issues regarding patents

**Prerequisites / notice**
- only for students participating in a Focus Project in the same semester

**Information**
- Lecture notes will be electronically available.

**Practice Course to Focus Projects on CAD and CAE Based on Siemens NX**

**Abstract**
This course provides comprehensive input to ongoing Focus Projects teams in the areas of CAD and CAE with Siemens NX.

**Objective**
Participants will receive tips, hints and background information from experienced tutors applicable to current projects.

**Content**
- **CAD with Siemens NX**
  - 2 day of intensive training (2x4h, 1x8L)
- **CAE with Siemens NX**
  - 2 separate days of intensive training (2x8L)

**Prerequisites / notice**
- only for students participating in a Focus Project in the same semester
- use of Siemens NX CAD/CAE in the corresponding Focus Project required

**Product Design for Focus Projects**

**Abstract**
This course introduces students to fundamental topics in product design and development specifically directed towards focus project students. The course will be taught using the students’ focus projects as the main case study during the hands-on exercises.

**Objective**
The objectives of the course are to introduce students to the most important topics in product design and development focusing on the early design phases and conceptual design methods. A further goal is to develop design reasoning and critical thinking skills important for focus projects.

**Content**
The content of the course will follow a product design and development process that is introduced. The focus will be on the concept design phase including design task definition, understanding users, product specifications, concept design methods, product architecture, industrial design, prototyping methods, design for manufacture and a review of technical drawing and norms.

**Focus Specialization Energy, Flows and Processes**

**Focus Coordinator:** Prof. Christoph Müller

In order to achieve the required 20 credit points for the Focus Specialization Energy, Flows and Processes you need to choose at least 2 of the 4 compulsory courses (HS/FS) and at least 2 of the electives courses (HS/FS). One course could be selected among all the courses offered by D-MAVT (Bachelor and Masters).

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0123-00L</td>
<td>Experimental Methods for Engineers</td>
<td>W+</td>
<td>4</td>
<td>2V+2U</td>
<td>T. Rösgen, R. S. Abhari, K. Boulouchos, D. J. Norris, H.M. Prasser, A. Steinfeld</td>
</tr>
</tbody>
</table>

**Abstract**
The course presents an overview of measurement tasks in engineering environments. Different concepts for the acquisition and processing of typical measurement quantities are introduced. Following an initial in-class introduction, laboratory exercises from different application areas (especially in thermofluidics and process engineering) are attended by students in small groups.
Introduction to various aspects of measurement techniques, with particular emphasis on thermo-fluidic applications.

Understanding of various sensing technologies and analysis procedures.

Study of applications in the laboratory.

Fundamentals of scientific documentation & reporting.

In-class introduction to representative measurement techniques in the research areas of the participating institutes (fluid dynamics, energy technology, process engineering).

Student participation in 8-10 laboratory experiments (study groups of 3-5 students, dependent on the number of course participants and available experiments).

Lab reports for all attended experiments have to be submitted by the study groups. A final exam evaluates the acquired knowledge individually.

Presentations, handouts and instructions are provided for each experiment.


Basic understanding in the following areas:
- fluid mechanics, thermodynamics, heat and mass transfer
- electrical engineering / electronics
- numerical data analysis and processing (e.g. using MATLAB)

**151-0293-00L Combustion and Reactive Processes in Energy and Materials Technology**

**W+ 4 credits 2V+1U+2A K. Boulouchos, F. Ernst, Y. M. Wright**

**Abstract**

The students should become familiar with the fundamentals and with application examples of chemically reactive processes in energy conversion (combustion engines in particular) as well as the synthesis of new materials.

**Objective**

The students should become familiar with the fundamentals and with application examples of chemically reactive processes in energy conversion (combustion engines in particular) as well as the synthesis of new materials. The course is part of the focus "Energy, Flows & Processes" on the Bachelor level and is recommended as a basis for a future Master in the area of energy. It is also a facilitative lecture on Master level in Energy Science and Technology and Process Engineering.

**Content**


**Literature**


**Prerequisites / notice**

HANDBOUTS are EXCLUSIVELY IN GERMAN ONLY, however recommendations for English text books will be provided.

**151-0109-00L Turbulent Flows**

**W 4 credits 2V+1U P. Jenny**

**Abstract**

Basic physical phenomena of turbulent flows, quantitative and statistical description, basic and averaged equations, principles of turbulent flow computation and elements of turbulence modelling.

**Objective**

Basic physical phenomena of turbulent flows, instability and origin of turbulence - Statistical description: averaging, turbulent energy, dissipation, closure problem - Scalings. Homogeneous isotropic turbulence, correlations, Fourier representation, energy spectrum - Free turbulence: wake, jet, mixing layer - Wall turbulence: Channel and boundary layer - Computation and modelling of turbulent flows

**Content**

- Properties of laminar, transitional and turbulent flows.
- Origin and control of turbulence. Instability and transition.
- Statistical description, averaging, equations for mean and fluctuating quantities, closure problem.
- Scalings, homogeneous isotropic turbulence, energy spectrum.
- Turbulent free shear flows. Jet, wake, mixing layer.
- Wall-bounded turbulent flows.
- Turbulent flow computation and modeling.

**Literature**


**151-0235-00L Thermodynamics of Novel Energy Conversion Technologies**

**W 4 credits 3G C. S. Sharma, D. Poulikakos, G. Sansavini**

**Abstract**

In the framework of this course we will look at current electronic thermal and energy management strategies and novel energy conversion processes. The course will focus on component level fundamentals of these processes and system level analysis of interactions among various energy conversion components.

**Objective**

This course deals with liquid cooling based thermal management of electronics, reuse of waste heat and novel energy conversion and storage systems such as batteries, fuel cells and micro-fuel cells. The focus of the course is on the physics and basic understanding of these systems as well as their real-world applications. The course will also look at analysis of system level interactions between a range of energy conversion components.

**Content**

Part 1: Fundamentals:
- Overview of exergy analysis, Single phase liquid cooling and micro-mixing;
- Thermodynamics of multi-component-systems (mixtures) and phase equilibrium;
- Electrochemistry;

Part 2: Applications:
- Basic principles of battery;
- Introduction to fuel cells;
- Reuse of waste heat from supercomputers
- Hotspot targeted cooling of microprocessors
- Microfluidic fuel cells

Part 3: System: level analysis
- Integration of the components into the system: a case study
- Analysis of the coupled operations, identification of critical states
- Support to system-oriented design

**Lecture notes**

Lecture slides will be made available. Lecture notes will be available for some topics (in English).
The course will be given in English:

1- Mid-term examination: Mid-term exam grade counts as 20% of the final grade.
2- Final exam: Written exam during the regular examination session. It counts as 80% of the final grade.

### 151-0917-00L Mass Transfer

**Abstract**
This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore the application of these principles to important engineering problems is demonstrated.

**Objective**
This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore the application of these principles to important engineering problems is demonstrated.

**Content**
Fick's laws; application and significance of mass transfer; comparison of Fick's laws with Newton's and Fourier's laws; derivation of Fick's

**Literature**

**Prerequisites / notice**
Two tests are offered for practicing the course material. Participation is mandatory.

### 151-0973-00L Fundamentals in Process Engineering

**Abstract**
Overview of process engineering, reactions, balances and residence time analysis; overview of the thermal separation processes; equilibria for multiphase systems; introduction into mechanical process engineering and particle technology

**Objective**
To expound fundamentals in process engineering

**Content**
Overview of process engineering, reactions, balances and residence time analysis; overview of the thermal separation processes; equilibria for multiphase systems; introduction into mechanical process engineering and particle technology

**Lecture notes**
script in German available

### 151-0135-00L Additional Case for the Focus Specialization

**Abstract**
Additional Case for D-MAVT Bachelor's students in Focus Specialization, For enrollment, please contact the D-MAVT Student Administration

**Objective**
Independent studies on a defined field within the selected Focus Specialization.

### Mechatronics

**Focus Coordinator:** Prof. Bradley Nelson

To achieve the 20 credits for Focus Specialization Mechatronics, 151-0640-00L Studies on Mechatronics is compulsory.

#### Compulsory Courses

**Number** | **Title** | **Type** | **ECTS** | **Hours** | **Lecturers**
--- | --- | --- | --- | --- | ---
151-0640-00L | Studies on Mechatronics | O | 5 credits | 11A | Professors

**Abstract**
The following professors can be chosen and please contact the professor directly:

This course is not available to incoming exchange students.

**Objective**
The students are familiar with the challenges of the fascinating and interdisciplinary field of Mechatronics and Mikrosystems. They are introduced in the basics of independent non-experimental scientific research and are able to summarize and to present the results efficiently.

**Content**
The students work independently on a study of selected topics in the field of Mechatronics or Microsystems. They start with a selection of scientific papers to continue literature research. The results (e.g. state-of-the-art, methods) are evaluated with respect to predefined criteria. Then the results are presented in an oral presentation and summarized in a report, which takes the discussion of the presentation into account.

**Literature**
will be available

#### Elective Courses

**Number** | **Title** | **Type** | **ECTS** | **Hours** | **Lecturers**
--- | --- | --- | --- | --- | ---
151-0509-00L | Microscale Acoustofluidics | W | 4 credits | 3G | J. Dual

**Abstract**
In this lecture the basics as well as practical aspects (from modelling to design and fabrication ) are described from a solid and fluid mechanics perspective with applications to microsystems and lab on a chip devices.

**Objective**
Understanding acoustophoresis, the design of devices and potential applications

**Content**
Linear and nonlinear acoustics, foundations of fluid and solid mechanics and piezoelectricity, Gorkov potential, numerical modelling, acoustic streaming, applications from ultrasonic microrobotics to surface acoustic wave devices

**Lecture notes**

**Literature**

**Prerequisites / notice**
Solid and fluid continuum mechanics. Notice: The exercise part is a mixture of presentation, lab session and hand in homework.

151-0575-01L | Signals and Systems | W | 4 credits | 2V+2U | R. D'Andrea

**Abstract**
Signals arise in most engineering applications. They contain information about the behavior of physical systems. Systems respond to signals and produce other signals. In this course, we explore how signals can be represented and manipulated, and their effects on systems. We further explore how we can discover basic system properties by exciting a system with various types of signals.

**Objective**
Master the basics of signals and systems. Apply this knowledge to problems in the homework assignments and programming exercise.
Content

Lecture notes
Lecture notes available on course website.

151-0604-00L  Microrobotics  W  4 credits  3G  B. Nelson

Abstract
Microrobotics is an interdisciplinary field that combines aspects of robotics, micro and nanotechnology, biomedical engineering, and materials science. The aim of this course is to expose students to the fundamentals of this emerging field. Throughout the course students are expected to submit assignments. The course concludes with an end-of-semester examination.

Objective
The objective of this course is to expose students to the fundamental aspects of the emerging field of microrobotics. This includes a focus on physical laws that predominate at the microscale, technologies for fabricating small devices, bio-inspired design, and applications of the field.

Content
Main topics of the course include:
- Scaling laws at micro/nano scales
- Electrostatics
- Electromagnetism
- Low Reynolds number flows
- Observation tools
- Materials and fabrication methods
- Applications of biomedical microrobots

Prerequisites / notice
The lecture will be taught in English.

151-0621-00L  Microsystems Technology  W  6 credits  4G  C. Hierold, M. Huluska

Abstract
Students are introduced to the basics of micromachining and silicon process technology and will learn about the fabrication of Microsystems and -devices by a sequence of defined processing steps (process flow).

Objective
Students are introduced to the basics of micromachining and silicon process technology and will understand the fabrication of microsystems devices by the combination of unit process steps (→ process flow).

Content
- Introduction to Microsystems technology (MST) and micro electro mechanical systems (MEMS)
- Basic silicon technologies: Thermal oxidation, photolithography and etching, diffusion, implantation, thin film deposition.
- Specific Microsystems technologies: Bulk and surface micromachining, dry etching and wet etching, isotropic and anisotropic etching, beam and membrane formation, wafer bonding, thin film mechanical and thermal properties, piezoelectric and piezoresistive materials.
- Selected Microsystems: Mechanical sensors and actuators, microresonators, thermal sensors and actuators, system integration and encapsulation.

Prerequisites / notice
The lecture notes will be made available in hardcopy and as pdf files. Several readings will also be made available electronically.

227-0113-00L  Power Electronics  W  6 credits  4G  J. W. Kolar

Abstract
Fields of application of power electronic systems. Principle of operation of basic pulse-width modulated and line-commutated power electronic converters, analysis of the operating behavior and of the control oriented behavior, converter design. Reduction of effects of line-commutated rectifiers on the mains, electromagnetic compatibility.

Objective
Fields of application of power electronic systems. Principle of operation of basic pulse-width modulated and line-commutated power electronic converters, analysis of the operating behavior and of the control oriented behavior, converter design. Reduction of effects of line-commutated rectifiers on the mains, electromagnetic compatibility.

Content

Prerequisites / notice
Prerequisites: Basic knowledge of electric circuit analysis and signal theory.

227-0517-00L  Electrical Drive Systems II  W  6 credits  4G  P. Steimer, G. Scheuer, C. A. Stulz

Abstract
In the course "Drive System II" the power semiconductors are repeated. The creation of converters based on the combination of switches/cells and based topologies is explained. Another main focus is on the 3-level inverter with its switching and transfer functions. Further topics are the control of the synchronous machine, of line-side converters and issues with converter-fed machines.

Objective
The students establish a deeper understanding in regards of the design of the main components of an electrical drive system. They establish knowledge on the most important interaction with the grid and the machine and their related high dynamic control.

Content
Converter topologies (switch or cell based), multi-pulse diode rectifiers, system aspects of transformer and electrical machines. 3-level inverter with its switching and transfer functions, grid side harmonics, modeling and control of synchronous machines (including permanent magnet machines), control of line-side converters, reflection effects with power cables, winding isolation and bearing stress. Field trip to ABB Semiconductors.

Prerequisites / notice
Prerequisites: Basic knowledge of electric circuit analysis and signal theory.

376-1504-00L  Physical Human Robot Interaction (pHRI)  W  4 credits  2V+2U  R. Gassert, O. Lamberty

Abstract
This course focuses on the emerging, interdisciplinary field of physical human-robot interaction, bringing together themes from robotics, real-time control, human factors, haptics, virtual environments, interaction design and other fields to enable the development of human-oriented robotic systems.

Number of participants limited to 26.
Objective

The objective of this course is to give an introduction to the fundamentals of physical human robot interaction, through lectures on the underlying theoretical/mechatronics aspects and application fields, in combination with a hands-on lab tutorial. The course will guide students through the design and evaluation process of such systems.

By the end of this course, you should understand the critical elements in human-robot interactions - both in terms of engineering and human factors - and use these to evaluate and design safe and efficient assistive and rehabilitative robotic systems. Specifically, you should be able to:

1) identify critical human factors in physical human-robot interaction and use these to derive design requirements;
2) compare and select mechatronic components that optimally fulfill the defined design requirements;
3) derive a model of the device dynamics to guide and optimize the selection and integration of selected components into a functional system;
4) design control hardware and software and implement and test human-interactive control strategies on the physical setup;
5) characterize and optimize such systems using both engineering and psychophysical evaluation metrics;
6) investigate and optimize one aspect of the physical setup and convey and defend the gained insights in a technical presentation.

Content

This course provides an introduction to fundamental aspects of physical human-robot interaction. After an overview of human haptic, visual and auditory sensing, neurophysiology and psychophysics, principles of human-robot interaction systems (kinematics, mechanical transmissions, robot sensors and actuators used in these systems) will be introduced. Throughout the course, students will gain knowledge of interaction control strategies including impedance/admittance and force control, haptic rendering basics and issues in device design for humans such as transparency and stability analysis, safety hardware and procedures. The course is organized into lectures that aim to bring students up to speed with the basics of these systems, readings on classical and current topics in physical human-robot interaction, laboratory sessions and lab visits.

Students will attend laboratory sessions where they will implement the theoretical aspects learned during the lectures. Here the salient features of haptic device design will be identified and theoretical aspects will be implemented in a haptic system based on the haptic paddle (http://www.relab.ethz.ch/education/courses/phri/request-ethz-haptic-paddle-hardware-documentation.html), by creating simple dynamic haptic virtual environments and understanding the performance limitations and causes of instabilities (direct/virtual coupling, friction, time delays, multimodal demand, sensor quantization, etc.) during rendering of different mechanical properties.

Lecture notes

Will be distributed through the document repository before the lectures.

http://www.relab.ethz.ch/education/courses/phri.html

Literature


Prerequisites / notice

Notice:
The registration is limited to 26 students
There are 4 credit points for this lecture.
The lecture will be held in English.
The students are expected to have basic control knowledge from previous classes.

http://www.relab.ethz.ch/education/courses/phri.html

151-0135-00L Additional Case for the Focus Specialization ■  W 1 credit 2A Professors

Exclusive for D-MAVT Bachelor's students in Focus Specialization.
For enrollment, please contact the D-MAVT Student Administration.

Abstract

Independent studies on a defined field within the selected Focus Specialization.

Objective

Independent studies on a defined field within the selected Focus Specialization.

▶▶▶ Microsystems and Nanoscale Engineering

Data: 06.03.2019 12:57  Autumn Semester 2016  Page 1011 of 1571
151-0604-00L  
**Microelectronics**  
Does not take place this semester.

**Abstract**  
Microelectronics is an interdisciplinary field that combines aspects of electronics, materials science, and devices fabrication. The aim of this course is to expose students to the fundamentals of this emerging field. Throughout the course, students are expected to submit assignments. The course concludes with an end-of-semester examination.

**Objective**  
The objective of this course is to expose students to the fundamental aspects of the emerging field of microelectronics. This includes a focus on physical laws that predominate at the microscale, technologies for fabricating small devices, and applications of the field.

**Content**  
Main topics of the course include:
- Scaling laws at micro/nano scales
- Electrodynamics
- Electromagnetism
- Low Reynolds number flows
- Observation tools
- Materials and fabrication methods
- Applications of biomedical microsystems

**Lecture notes**  
The powerpoint slides presented in the lectures will be made available in hardcopy and as pdf files. Several readings will also be made available electronically.

**Prerequisites**  
The lecture will be taught in English.

151-0619-00L  
**Introduction to Nanoscale Engineering**  
This class is strictly only for BSc MAVT students.

**Abstract**  
Nano is the new scale in science & engineering as micro was ~150 years ago. This BSc course demands substantial effort! It gives a flavor of nanotechnology with hands-on student projects on gas-phase synthesis of nanoparticles & applications in catalysis, gas sensing and biomedical engineering. Projects are conducted individually under the close supervision of MSc, PhD or post-doctoral students.

**Objective**  
This course aims to familiarize BSc students with some of the basic phenomena of nanoscale, thereby illustrating the links between physics, chemistry, materials science and/or biology through hands-on experience. Furthermore, it aims to give an overview of the field with motivating lectures from industry and academia, including the development of technologies and processes based on or involving nanoscale phenomena. Most importantly, the course aims to develop the creativity, and sharpen the communication skills of the students through their individual projects, a PERFECT preparation for the BSc thesis (e.g. efficient & critical literature search, effective oral/written project presentations), the future profession itself and even life, in general, as the abc questions (in the Content below) are always there!

**Content**  
This is strictly a BSc course. Its objectives are met primarily through the individual student project which may involve experiments, simulations, or critical & quantitative reviews of the literature. Therein, a 2-page proposal (15% of the grade) is submitted within the first two semester weeks addressing explicitly, at least, 10 well-selected research articles and thoughtful meetings with the project supervisor. The proposal address three basic questions: a) how important is the project; b) what has been done already in that field and c) what will be done by the student. Detailed feedback on each proposal is given by the supervisor, assistant and professor two weeks later. Towards the end of the semester, a 10-minute oral presentation is given by the student followed by 10 minutes Q&A (30% of the grade). A 10-page final report is submitted by noon of the last day of the semester (55% of the grade). The project supervisor will provide guidance throughout the course especially when called for by the student. Detailed feedback on each proposal, presentation, and final report is given by the supervisor, assistant, and professor.

Course lectures will include some, if not all, of the following:
- Overview of Nanotechnology & Project Presentation
- Control of nanoparticle size & structure in the gas-phase
- Multi-scale design of nanomaterial synthesis
- Characterization of nanostructured materials
- Encapsulation technologies for active food ingredients
- Aerosol manufacture of nanoparticles
- Physical Chemistry of Nanoparticles (structure, molecular forces, statistical thermodynamics)
- Thermodynamics of nanoparticles (the basics, thermal stability, nanophases, melting temperature)
- Transport properties of nanoparticles (diffusivity, mobility, settling, adsorption)
- Computer simulations of nanoparticles (from atoms, to primary particles, to agglomerates)
- Thin film coatings
- Cluster beam deposition
- Coaching for proposal & report writing as well as oral presentations

**Prerequisites**  
The lecture is intended for 5th semester students standing in D-MAVT. Students attending this course are expected to allocate sufficient additional time within their weekly lecture schedule in order to successfully conduct the project work. As exceptional effort will be required, having seen "Chasing Mavericks" (2012) by Apted & Henson, "Unbroken" (2014) by Angelina Jolie and, in particular, "The Salt of the Earth" (2014) by Wim Wenders might be helpful and even motivating. These movies show how methodic effort can bring superior and truly unexpected results (e.g. stay under water for 5 minutes to overcome the fear of riding huge waves or merciless Olympic athlete training that help him survive 45 days on a raft in Pacific Ocean followed by 2 years in a Japanese POW camp during WW2).

151-0621-00L  
**Microsystems Technology**  
W+  6 credits  4G  C. Hierold, M. Haluska

**Abstract**  
Students are introduced to the basics of micromachining and silicon process technology and will learn about the fabrication of microsystems and -devices by a sequence of defined processing steps (process flow).

**Objective**  
Students are introduced to the basics of micromachining and silicon process technology and will understand the fabrication of microsystems devices by the combination of unit process steps (= process flow).

**Content**  
- Introduction to microsystems technology (MST) and micro electro mechanical systems (MEMS)
- Basic silicon technologies: Thermal oxidation, photolithography and etching, diffusion and ion implantation, thin film deposition.
- Specific microsystems technologies: Bulk and surface micromachining, dry and wet etching, isotropic and anisotropic etching, beam and membrane formation, wafer bonding, thin film mechanical and thermal properties, piezoelectric and piezoresistive materials.
- Selected microsystems: Mechanical sensors and actuators, microresonators, thermal sensors and actuators, system integration and encapsulation.

**Lecture notes**  
Handouts (available online)

**Literature**  
- S.M. Sze: Semiconductor Devices, Physics and Technology
- W. Mentz, J. Mohr, O.Paul: Microsystem Technology
- G. Kovacs: Micromachined Transducer Sourcebook

**Prerequisites**  
Prerequisites: Physics I and II

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**Number**  | **Title**  | **Type**  | **ECTS**  | **Hours**  | **Lecturers**
---|---|---|---|---|---
151-0604-00L | **Microelectronics** | W | 4 credits | 3G | B. Nelson
151-0619-00L | **Introduction to Nanoscale Engineering** | W | 5 credits | 2V+3P | S. E. Pratsinis, V. Mavrantzas, A. Teleki Sotiriou, K. Wegner
151-0621-00L | **Microsystems Technology** | W+ | 6 credits | 4G | C. Hierold, M. Haluska
151-0643-00L | **Studies on Micro and Nano Systems** | W+ | 5 credits | 11A | Professors
This course is not available to incoming exchange students.

**Abstract**
The students get familiarized with the challenges of the fascinating and interdisciplinary field of Micro- and Nanosystems. They are introduced to the basics of independent non-experimental scientific research and are able to summarize and to present the results efficiently.

**Objective**
The students get familiarized with the challenges of the fascinating and interdisciplinary field of Micro- and Nanosystems. They are introduced to the basics of independent non-experimental scientific research and are able to summarize and to present the results efficiently.

**Content**
Students work independently on a study of selected topics in the field of Micro- and Nanosystems. They start with a selection of scientific papers, and continue with an independent literature research. The results (e.g. state-of-the-art, methods) are evaluated with respect to predefined criteria. Then the results are presented in an oral presentation and summarized in a report, which takes the discussion of the presentation into account.

**Literature**
Literature will be provided.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0911-00L</td>
<td>Introduction to Plasmonics</td>
<td>W</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>D. J. Norris</td>
</tr>
<tr>
<td>151-0135-00L</td>
<td>Additional Case for the Focus Specialization</td>
<td>W</td>
<td>1 credit</td>
<td>2A</td>
<td>Professors</td>
</tr>
<tr>
<td>151-0705-00L</td>
<td>Manufacturing I</td>
<td>O</td>
<td>4 credits</td>
<td>2V+2U</td>
<td>K. Wegener, M. Boccadoro, F. Kuster</td>
</tr>
<tr>
<td>151-0733-00L</td>
<td>Forming Technology III - Forming Processes</td>
<td>O</td>
<td>4 credits</td>
<td>2V+2U</td>
<td>P. Hora</td>
</tr>
<tr>
<td>151-0573-00L</td>
<td>System Modeling</td>
<td>W</td>
<td>4 credits</td>
<td>2V+2U</td>
<td>G. Ducard, C. Onder</td>
</tr>
</tbody>
</table>

**Introduction to Plasmonics**

This course provides fundamental knowledge of surface plasmon polaritons and discusses their applications in plasmonics.

**Content**
- Fundamentals of Plasmonics
  - Basic electromagnetic theory
  - Optical properties of metals
  - Surface plasmon polaritons on surfaces
  - Surface plasmon polariton propagation
  - Localized surface plasmons
- Applications of Plasmonics
  - Waveguides
  - Extraordinary optical transmission
  - Enhanced spectroscopy
  - Sensing
  - Metamaterials

**Literature**

**Additional Case for the Focus Specialization**

Excl. for D-MAVT Bachelor's students in Focus Specialization.

For enrollment, please contact the D-MAVT Student Administration.

**Objective**
Independent studies on a defined field within the selected Focus Specialization.

**Language**
Help for English speaking students on request as well as English translations of the slides shown.

**Title**

**Number**

**Abstract**

**Objective**

**Content**

**Lecture notes**

**Prerequisites / notice**

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**Manufacturing Science**

Focus Coordinator: Prof. Konrad Wegener

To achieve the required 20 credit points for the focus specialization you need to pass all 3 compulsory courses (HS/FS). The other 8 credit points can be achieved from the elective courses.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0700-00L</td>
<td>Manufacturing elective course in the 4th semester.</td>
<td>O</td>
<td>4 credits</td>
<td>2V+2U</td>
<td>K. Wegener, M. Boccadoro, F. Kuster</td>
</tr>
<tr>
<td>151-0570-00L</td>
<td>Manufacturing elective course in the 4th semester.</td>
<td>O</td>
<td>4 credits</td>
<td>2V+2U</td>
<td>K. Wegener, M. Boccadoro, F. Kuster</td>
</tr>
</tbody>
</table>

**Abstract**

Deeper insight in manufacturing processes: drilling, milling, grinding, honing, lapping, electro erosion and electrochemical machining.

**Objective**

Deeper discussion on the machining processes and their optimisation. Outlook on additional areas such as NC-Technique, dynamics of processes and machines, chatter as well as process monitoring.

**Content**

Deepened insight in the machining processes and their optimisation, chip removal by undefined cutting edge such as grinding, honing and lapping, machining processes without cutting edges such as EDM, ECM, outlook on additional areas as NC-technique, machine- and process dynamics including chatter and process monitoring.

**Lecture notes**

yes

**Prerequisites / notice**

Prerequisites: Recommendation: Lecture 151-0700-00L Manufacturing elective course in the 4th semester.

Language: Help for English speaking students on request as well as English translations of the slides shown.

---

**Forming Technology III - Forming Processes**

The lecture teaches on the basic knowledge of major processes in sheet metal, tube and bulk metal forming technologies. In particular it focuses on fundamental computation methods, which allow a fast assessment of process behaviour and a rough layout. Process-specific states of stress and deformation are analysed and process limits are identified.

**Objective**

The study of metal working processes: sheet metal forming, folding die cutting, cold bulk metal forming, ro extrusion, plunging, open die forging, drop forging, milling; active principle; elementary methods to estimate stress and strain; fundamentals of process design; manufacturing limits and machining accuracy; tools and operation; machinery and machine usage.

**Content**

Acquaintance with forming processes. Determination of forming processes. Interpretation of forming manufacturing

**Lecture notes**

ja

**System Modeling**


**Abstract**

Acquaintance with forming processes. Determination of forming processes. Interpretation of forming manufacturing

**Objective**

The study of metal working processes: sheet metal forming, folding die cutting, cold bulk metal forming, ro extrusion, plunging, open die forging, drop forging, milling; active principle; elementary methods to estimate stress and strain; fundamentals of process design; manufacturing limits and machining accuracy; tools and operation; machinery and machine usage.

**Content**

Acquaintance with forming processes. Determination of forming processes. Interpretation of forming manufacturing

**Lecture notes**

ja
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Event-driven and computer-based simulation applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Content</td>
<td>Introduction to generic system modeling approaches for control-oriented models based on first principles and on experimental data. Examples: mechatronic, thermodynamic, chemistry, fluid dynamic, energy, and process engineering systems. Model scaling, linearization, order reduction, and balancing. Estimation techniques (least-squares methods). Class case studies: Loud-speaker, Water-propelled rocket, geostationary satellites, etc.</td>
</tr>
<tr>
<td>Literature</td>
<td>The exercises address practical examples. One larger case study is to be solved.</td>
</tr>
<tr>
<td>Lecture notes</td>
<td>A list of references is included in the handouts.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Operational Simulation of Production Lines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective</td>
<td>The student learns the right use of (Who? When? How?) of the event-driven and computer-based simulation for layout and operational improvement of production facilities by means of practical examples.</td>
</tr>
<tr>
<td>Content</td>
<td>- Application and application areas of the event-driven simulation - Exemplary application of a software tool (Technomatric-Simulation-Software) - Internal organisation and functionality of simulation tools - Procedure for application: optimizing, experimental design planning, analysis, data preparation - Controlling philosophies, emergency concepts, production in sequence, line production, rescheduling - Application on the facilities projecting</td>
</tr>
<tr>
<td>Prerequisites / notice</td>
<td>The knowledge is enhanced by practice-oriented exercises and an excursion. A guest speaker will present a practical example.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Mechanical Production: Assembly, Joining and Coating Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>Understanding of the complexity of the assembly process as well as its meaning as success and cost factor. The assembly with the different aspects of adding, moving, adjusting, controlling parts etc. Adding techniques; solvable and unsolvable connections. Assembly plants. Coating techniques and their tasks, in particular corrosion protection.</td>
</tr>
<tr>
<td>Objective</td>
<td>To understand assembly in its full complexity and its paramount importance regarding cost and financial success. An introduction into a choice of selected joining and coating techniques.</td>
</tr>
<tr>
<td>Content</td>
<td>- Assembly as combination of several classes of action like, e.g., joining, handling, fine adjustments, etc. Techniques for joining objects temporarily or permanently. Assembly systems. - Coating processes and their specific applications, with particular emphasis on corrosion protection.</td>
</tr>
<tr>
<td>Lecture notes</td>
<td>Recommended for all Bachelor-Students in the 5th semester and Master-Students in the 7th semester.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Quality of Machine Tools - Dynamics and Metrology at Micro and Submicro Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective</td>
<td>The course “Machine tool metrology” deals with the principal design of machine tools, their spindles and linear axes, with possible geometric, kinematic, thermal and dynamic errors of machine tools and testing these errors, with the influence of errors on the workpiece (error budgeting), with testing of drives and numerical control, as well as with checking the machine tool capability.</td>
</tr>
<tr>
<td>Content</td>
<td>- Knowledge of - principal design of machine tools - errors of linear and rotational axes and of machine tools, - influence of errors on the workpiece (error budgeting) - dynamics of mechanical systems - geometric, kinematic, thermal, dynamic testing of machine tools - test uncertainty - machine tool capability</td>
</tr>
<tr>
<td>Lecture notes</td>
<td>New exercises in the laboratories and with the machine tools of the institute for machine tools and manufacturing (IWF) provide the practical background for this course.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Manufacturing of Electronic Devices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective</td>
<td>Knowledge about the value added process sequence for electronics manufacturing, manufacturing of electronic and electric product as well as their production, planning of production lines, value added process sequence for photovoltaics.</td>
</tr>
<tr>
<td>Content</td>
<td>The exercises address practical examples. One larger case study is to be solved.</td>
</tr>
<tr>
<td>Lecture notes</td>
<td>The handsout in English will be sold in the first lecture.</td>
</tr>
</tbody>
</table>

Data: 06.03.2019 12:57  Autumn Semester 2016  Page 1014 of 1571
Content

Nothing works without electronics! Typical products in mechanical engineering such as machine tools, as well as any kind of vehicle contain a significant amount of electric or electronic components of more than 60%. Thus, it is important to master the value added process sequence for electric and electronic components.

The lecture starts with a brief introduction of electronic components and the planning of integrated circuits. Next, an overview will be provided about electronic functional units assembled from these electronic components, on printed circuit boards as well as in hybrid technology. Value added process steps are shown as well as their quality check and their combination for planning a complete manufacturing line. The lecture further describes the manufacturing of integrated circuits, starting from the wafer via the structuring and bonding to the packaging. As an example, the manufacturing of micro-electromechanics and electro-optical systems and actuators is described. Due to similar processes in the electronic production, the value added process sequence for photovoltaics will described too.

The lecture concludes with an excursion to a large manufacturing company. Here, students can see the application and realization of the manufacturing of electric and electronic devices.

Lecture notes

Lecture notes are handed out during the individual lessons (CHF 20.-).

Prerequisites / notice

Help for English speaking students on request.

The lecture is partly given by experts from industry. It is supplemented by an excursion to one of the industry partners.

151-0731-00L
Forming Technology I - Basic Knowledge

Abstract
The fundamentals of forming technology are presented to Mechanical, Production and Material Engineers. The content of the lecture includes:
Overview of manufacturing with forming techniques, deformation specific description of material properties and their experimental measurement, material laws, residual stresses, heat balance, tribological aspects of forming processes, workpiece and tool failure.

Objective
Forming technology represents with its 70% global share in manufactured metal volume with respect to yield and cost, the most important manufacturing process in metal-working industries. Typical applications of forming technology range from the manufacturing of sheet metal components in auto bodies to applications in food and pharma packaging, fabrication of implants in medical technologies and to the fabrication of leads in microelectronic components. This course introduces the fundamentals which are essential to evaluate metal-forming processes and its industrial applications. This includes, together with the requirements of the most important forming processes, the characterization of plastic material behavior and manufacturing limits.

Content
Overview of the most important processes of metal-forming technology and its field of applications, characterization of the plastic metal-forming behavior, basic principles of plastic-mechanical calculations, metal-forming residual stresses, thermo-mechanical coupling of metal-forming processes, influence of tribology, Work piece failure through cracking and folding, tool failure through rupture and mechanical wear, metal-forming tools, sheet forming and massive forming processes, handling systems, metal-forming machinery.

Prerequisites
Course in continuum mechanics (mandatory), finite element method (recommended)

Literature
Various books will be recommended covering the topics discussed in class

Help for English speaking students on request.

151-0735-00L
Dynamic Behavior of Materials and Structures

Abstract
Lectures and computer labs concerned with the modeling of the deformation response and failure of engineering materials (metals, polymers and composites) subject to extreme loadings during manufacturing, crash, impact and blast events.

Objective
Students will learn to apply, understand and develop computational models of a large spectrum of engineering materials to predict their dynamic deformation response and failure in finite element simulations. Students will become familiar with important dynamic testing techniques to identify material model parameters from experiments. The ultimate goal is to provide the students with the knowledge and skills required to engineer modern multi-material solutions for high performance structures in automotive, aerospace and naval engineering.

Content
Topics include viscoelasticity, temperature and rate dependent plasticity, dynamic brittle and ductile fracture; impulse transfer, impact and wave propagation in solids; computational aspects of material model implementation into hydrocodes; simulation of dynamic failure of structures;

Prerequisites
Course in continuum mechanics (mandatory), finite element method (recommended)

151-0833-00L
Principles of Nonlinear Finite-Element-Methods

Abstract
Most problems in engineering are of nonlinear nature. The nonlinearities are caused basically due to the nonlinear material behavior, contact conditions and instability of structures. The principles of the nonlinear Finite-Element-Method (FEM) will be introduced in the scope of this lecture for treating such problems.

Objective
The goal of the lecture is to provide the students with the fundamentals of the non linear Finite Element Method (FEM). The lecture focuses on the principles of the nonlinear Finite-Element-Method based on explicit and implicit formulations. Typical applications of the nonlinear Finite-Element-Methods are simulations of:
- Crash
- Collapse of structures
- Materials in Biomechanics (soft materials)
- General forming processes

Special attention will be paid to the modeling of the nonlinear material behavior, thermo-mechanical processes and processes with large plastic deformations. The ability to independently create a virtual model which describes the complex non linear systems will be acquired through accompanying exercises. These will include the Matlab programming of important model components such as constitutive equations

Content
- Fundamentals of continuum mechanics to characterize large plastic deformations
- Elasto-plastic material models
- Updated-Lagrange (UL), Euler and combined Euler-Lagrange (ALE) approaches
- FEM implementation of constitutive equations
- Element formulations
- Implicit and explicit FEM methods
- FEM formulations of coupled thermo-mechanical problems
- Modeling of tool contact and the influence of friction
- Solvers and convergence
- Modeling of crack propagation
- Introduction of advanced FE-Methods

Prerequisites

Literature

If we will have a large number of students, two dates for the exercises will be offered.
Abstract  Fields of application of power electronic systems. Principle of operation of basic pulse-width modulated and line-commutated power electronic converters, analysis of the operating behavior and of the control oriented behavior, converter design. Reduction of effects of line-commutated rectifiers on the mains, electromagnetic compatibility.

Objective  Fields of application of power electronic systems. Principle of operation of basic pulse-width modulated and line-commutated power electronic converters, analysis of the operating behavior and of the control oriented behavior, converter design. Reduction of effects of line-commutated rectifiers on the mains, electromagnetic compatibility.


Lecture notes  Lecture notes and associated exercises including correct answers, simulation program for interactive self-learning including visualization/animation features.

Prerequisites / notice  Prerequisites: Basic knowledge of electric circuit analysis and signal theory.

Compulsory Courses

Elective Courses

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### Biomedical Engineering

Focus Coordinator: Prof. Edoardo Mazza

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>151-0525-00L</td>
<td>Energy Conversion and Transport in Biosystems</td>
<td>W</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>D. Poulikakos, A. Ferrari</td>
</tr>
</tbody>
</table>

#### Abstract
Theory and application of thermodynamics and energy conversion in biological systems with focus on the cellular level.

#### Objective
Theory and application of energy conversion at the cellular level. Understanding of the basic features governing solutes transport in the principal systems of the human cell. Connection of characteristics and patterns from other fields of engineering to biofluidics. Heat and mass transport processes in the cell, generation of forces, work and relation to biomedical technologies.

#### Content
Mass transfer models for the transport of chemical species in the human cell. Organization and function of the cell membrane and of the cell cytoskeleton. The role of molecular motors in cellular force generation and their function in cell migration. Description of the functionality of these systems and of analytical and experimental techniques for understanding of their operation.

#### Literature
Material in the form of hand-outs will be distributed.

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### Microscale Acoustofluidics

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<tr>
<th>Number</th>
<th>Title</th>
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<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>151-0509-00L</td>
<td>Microscale Acoustofluidics</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>J. Dual</td>
</tr>
</tbody>
</table>

#### Abstract
In this lecture the basics as well as practical aspects (from modelling to design and fabrication) are described from a solid and fluid mechanics perspective with applications to microsystems and lab on a chip devices.

#### Objective
Understanding acoustophoresis, the design of devices and potential applications

#### Content
Linear and nonlinear acoustics, foundations of fluid and solid mechanics and piezoelectricity, Gorkov potential, numerical modelling, acoustic streaming, applications from ultrasonic microfluidics to surface acoustic wave devices

#### Literature

#### Prerequisites / notice
Solid and fluid continuum mechanics. Notice: The exercise part is a mixture of presentation, lab session and hand in homework.

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### Continuum Mechanics I

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<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0524-00L</td>
<td>Continuum Mechanics I</td>
<td>W</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>E. Mazza</td>
</tr>
</tbody>
</table>

#### Abstract
The lecture deals with constitutive models that are relevant for design and calculation of structures. These include anisotropic linear elasticity, linear viscoelasticity, plasticity, viscoplasticity. Homogenization theories and laminate theory are presented. Theoretical models are complemented by examples of engineering applications and experiments.

#### Objective
Basic theories for solving continuum mechanics problems of engineering applications, with particular attention to material models.

#### Content

#### Lecture notes
Yes

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### Microrobotics

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<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0604-00L</td>
<td>Microrobotics</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>B. Nelson</td>
</tr>
</tbody>
</table>

#### Abstract
Microrobotics is an interdisciplinary field that combines aspects of robotics, micro and nanotechnology, biomedical engineering, and materials science. The aim of this course is to expose students to the fundamentals of this emerging field. Throughout the course students are expected to submit assignments. The course concludes with an end-of-semester examination.

#### Objective
The course will cover topics that are relevant for the design and fabrication of microrobots. The course is interdisciplinary in nature.

#### Content
Microrobotics is an interdisciplinary field that combines aspects of robotics, micro and nanotechnology, biomedical engineering, and materials science. The aim of this course is to expose students to the fundamentals of this emerging field. Throughout the course students are expected to submit assignments. The course concludes with an end-of-semester examination.

#### Lecture notes
The powerpoint slides presented in the lectures will be made available in hardcopy and as pdf files. Several readings will also be made available electronically.

#### Prerequisites / notice
The lecture will be taught in English.

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### Introduction to Nanoscale Engineering

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0619-00L</td>
<td>Introduction to Nanoscale Engineering</td>
<td>W</td>
<td>5 credits</td>
<td>2V+3P</td>
<td>S. E. Pratsinis, V. Mavrantzas, A. Teleki Sotiriou, K. Wegner</td>
</tr>
</tbody>
</table>

This class is strictly only for BSc MAVT student.
Abstract
Nano is the new scale in science & engineering as micro was ~150 years ago. This BSc course demands substantial effort! It gives a flavor of nanotechnology with hands-on student projects on gas-phase synthesis of nanoparticles & applications in catalysis, gas sensing and biomedical engineering. Projects are conducted individually under the close supervision of MSc, PhD or post-doctoral students.

Objective
This course aims to familiarize BSc students with some of the basic phenomena of nanoscale, thereby illustrating the links between physics, chemistry, materials science and/or biology through hands-on experience. Furthermore it aims to give an overview of the field with motivating lectures from industry and academia, including the development of technologies and processes based on or involving nanoscale phenomena. Most importantly, this course aims to develop the creativity and sharpen the communication skills of the students through their individual projects, a PERFECT preparation for the BSc thesis (e.g. efficient & critical literature search, effective oral/written project presentations), the future profession itself and even life, in general, as the abc questions (in the Content below) are always there!

Content
This is strictly a BSc course. Its objectives are met primarily through the individual student project which may involve experiments, simulations or critical & quantitative reviews of the literature. Therein, a 2-page proposal (15% of the grade) is submitted within the first two semester weeks addressing explicitly, at least, 10 well-selected research articles and thoughtful meetings with the project supervisor. The proposal address 3 basic questions: a) how important is the project; b) what has been done already in that field and c) what will be done by the student. Detailed feedback on each proposal is given by the supervisor, assistant and professor two weeks later. Towards the end of the semester, a 10-minute oral presentation is given by the student followed 10 minutes Q&A (30% of the grade). A 10-page final report is submitted by noon of the last day of the semester (55% of the grade). The project supervisor will provide guidance throughout the course especially when called for by the student. Detailed feedback on each proposal, presentation and final report is given by the supervisor, assistant and professor.

Course lectures will include some, if not all, of the following:
- Overview of Nanotechnology & Project Presentation
- Control of nanoparticle size & structure in the gas-phase
- Multi-scale design of nanomaterial synthesis
- Characterization of nanostructured materials
- Encapsulation technologies for active food ingredients
- Aerosol manufacture of nanoparticles
- Physical Chemistry of Nanoparticles (structure, molecular forces, statistical thermodynamics)
- Thermodynamics of nanoparticles (the basics, thermal stability, nanophases, melting temperature)
- Transport properties of nanoparticles (diffusivity, mobility, settling, adsorption)
- Computer simulations of nanoparticles (from atoms, to primary particles, to agglomerates)
- Thin film coatings
- Cluster beam deposition
- Coaching for proposal & report writing as well as oral presentations

Prerequisites / notice
5th semester student standing in D-MAVT. Students attending this course are expected to allocate sufficient additional time within their weekly lecture schedule in order to successfully conduct the project work. As exceptional effort will be required, having seen “Chasing Mavericks” (2012) by Apted & Henson, “Unbroken” (2014) by Angelina Jolie and, in particular, “The Salt of the Earth” (2014) by Wim Wenders might be helpful and even motivating. These movies show how methodic effort can bring superior and truly unexpected results (e.g. stay under water for 5 minutes to overcome the fear of riding huge waves or merciless Olympic athlete training that help him survive 45 days on a raft in Pacific Ocean followed by 2 years in a Japanese POW camp during WW-II).
Objective

During this course the students will:
- learn the basic concepts in biosensing and bioelectronics
- be able to solve typical problems in biosensing and bioelectronics
- learn about the remaining challenges in this field

Content

L1. Bioelectronics history, its applications and overview of the field
- Volta and Galvani dispute
- BMI, pacemaker, cochlear implant, retinal implant, limb replacement devices
- Fundamentals of biosensing
- Glucose meter and ELISA

L2. Fundamentals of quantum and classical noise in measuring biological signals

L3. Biomeasurement techniques with photons

L4. Acoustics sensors
- Differential equation for quartz crystal resonance
- Acoustic sensors and their applications

L5. Engineering principles of optical probes for measuring and manipulating molecular and cellular processes

L6. Optical biosensors
- Differential equation for optical waveguides
- Optical sensors and their applications
- Plasmonic sensing

L7. Basic notions of molecular adsorption and electron transfer
- Quantum mechanics: Schrödinger equation energy levels from H atom to crystals, energy bands
- Electron transfer: Marcus theory, Gerischer theory

L8. Potentiometric sensors
- Fundamentals of the electrochemical cell at equilibrium (Nernst equation)
- Principles of operation of ion-selective electrodes

L9. Amperometric sensors and bioelectric potentials
- Fundamentals of the electrochemical cell with an applied overpotential to generate a faraday current
- Principles of operation of amperometric sensors
- Ion flow through a membrane (Fick equation, Nernst equation, Donnan equilibrium, Goldman equation)

L10. Channels, amplification, signal gating, and patch clamp Y4

L11. Action potentials and impulse propagation

L12. Functional electric stimulation and recording
- MEA and CMOS based recording
- Applying potential in liquid - simulation of fields and relevance to electric stimulation

L13. Neural networks memory and learning

Literature

Plonsey and Barr, Bioelectricity: A Quantitative Approach (Third edition)

Prerequisites / notice

Supervised exercises solving real-world problems. Some Matlab based exercises in groups.
Objective

The objective of this course is to give an introduction to the fundamentals of physical human robot interaction, through lectures on the underlying theoretical/mechatronics aspects and application fields, in combination with a hands-on lab tutorial. The course will guide students through the design and evaluation process of such systems.

By the end of this course, you should understand the critical elements in human–robot interactions - both in terms of engineering and human factors - and use these to evaluate and de-design safe and efficient assistive and rehabilitative robotic systems. Specifically, you should be able to:

1) Identify critical human factors in physical human–robot interaction and use these to derive design requirements;
2) Compare and select mechatronic components that optimally fulfill the defined design requirements;
3) Derive a model of the device dynamics to guide and optimize the selection and integration of selected components into a functional system;
4) Design control hardware and software and implement and test human–interactive control strategies on the physical setup;
5) Characterize and optimize such systems using both engineering and psychophysical evaluation metrics;
6) Investigate and optimize one aspect of the physical setup and convey and defend the gained insights in a technical presentation.

Content

This course provides an introduction to fundamental aspects of physical human–robot interaction. After an overview of human haptic, visual and auditory sensing, neurophysiology and psychophysics, principles of human–robot interaction systems (kinematics, mechanical transmissions, robot sensors and actuators used in these systems) will be introduced. Throughout the course, students will gain knowledge of interaction control strategies including impedance/admittance and force control, haptic rendering basics and issues in device design for humans such as transparency and stability analysis, safety hardware and procedures. The course is organized into lectures that aim to bring students up to speed with the basics of these systems, readings on classical and current topics in physical human–robot interaction, laboratory sessions and lab visits.

Students will attend laboratory sessions where they will implement the theoretical aspects learned during the lectures. Here the salient features of haptic device design will be identified and theoretical aspects will be implemented in a haptic system based on the haptic paddle (http://www.relab.ethz.ch/education/courses/phri/request-ethz-haptic-paddle-hardware-documentation.html), by creating simple dynamic haptic virtual environments and understanding the performance limitations and causes of instabilities (direct/virtual coupling, friction, time delays, sampling rate, sensor quantization, etc.) during rendering of different mechanical properties.

Lecture notes

Will be distributed through the document repository before the lectures.

http://www.relab.ethz.ch/education/courses/phri.html

Literature


Prerequisites / notice

Notice:
The registration is limited to 26 students.
There are 4 credit points for this lecture.
The lecture will be held in English.
The students are expected to have basic control knowledge from previous classes.

http://www.relab.ethz.ch/education/courses/phri.html

Data: 06.03.2019 12:57 Autumn Semester 2016 Page 1019 of 1571
Discovering Management offers an introduction to the field of business management and entrepreneurship for engineers and natural scientists. The module provides an overview of the principles of management, teaches knowledge about management that is highly complementary to the students' technical knowledge, and provides a basis for advancing the knowledge of the various subjects offered at D-MTEC.

Management, Technology, and Economics
Focus Coordinators: Prof. Marko Köthenbürger D-MTEC and Dr. Jost Hamschmidt D-MTEC

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Entry level course in management for BSc, MSc and PHD students at all levels not belonging to D-MTEC. This course can be complemented with Discovering Management (Exercises) 351-0778-01.</td>
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</table>

Discovering Management aims to broaden the students' understanding of the principles of business management, emphasizing the interdependence of various topics in the development and management of a firm. The lectures introduce students not only to topics relevant for managing large corporations, but also touch upon the different aspects of starting up your own venture. The lectures will be presented by the respective area specialists at D-MTEC.

The course broadens the view and understanding of technology by linking it with its commercial applications and with society. The lectures are designed to introduce students to topics related to strategy, corporate innovation, leadership, corporate and entrepreneurial finance, value chain analysis, corporate social responsibility, and business model innovation. Practical examples from industry experts will stimulate the students to critically assess these issues. Creative skills will be trained by the business game exercise, a participant-centered learning environment and successfully respond to it by taking systematic decisions, e.g. critical assessment of technological possibilities.

Discovering Management combines in an innovate format a set of lectures and an advanced business game. The learning model for Discovering Management involves ‘learning by doing’. The objective is to introduce the students to the relevant topics of the management literature and give them a good introduction in entrepreneurship topics too. The course is a series of lectures on the topics of strategy, innovation, corporate finance, leadership, design thinking and corporate social responsibility. While the 14 different lectures provide the theoretical and conceptual foundations, the experiential learning outcomes result from the interactive business game. The purpose of the business game is to analyse the innovative needs of a large multinational company and develop a business case for the company to grow. This business case is as relevant to someone exploring innovation within an organisation as it is if you are planning to start your own business. By discovering the key aspects of entrepreneurial management, the purpose of the course is to advance students' understanding of factors driving innovation, entrepreneurship, and company success.

Prerequisites / notice
Discovering Management is designed to suit the needs and expectations of Bachelor students at all levels as well as Master and PhD students not belonging to D-MTEC. By providing an overview of Business Management, this course is an ideal enrichment of the standard curriculum at ETH Zurich.

No prior knowledge of business or economics is required to successfully complete this course.

Complementary exercises for the module Discovering Management.
Prerequisite: Participation and successful completion of the module Discovering Management (351-0778-00L) is mandatory.

This course is offered complementary to the basis course 351-0778-00L, "Discovering Management". The course offers additional exercises and case studies.

The course offers additional exercises and case studies concerning: Strategic Management; Technology and Innovation Management; Operations and Supply Chain Management; Finance and Accounting; Marketing and Sales.

Please refer to the course website for further information on the content, credit conditions and schedule of the module: www.dm.ethz.ch
Abstract
The lectures addresses the assessment of corporate sustainability and its links to strategy, technology, and finance. Students learn why sustainability matters for managers and how businesses can act towards it. E-modules allow students to train critical thinking skills. In the 2nd half of the semester, sustainability challenges on water, energy, mobility, and food are explored in group projects.

Objective
Understand the limits and the potential of corporate sustainability for sustainable development.

Be able to recognize and realize opportunities for corporate sustainability in a business environment.

Content
Overview of the key concepts of corporate sustainability and topics related to Water, Energy, Mobility, and Food.

Business implications of sustainable development, in particular for the assessment of sustainability performance, strategic change towards sustainability, technological innovations and sustainability, and finance and corporate sustainability.

Critical thinking skills for corporate sustainability.

In-depth case studies of corporate sustainability challenges in the track phase: How to deal with environmental pressure groups? How to use the strengths of business to solve pressing sustainability problems? How to catalyze technological innovations for sustainability? How to invest money in a sustainable way?

Lecture notes
Presentation slides will be made available on moodle prior to lectures.

Literature
Lecture recommendations will be distributed during the lecture.

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363-0389-00L Technology and Innovation Management W 3 credits 2G S. Brusoni

Abstract
This course focuses on the analysis of innovation as a pervasive process that cut across organizational and functional boundaries. It looks at the sources of innovation, at the tools and techniques that organizations deploy to routinely innovate, and the strategic implications of technical change.

Objective
This course intends to enable all students to:
- understand the core concepts necessary to analyze how innovation happens
- master the most common methods and tools organizations deploy to innovate
- develop the ability to critically evaluate the innovation process, and act upon the main obstacles to innovation

Content
This course looks at technology and innovation management as a process. Continuously, organizations are faced with a fundamental decision: they have to allocate resources between well-known tasks that reliably generate positive results; or explore new ways of doing things, new technologies, products and services. The latter is a high risk choice. Its rewards can be high, but the chances of success are small. How do firms organize to take these decisions? What kind of management skills are necessary to take them? What kind of tools and methods are deployed to sustain managerial decision-making in highly volatile environments? These are the central questions on which this course focuses, relying on a combination of lectures, case-based discussion, guest speakers, simulations and group work.

Lecture notes
Slides will be available on the TIMGROUP website.

Literature
Readings will be available on the TIMGROUP website.

Prerequisites / notice
No specific background in economics or management is required.

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363-0389-02L Technology and Innovation Management (Additional Cases) W 1 credit 1U S. Brusoni

Only for Mechanical Engineering BSc.

Abstract
This module focuses on the topics that lie at the intersection between management and engineering.

Objective
Through a project, the students will focus on discussing the business implications of a technology using the tools and theories used in the TIM lecture. This would enable the students to deepen their understanding of managerial issues while focusing on a specific technology.

Topics for project work will be proposed in the beginning of the semester.

Prerequisites / notice
The lecture 363-0389-00L Technology and Innovation Management needs to be taken in order to participate in this module.

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363-0445-00L Production and Operations Management W+ 3 credits 2G T. Netland, P. Schönsleben

Abstract
This core course on Production and Operations Management provides the students insights into the basic theories, principles, concepts, and techniques used to design, analyze, and improve the operational capabilities of an organization.

Objective
Students learn why and how operations can be a competitive weapon; how to design, plan, control, and manage production and service processes; how to improve effectiveness and efficiency in operations; how to take advantage of new technological advancements; and how environmental and social concerns affect decisions in global production networks.

Content
The course covers the most fundamental strategic and tactical concepts in production and operations management. The lectures cover: Introduction to POM; Operations strategy; Capacity management; Production planning and control; Production philosophies; Lean management; Performance measurement; Problem solving; Service operations; New technologies in POM; Servitization; Global production; and Triple-bottom line.

Literature

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363-0445-02L Production and Operations Management (Additional Cases) W* 1 credit 2A T. Netland, P. Schönsleben

Abstract
Extension to course 363-0445-00 Production and Operations Management.

Objective
Extension to course 363-0445-00 Production and Operations Management.

Content
Additional cases to course 363-0445-00 Production and Operations Management.

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363-0503-00L Principles of Microeconomics W 3 credits 2G M. Filippini

Abstract
The course introduces basic principles, problems and approaches of microeconomics.

Objective
The learning objectives of the course are:
(1) Students must be able to discuss basic principles, problems and approaches in microeconomics. (2) Students can analyse and explain single economic principles in a market using supply and demand graphs. (3) Students can contrast different market structures and describe firm and consumer behaviour. (4) Students can identify market failures such as externalities related to market activities and illustrate how these affect the economy as a whole. (5) Students can apply simple mathematical treatment of some basic concepts and can solve utility maximization and cost minimization problems.

Lecture notes
Lecture notes, exercises and reference material can be downloaded from Moodle.
Literature


For students taking only the course ‘Principles of Microeconomics’ there is a shorter version of the same book:


Complementary:


363-0541-00L Systems Dynamics and Complexity W+ 3 credits 3G F. Schweitzer, G. Casiraghi, V. Nanumyan

Abstract

Finding solutions: what is complexity, problem solving cycle.

Implementing solutions: project management, critical path method, quality control feedback loop.

Controlling solutions: Vensim software, feedback cycles, control parameters, instabilities, chaos, oscillations and cycles, supply and demand, production functions, investment and consumption

Objective

A successful participant of the course is able to:
- understand why most real problems are not simple, but require solution methods that go beyond algorithmic and mathematical approaches
- apply the problem solving cycle as a systematic approach to identify problems and their solutions
- calculate project schedules according to the critical path method
- setup and run systems dynamics models by means of the Vensim software
- identify feedback cycles and reasons for unintended systems behavior
- analyse the stability of nonlinear dynamical systems and apply this to macroeconomic dynamics

Content

Why are problems not simple? Why do some systems behave in an unintended way? How can we model and control their dynamics? The course provides answers to these questions by using a broad range of methods encompassing systems oriented management, classical systems dynamics, nonlinear dynamics and macroeconomic modeling.

The course is structured along three main tasks:
1. Finding solutions
2. Implementing solutions
3. Controlling solutions

PART 1 introduces complexity as a system immanent property that cannot be simplified. It introduces the problem solving cycle, used in systems oriented management, as an approach to structure problems and to find solutions.

PART 2 discusses selected problems of project management when implementing solutions. Methods for identifying the critical path of subtasks in a project and for calculating the allocation of resources are provided. The role of quality control as an additional feedback loop and the consequences of small changes are discussed.

PART 3, by far the largest part of the course, provides more insight into the dynamics of existing systems. Examples come from biology (population dynamics), management (inventory modeling, technology adoption, production systems) and economics (supply and demand, investment and consumption). For systems dynamics models, the software program VENSIM is used to evaluate the dynamics. For economic models analytical approaches, also used in nonlinear dynamics and control theory, are applied. These together provide a systematic understanding of the role of feedback loops and instabilities in the dynamics of systems. Emphasis is on oscillating phenomena, such as business cycles and other life cycles.

Weekly self-study tasks are used to apply the concepts introduced in the lectures and to come to grips with the software program VENSIM.

The lecture slides are provided as handouts - including notes and literature sources - to registered students only. All material is to be found on the Moodle platform. More details during the first lecture

Prerequisites / notice

Self-study tasks (discussion exercises, Vensim exercises) are provided as home work. Weekly exercise sessions (45 min) are used to discuss selected solutions. Regular participation in the exercises is an efficient way to understand the concepts relevant for the final exam.

Lecture notes

The lecture slides are provided as handouts - including notes and literature sources - to registered students only. All material is to be found on the Moodle platform. More details during the first lecture

363-0541-02L Systems Dynamics and Complexity (Additional Cases) W+ 1 credit F. Schweitzer

Only for Mechanical Engineering BSc.

Abstract

This module is an addition to the course Systems Dynamics and Complexity. It offers additional study cases to MAVT Bachelor students who enroll in the main course.

Objective

MAVT Bachelor students learn how to develop and analyze more sophisticated systems dynamics models from different areas, e.g. from biology (population dynamics, cooperation), management (inventory modeling, technology adoption and economics (supply and demand, investment and consumption), to name but a few. The goal is to apply analytical and numeric techniques to gain a deeper understanding of the dynamics of complex systems.
1. Modelling path dependence and formation of standards
- Why do clocks go clockwise? Why do people in most nations drive on the right? Why do nearly all computer keyboards have the QWERTY layout, even though it is more inefficient compared to DVORAK? It turns out that many real-world processes are path dependent, i.e. small random events early in their history determine the ultimate end state, even when all end states are equally likely at the beginning. Students will learn how to model such processes, to understand the feedback mechanisms that lead to path dependence. As a case in point, we will study the ‘war’ between the Betamax and the VHS standards.

2. Optimal migration as promoter of cooperation
- Mechanisms to promote cooperative behaviour is a vibrant research topic in various fields - economics, evolutionary biology and management science to name but a few. Students will be introduced to one such mechanism - migration. They will develop and analyse a macroscopic model to study how the rate of migration affects the long-term cooperation rate in a population.

3. Information transfer
- Information flow in a social system (e.g. about the location of resources or appearance of a competitor) is an important component of group living. For example, it is well known that ants can achieve remarkable feats in finding an optimal route to a food patch through pheromone trails. The goal of this study case is to model information transfer in such systems by investigating the dynamics of trail formation in ants. The students will learn that the complexity in navigating to a food source may nevertheless be explained as a simple dynamical system with one control parameter only.

4. Decisions in social societies
- In many situations individuals have to decide between two or more options. Such decisions often have a profound impact on the system as a whole, especially regarding group cohesion. Group cohesion is preferred, as individuals can benefit from living in groups, yet it may not be the underlying reason behind individual choices. In this case, students will develop and extend a macroscopic model of an animal social system faced with a decision to choose a new home, and identify the conditions which promote group cohesion versus group splitting.

5. Antigenic variation of HIV
- One of the characteristic traits of HIV is that a host can be a carrier and a transmitter of the virus without experiencing symptoms for up to 10 years. This case is concerned with finding the mechanism of HIV disease progression. The students will develop a general population-based model for the interaction of an infectious agent with the host immune system. The model is applicable to a variety of infectious agents, ranging from acute lethal infections to chronic illness. Through analysing and simulating the model, the students will understand how the HIV virus interacts with the host and how the mutation rate of the virus is ultimately responsible for this long asymptomatic period.

6. Compartmental models in epidemiology
- Many diffusive processes in social systems, such as epidemics, can be understood as a result of the interaction between a few groups (compartments) of individuals. The most common example is to divide a population into those who are susceptible (S) to a disease, those who are infected (I), and those who have recovered (R) and are immune, and to model their interactions. These so called SIR models find wide application in studying non-biological diffusive processes, e.g. spread of technological innovations, fads, internet memes etc. In this study case, students will become familiar with the basic components of an SIR model and the conditions under which a disease can cause the outbreak of an epidemic. Students will extend the basic model to investigate more realistic scenarios relevant to e.g. different vaccination strategies.

Lecture notes
Will be provided

363-0565-00L Principles of Macroeconomics

<table>
<thead>
<tr>
<th>W</th>
<th>3 credits</th>
<th>2V</th>
<th>J.E. Sturm</th>
</tr>
</thead>
</table>

Objective
This course examines the behaviour of macroeconomic variables, such as gross domestic product, unemployment and inflation rates. It tries to answer questions like: How can we explain fluctuations of national economic activity? What can economic policy do against unemployment and inflation. What significance do international economic relations have for Switzerland?

Content
This course introduces the fundamentals of macroeconomic theory and explain their relevance to everyday economic problems.

Lecture notes
The course webpage (to be found at https://moodle-app2.let.ethz.ch/course/view.php?id=2467) contains announcements, course information and lecture slides.

Literature

We advise you to also buy access to Apila. This internet platform will support you in learning for this course. To save money, you should buy the book together with Apila. This is sold as a bundle (ISBN: 9781473715998).

Besides this textbook, the slides and lecture notes will cover the content of the lecture and the exam questions.

Design, Mechanics and Materials

Focus Coordinator: Prof. Kristina Shea

In order to achieve the required 20 credit points for the Focus Specialization Design, Mechanics and Material you are free to choose any of the courses offered within the focus and are encouraged to select among those recommended. If you wish to take one of the Master level courses, you must get approval from the lecturer.

Number Title Type ECTS Hours Lecturers
151-0360-00L Procedures for the Analysis of Structures W+ 4 credits 2V+1U G. Kress

Abstract
Basic theories for structure integrity calculations are presented with focus on strength, stability, fatigue and elasto-plastic structural analysis.

Theories and models for one dimensional and planar structures are presented based on energy theorems.

Basic principles applied in structural mechanics. Introduction to the theories of planar structures. Development of an understanding of the relationship between material properties, structural theories and design criteria.

Inhalt:
1. Basic problem of continuum mechanics and energy principles: structural theories, homogenization theories; finite elements; fracture mechanics.
3. Strength of material theories and material properties: ductile behaviour, plasticity, von Mises, Tresca, principal stress criterion; brittle behaviour; viscoplastic behaviour, creep resistance.
4. Structural design: fatigue and dynamic structural analysis.
Lecture notes

151-0364-00L  Lightweight Structures Laboratory  W  4 credits  5A  M. Zogg, P. Ermanni

Abstract
Teams of 2 to 4 students have to design, size, and manufacture a lightweight structure complying with given specifications. A prototype as well as an improved component will be tested and assessed regarding to design and to structural mechanical criteria.

Objective
To develop the skills to identify and solve typical problems of the structure mechanics on a real application. Other important aspects are to foster team work and team spirit, to link theoretical knowledge and practice, to gather practical experiences in various fields related to lightweight structures such as design, different CAE-methods and structural testing.

Content
The task of each team (typically 2-4 students) is the realization of a load-carrying structure with selected materials. The teams are free to develop and implement their own ideas. In this context, specified requirements include information about loads, interfaces to the surrounding structures.

The project is structured as described below:
- Concept development
- design of the component including FEM simulation and stability checks
- manufacturing and structural testing of a prototype
- manufacturing and structural testing of an improved component
- Report

The project work is supported by selected teaching units.

handouts for selected topics are available


Lecture notes

151-0509-00L  Microscale Acoustofluidics  W  4 credits  3G  J. Dual

Number of participants limited to 30.

Abstract
In this lecture the basics as well as practical aspects (from modelling to design and fabrication) are described from a solid and fluid mechanics perspective with applications to microsystems and lab-on-a-chip devices.

Objective
Understanding acoustophoresis, the design of devices and potential applications

Content
Linear and nonlinear acoustics, foundations of fluid and solid mechanics and piezoelectricity, Gorkov potential, numerical modelling, acoustic streaming, applications from ultrasonic microrobots to surface acoustic wave devices

Lecture notes

Prerequisites / notice
Solid and fluid continuum mechanics. Notice: The exercise part is a mixture of presentation, lab session and hand in homework.

151-0524-00L  Continuum Mechanics I  W  4 credits  2V+1U  E. Mazza

Abstract
The lecture deals with constitutive models that are relevant for design and calculation of structures. These include anisotropic linear elasticity, linear viscoelasticity, plasticity, viscoplasticity. Homogenization theories and laminate theory are presented. Theoretical models are complemented by examples of engineering applications and experiments.

Objective
Basic theories for solving continuum mechanics problems of engineering applications, with particular attention to material models.

Content

Lecture notes
yes

151-0532-00L  Nonlinear Dynamics and Chaos I  W  4 credits  2V+2U  G. Haller, F. Kogelbauer

Abstract
Basic facts about nonlinear systems; stability and near-equilibrium dynamics; bifurcations; dynamical systems on the plane; non-autonomous dynamical systems; chaotic dynamics.

Objective
This course is intended for Masters and Ph.D. students in engineering sciences, physics and applied mathematics who are interested in the behavior of nonlinear dynamical systems. It offers an introduction to the qualitative study of nonlinear physical phenomena modeled by differential equations or discrete maps. We discuss applications in classical mechanics, electrical engineering, fluid mechanics, and biology. A more advanced Part II of this class is offered every other year.

Content
(1) Basic facts about nonlinear systems: Existence, uniqueness, and dependence on initial data.
(2) Near equilibrium dynamics: Linear and Lyapunov stability
(3) Bifurcations of equilibria: Center manifolds, normal forms, and elementary bifurcations
(4) Nonlinear dynamical systems on the plane: Phase plane techniques, limit sets, and limit cycles.
(5) Time-dependent dynamical systems: Floquet theory, Poincare maps, averaging methods, resonance

Lecture notes
The class lecture notes will be posted electronically after each lecture. Students should not rely on these but prepare their own notes during the lecture.

- Prerequisites: Analysis, linear algebra and a basic course in differential equations.
- Exam: two-hour written exam in English.
- Homework: A homework assignment will be due roughly every other week. Hints to solutions will be posted after the homework due dates.

151-0731-00L  Forming Technology I - Basic Knowledge  W  4 credits  2V+2U  P. Hora

Abstract
The fundamentals of forming technology are presented to Mechanical, Production and Material Engineers. The content of the lecture is: Overview of manufacturing with forming techniques, deformation specific description of material properties and their experimental measurement, material laws, residual stresses, heat balance, tribological aspects of forming processes, workpiece and tool failure.

Objective
Forming technology represents with its 70% global share in manufactured metal volume with respect to yield and cost, the most important manufacturing process in metal-working industries. Typical applications of forming technology range from the manufacturing of sheet metal components in auto bodies to applications in food and pharma packaging, fabrication of implants in medical technologies and to the fabrication of leads in microelectronic components. This course introduces the fundamentals which are essential to evaluate metal-forming processes and its industrial applications. This includes, together with the acquisitions of the most important forming processes, the characterization of plastic material behavior and manufacturing limits.

Content
Overview of the most important processes of metal-forming technology and its field of applications, characterization of the plastic metal-forming behavior, basic principles of plasto-mechanical calculations, metal-forming residual stresses, thermo-mechanical coupling of metal-forming processes, influence of tribology, Work piece failure through cracking and folding, tool failure through rupture and mechanical wear, metal-forming tools, sheet forming and massive forming processes, handling systems, metal-forming machinery.

Lecture notes
ja

151-0735-00L  Dynamic Behavior of Materials and Structures  W  4 credits  2V+2U  D. Mohr
### Abstract
Lectures and computer labs concern the modeling of the deformation response and failure of engineering materials (metals, polymers and composites) subject to extreme loadings during manufacturing, crash, impact and blast events.

### Objective
Students will learn to apply, understand and develop computational models of a large spectrum of engineering materials to predict their dynamic deformation response and failure in finite element simulations. Students will become familiar with important dynamic testing techniques to identify material model parameters from experiments. The ultimate goal is to provide the students with the knowledge and skills required to engineer modern multi-material solutions for high performance structures in automotive, aerospace and naval engineering.

### Content
Topics include viscoelasticity, temperature and rate dependent plasticity, dynamic brittle and ductile fracture; impulse transfer, impact and wave propagation in solids; computational aspects of material model implementation into hydrocodes; simulation of dynamic failure of structures;

### Literature
Various books will be recommended covering the topics discussed in class

### Prerequisites / notice
Course in continuum mechanics (mandatory), finite element method (recommended)

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**151-3201-00L**

<table>
<thead>
<tr>
<th>Studies on Engineering Design</th>
<th>W+</th>
<th>3 credits</th>
<th>6A</th>
<th>K. Shea, P. Ermann, M. Meboldt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>This course introduces students to the exciting world of Engineering Design research, which crosses disciplines and requires a variety of skills. Each student identifies a topic in Engineering Design for further investigation, either based on those proposed or a new, agreed topic.</td>
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<tr>
<td>Objective</td>
<td>Students gain their first knowledge of Engineering Design research and carry out their first, independent scientific study. Students learn how to read scientific literature and critically analyze and discuss them, gain hands-on experience in the area and learn how to document their work concisely through a report and short presentation.</td>
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<tr>
<td>Content</td>
<td>Students identify 5-10 journal articles, or scientifically equivalent, in consultation with the supervisor and can define a small, related project in the area to gain hands-on experience. In the beginning of the semester, students develop with the supervisor a 2-page proposal outlining the objective of the study, tasks to be carried out and a brief time plan for the work. Once agreed, the project starts resulting in a report combining the state-of-art literature review and project results, if carried out.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>The students work independently on a study of selected topics in the field of Engineering Design. They start with a selection of the topic, identify scientific papers for the literature research and can define a small, related project. The results (e.g. state-of-the-art literature review and small project results where defined) are evaluated with respect to predefined criteria.</td>
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**151-3203-00L**

<table>
<thead>
<tr>
<th>Grand Challenges in Engineering Design</th>
<th>W+</th>
<th>1 credit</th>
<th>3S</th>
<th>P. Ermann, M. Meboldt, K. Shea</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>The course is structured in three main blocks, each of them addressing a specific grand challenge in engineering design. Each block is composed of an introductory lecture and two to three invited talks, considering a good mix between speakers coming from academia and industry. Each talk is introduced and moderated by the students.</td>
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<tr>
<td>Objective</td>
<td>The aim of the course is to introduce students to the engineering design research and practice in a multitude of Mechanical Engineering disciplines and convey knowledge from both academia and industry about state of the art methods, tools and processes.</td>
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<tr>
<td>Content</td>
<td>The students are exposed to a variety of topics in the field of Engineering Design. Topics are bundled in three main grand challenges and include an introductory lecture held by one of the responsible Professors and 2-3 invited talks of 45 min. each, addressing specific issues. The success of the course is largely dependant on active involvement of the students. Accordingly, a small group of students (1-3) is asked to introduce and moderate each external talk. The group will therefore gather adequate information about the speaker and topic, read and synthesize relevant documents and scientific papers, prepare questions to motivate the interaction with the audience and summarize, at the end of the lecture, the discussed points and outcome.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Students take this course in parallel to the Lecture &quot;Grand Challenges in Engineering Design&quot;. A general meeting will be held in the beginning of the semester to propose topics for the studies. Studies are carried out individually and can be the pre-study for a Bachelor thesis.</td>
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**151-3207-00L**

<table>
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<tr>
<th>Lightweight</th>
<th>W+</th>
<th>4 credits</th>
<th>4G</th>
<th>P. Ermann</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>The elective course Lightweight includes numerical methods for the analysis of the load carrying and failure behavior of lightweight structures, as well as construction methods and design principles for lightweight design.</td>
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<tr>
<td>Objective</td>
<td>The goal of this course is to convey substantiated background for the understanding and the design and sizing of modern lightweight structures in mechanical engineering, vehicle and airplane design.</td>
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<tr>
<td>Content</td>
<td>Lightweight design</td>
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<tr>
<td></td>
<td>Thin-walled beams and structures</td>
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<td></td>
<td>Instability behavior of thin walled structures</td>
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<td></td>
<td>Reinforced shell structures</td>
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<td></td>
<td>Load introduction in lightweight structures</td>
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<td></td>
<td>Joining technology</td>
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<tr>
<td></td>
<td>Sandwich design</td>
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<tr>
<td>Lecture notes</td>
<td>Offered in English and German</td>
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**151-3209-00L**

<table>
<thead>
<tr>
<th>Engineering Design Optimization</th>
<th>W</th>
<th>4 credits</th>
<th>4G</th>
<th>K. Shea, T. Stankovic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>The course covers fundamentals of computational optimization methods in the context of engineering design. It develops skills to formally state and model engineering design tasks as optimization problems and select appropriate methods to solve them.</td>
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<tr>
<td>Objective</td>
<td>The lecture and exercises teach the fundamentals of optimization methods in the context of engineering design. After taking the course students will be able to express engineering design problems as formal optimization problems. Students will also be able to select and apply a suitable optimization method given the nature of the optimization model. They will understand the links between optimization and engineering design in order to design more efficient and performance optimized technical products. The exercises are MATLAB based.</td>
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<tr>
<td>Lecture notes</td>
<td>available on Moodle</td>
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**327-0501-00L**

<table>
<thead>
<tr>
<th>Metals I</th>
<th>W</th>
<th>3 credits</th>
<th>2V+1U</th>
<th>R. Spolenak</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>Repetition and advancement of dislocation theory. Mechanical properties of metals: hardening mechanisms, high temperature plasticity, alloying effects. Case studies in alloying to illustrate the mechanisms.</td>
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<tr>
<td>Objective</td>
<td>Repetition and advancement of dislocation theory. Mechanical properties of metals: hardening mechanisms, high temperature plasticity, alloying effects. Case studies in alloying to illustrate the mechanisms.</td>
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</table>

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Data: 06.03.2019 12:57  Autumn Semester 2016  Page 1025 of 1571
Content

Dislocation theory:
- Properties of dislocations, motion and kinetics of dislocations, dislocation-dislocation and dislocation-boundary interactions, consequences of partial dislocations, sessile dislocations

Hardening theory:
- a. solid solution hardening: case studies in copper-nickel and iron-carbon alloys
- b. particle hardening: case studies on aluminium-copper alloys

High temperature plasticity:
- thermally activated glide
- power-law creep
- diffusional creep: Coble, Nabarro-Herring
- deformation mechanism maps
- Case studies in turbine blades
- superplasticity
- alloying effects

Literature

Gottstein, "Physikalische Grundlagen der Materialkunde," Springer Verlag
Haasen, "Physikalische Metallkunde," Springer Verlag
Rösler/Harders/Bäker, "Mechanisches Verhalten der Werkstoffe," Teubner Verlag
Hull/Bacon, "Introduction to Dislocations," Butterworth & Heinemann

327-1204-00L Materials at Work I W 4 credits 4S R. Spolenak, E. Dufresne, R. Koopmans

Abstract

This course attempts to prepare the student for a job as a materials engineer in industry. The gap between fundamental materials science and the materials engineering of products should be bridged. The focus lies on the practical application of fundamental knowledge allowing the students to experience application related materials concepts with a strong emphasis on case-study mediated learning.

Objective

Teaching goals:

- to learn how materials are selected for a specific application
- to understand how materials around us are produced and manufactured
- to understand the value chain from raw material to application
- to be exposed to state of the art technologies for processing, joining and shaping
- to be exposed to industry related materials issues and the corresponding language (terminology) and skills
- to create an impression of how a job in industry "works", to improve the perception of the demands of a job in industry

Content

This course is designed as a two semester class and the topics reflect the contents covered in both semesters.

Lectures and case studies encompass the following topics:

- Strategic Materials (where do raw materials come from, who owns them, who owns the IP and can they be substituted)
- Materials Selection (what is the optimal material (class) for a specific application)
- Materials systems (subdivisions include all classical materials classes)
  - Processing
  - Joining (assembly)
  - Shaping
- Materials and process scaling (from nm to m and vice versa, from mg to tons)
- Sustainable materials manufacturing (cradle to cradle)
- Recycling (Energy recovery)

After a general part of materials selection, critical materials and materials and design four parts consisting of polymers, metals, ceramics and coatings will be addressed.

In the fall semester the focus is on the general part, polymers and alloy case studies in metals. The course is accompanied by hands-on analysis projects on everyday materials.

Literature

- Manufacturing, Engineering & Technology
  - Serope Kalpakjian, Steven Schmid
  - ISBN: 978-0131489653

Prerequisites / notice

- Profound knowledge in Physical Metallurgy and Polymer Basics and Polymer Technology required (These subjects are covered at the Bachelor Level by the following lectures: Metalle 1, 2; Polymere 1,2)

Engineering Tools IV

The participation at the Engineering Tools course is mandatory. If you miss any classes, no credit points will be awarded. For exemptions you have to contact the lecturer of the course.

Number Title Type ECTS Hours Lecturers

151-0015-10L Engineering Tool IV: Experimental Modal Analysis W 0.4 credits 1K F. Kuster, K. Wegener

Abstract

Measuring- and analysis-methods for the determination of transfer functions of mechanical structures. Evaluation and preparation of the measured data for visualisation and interpretation of the dynamic behaviour.

Objective

Introduction into the practical application of measuring- and analysis-methods for determination of transfer functions of mechanical structures. Evaluation and preparation of the measured data for visualisation and interpretation of the dynamic behaviour.

Content

Acquaintance with the acceleration- and force-sensors, measurement of transfer functions of mechanical structures, determination and description of modes of vibration by means of practical examples, introduction into the vibration theory and its fundamental terms, discrete oscillator.

Prerequisites / notice

Only one course can be chosen per semester.

Lecture notes

Yes, distribution in the course (CHF 20.-)

Literature

David Ewins, Modal Testing: Theory and Practice

In the practical part of the course the participants will make measurements on structures and then analyse them for eigenfrequencies and modes of vibrations.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Type</th>
<th>Credits</th>
<th>Module</th>
<th>Instructor(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0017-10L</td>
<td>Engineering Tool IV: Introduction to Structural Testing</td>
<td>W</td>
<td>0.4</td>
<td>1K</td>
<td>P. Ermanni</td>
</tr>
<tr>
<td></td>
<td>Does not take place this semester.</td>
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<td>All Engineering Tool courses are for MAVT-Bachelor students only.</td>
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<tr>
<td></td>
<td>Eligible to students of Focus Specialization &quot;Structure Mechanics&quot;.</td>
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<td>Number of participants limited to 18.</td>
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<td>Only one course can be chosen per semester.</td>
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<tr>
<td></td>
<td>Abstract</td>
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<tr>
<td></td>
<td>Structural testing is a very broad and interdisciplinary field. Taking into</td>
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<td>account the limited time, the scope of this tool-course is to provide a</td>
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<td>general introduction to structural testing, with particular attention to</td>
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<td>theoretical and practical aspects of strain gage measurements. Furthermore</td>
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<td>a real engineering case is presented and discussed in small groups.</td>
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<td></td>
<td>Objective</td>
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<td>Introduction to structural testing. Focus lies in measurements with strain</td>
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<td>gages. Selected case-studies help the participant to better understand critical</td>
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<td>issues and possible solutions.</td>
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<td>Introduction to Structural Testing (Theory)</td>
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<td>Case Study: Problem presentation, development of possible solutions,</td>
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<td>presentation and discussion in the lab.</td>
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<tr>
<td>151-0024-10L</td>
<td>Engineering Tool IV/V: Digital Automotive Plant Simulation Methods</td>
<td>W</td>
<td>0.4</td>
<td>1K</td>
<td>P. Hora</td>
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<td>All Engineering Tool courses are for MAVT-Bachelor students only.</td>
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<td>Application of the special-purpose simulation and planning tool AUTOFORM for</td>
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<td>the digital modelling of manufacturing processes in sheet metal forming</td>
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<td>(car panels production). Introduction to virtual methods. Demonstration of</td>
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<td>industrial examples.</td>
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<td>Modern FEM tools for virtual modeling of forming processes. The course</td>
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<td>provides following concepts:</td>
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<td>- Fundamentals of non linear Finite-Element-Methods (FEM)</td>
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<td>- The development of the virtual model</td>
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<td>- Material properties</td>
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<td>- Tool and contact conditions</td>
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<td>- Process evolution</td>
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<td>- Introduction to AUTOFORM software</td>
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<td>- Independent simulation exercises</td>
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<td>The simulation tool AUTOFORM allows the design of metal working</td>
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<td>manufacturing processes, optimization and additionally the possibility to</td>
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<td>examine the expected process robustness of fabrication processes. The methods</td>
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<td>are exemplified and the application of the software is exercised in the scope</td>
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<td>Lecture notes</td>
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<td>Course documentation</td>
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<td>maximal number of participants: 25</td>
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<tr>
<td>151-0025-10L</td>
<td>Engineering Tool IV: Introduction to CAM and Motion Simulation</td>
<td>W</td>
<td>0.4</td>
<td>1K</td>
<td>M. Schmid, K. Wegener</td>
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<td>All Engineering Tool courses are for MAVT-Bachelor students only.</td>
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<td>Introduction of integrated CAD applications CAM (Computer Aided Manufacturing,</td>
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<td>Motion Simulation (Kinematics)</td>
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<td>The participants learn the possibilities of integrated CAD applications. The</td>
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<td>goal is to understand the procedures and the most important functions of</td>
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<td>these applications.</td>
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<td>CAM: Introduction to CAM, practical examples for a 3-axle milling machine</td>
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<td>Motion simulation (kinematic): Introduction to the possibilities of the</td>
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<td>movement simulator.</td>
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<td>Voraussetzungen:</td>
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<td>- CAD-Grundkenntnisse in NX (CAD 1. Sem.)</td>
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<td>- Eigenes Laptop mit installierter, lauffähiger Software NX für die</td>
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<td>Durchführung der Übungen (Siemens NX kann über Stud-IDES kostenlos bestellen).</td>
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<td>151-0027-10L</td>
<td>Engineering Tool IV/V: Programming with LabView</td>
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<td>0.4</td>
<td>1K</td>
<td>L. Prochazka, T. Rösgen</td>
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<td>An introduction is given to the LabView programming environment. The basic</td>
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<td>concepts of &quot;virtual instruments&quot; and data flow programming are presented.</td>
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<td>acquisition module is used to demonstrate basic concepts of interface</td>
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<td>management and data acquisition.</td>
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<td>Introduction to the LabView programming environment. Understanding of</td>
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<td>fundamental concepts: virtual instruments, data flow programming, control</td>
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<td>structures, data types etc. Development of basic programming skills using</td>
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<td>in-class exercises on computers.</td>
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<td>151-0030-10L</td>
<td>Engineering Tool IV: Modelling and Servo Axis Control of Machine Tool</td>
<td>W</td>
<td>0.4</td>
<td>1K</td>
<td>O. Zirn, K. Wegener</td>
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<td>Manipulators</td>
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<td>structures, data types etc. Development of basic programming skills using</td>
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<td>in-class exercises on computers.</td>
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Prerequisites: Matlab skills; your laptop with Matlab/Simulink may be useful.

Number of participants limited to 30.

Abstract
This course covers model building and the applied stimulation of (power-assisted axles on production machinery using MATLAB/Simulink and provides a practical example of how drive parameters may be set up, how through simulation an optimal axis design can be developed and which characteristics of a production machine can be reliably estimated in advance.

Objective
The students are able to model servo axes considering all relevant components and process influences to simulate the achievable productivity.

Content
1. Introduction, complexity levels in model building for production machines.
2. Complexity level 1: Power-assisted axles, transmission systems, general structural model.
3. Complexity level 2: Robotic models, kinematics and dynamics
4. Complexity level 3: Multi-body models and finite element models
5. Regulation of power-assisted axles, cascade regulator and state regulator extensions.
7. Master slave and gantry operations with dispersed servo drive.
8. Simulation examples in MATLAB/Simulink ((Swivel axle, 5-axle milling machine, parallel kinematic milling machine, industrial robots).

Lecture notes
Prerequisites / notice
Prerequisite is knowledge of Matlab.

151-0032-10L  Engineering Tool IV: Introduction to the Methods of Six Sigma Quality Control and Lean Production
All Engineering Tool courses are for MAVT-Bachelor students only.

Number of participants limited to 36.

Abstract
The course introduces to Six Sigma quality management and quality improvement, which aims to reduce process variation and to sustain process capability. It introduces also to the Lean production principles, aiming to reduce waste within the processes as well as aiming to a customer taked pull-production.

Objective
The participant gets an overview to the Operational Excellence philosophy and the working methods of these two approches. He learns the most important tools and the interaction of these two approaches.

Content
1. Understanding the changing environment
   - Globalization, customer requirements, production systems
   - Six Sigma quality philosophy
   - Lean Manufacturing and TPS (Toyota Production System)
2. Quality management with Six Sigma
   - What is Six Sigma
   - DMAIC problem solving cycle
   - Use of different control charts
   - Evaluate process capability, DPMO, Cp, Cpk, Taguchi
   - Cause-effect diagram
   - Control plan and sustainability, PDCA
3. Introduction to the Lean approach
   - Lean goals and principles
   - A3 project management
   - The 9 types of waste
   - Value add and non value add activities
   - The 8 Lean-Tools, whereof 4
   - SS workplace organization
   - Value stream mapping (excercise), Little's law
   - Continuous flow vs batch
   - Pull Principles, Kanban, DBR
   - Cell design
   - Linear Programming
4. Lean and Six Sigma in practice
   - How fits Lean and Six Sigma together
   - Continuous Improvement/Kaizen organization
   - Change-Management, risks
   - Inspire deployment approach

Lecture notes
Notes will be distributet.

151-0044-10L  Engineering Tool IV/V: Computational Fluid Dynamics (CFD) with OpenFoam
All Engineering Tool courses are for MAVT-Bachelor students only.

Number of participants limited to 40.

Abstract
Participants will learn to use the open source simulation software OpenFOAM on a user level (i.e. to conduct classical CFD studies). We will also introduce the students into programming with OpenFOAM so they will be able to implement additional equations into existing solvers.

Objective
Participants will learn to use the open source simulation software OpenFOAM on a user level (i.e. to conduct classical CFD studies). We will also introduce the students into programming with OpenFOAM so they will be able to implement additional equations into existing solvers.
OpenFOAM is a very professional open-source simulation package which is freely (CHF 0.-) available under the GNU General Public License (GPL). It consists of a vast C++ library, many different applications and additional tools. Although most of the existing applications are flow solvers, OpenFOAM can be used in many different areas, as varied as solid dynamics, electromagnetics or pricing of financial options.

Most users make only use of the included applications. One particular strength of OpenFOAM, however, is that new applications and even extensions of the library can be developed in a rather compact and elegant way.

Prerequisites / notice
Knowing C++ or at least having some experience in another programming language will be of an advantage but is not strictly required to follow this course.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Type</th>
<th>Instructor(s)</th>
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</thead>
<tbody>
<tr>
<td>151-0057-10L</td>
<td>Engineering Tool IV/V: Systems Engineering for Project Work</td>
<td>0.4</td>
<td>W</td>
<td>R. Züst, K. Wegener</td>
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<tr>
<td>151-0059-10L</td>
<td>Engineering Tool IV: CAD-Methodology and PDM-Technology in the Focus Project</td>
<td>0.4</td>
<td>W</td>
<td>M. Schütz, K. Shea</td>
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</table>

Number of participants limited to 60.

Number of participants limited to 25.

Only one course can be chosen per semester.

1. Nachmittag:
- Einstieg ins Systems Engineering; Entstehung, Inhalt und Werdegang; Voraussetzungen (anspruchsvolle Fragestellungen, institutionelle Einbettung, Systemdenken und heuristische Prinzipien);
- Grundstruktur und Inhalt Lebensphasenmodell; Grundstruktur in Inhalt Problemlösungszyklus;
- Zusammenspiel von Lebensphasenmodell & Problemlösungszyklus in Projekten
2. Nachmittag:
- Situationsanalyse: Systemanalyse (Systemabgrenzung (gestaltbarer Bereich, relevante Bereiche des Umsystems)), Methoden der Analyse und Modellierung, Umgang mit Vernetzung, Dynamik und Unsicherheit; wichtigste Methoden der IST-Zustands- und Zukunftsanalyse),
- Zielformulierung (wichtigste Methoden der Zielformulieren),
- Konzeptsynthese und Konzeptanalyse (u.a. Kreativität; wichtigste Methoden der Synthese und Analyse),
3. Nachmittag:
- Beurteilung (u.a. Methoden für mehrdimensionale Kriterienvergleich, z.B. Kosten-Wirksamkeits-Analyse); Diskussion von Planungsbempielen
- Diskussion von Planungsbeispielen: Analyse des Methodeneinsatzes, Entwickeln alternativer Vorgehensschritte und Auswahl des zweckmässigsten Vorgehens

Lecture notes
Zusammenfassung wird in elektronischer Form abgegeben;
Lehrbuch: die Grundlagen sind in einem Lehrbuch beschrieben
Anwendungsbeispiele: 8 konkrete Anwendungen von Systems Engineering sind in einem Case-Book beschrieben

Zielpublikum: Der Kurs richtet sich insbesondere an Personen, welche anspruchsvolle Projekte initiieren, planen und leiten müssen
Lernmethode: Der Stoff wird mittels kurzer Vorträge vermittelt und an kurzen Fallbeispielen/Übungen vertieft. Zudem sollen die Lehrinhalte durch selbständiges Studium der Lehrmittel vertieft bzw. ergänzt werden.

The participants learn about the procedures and tools that are necessary to develop technical products. The focus is on computer-based design and development and the management in an integrated software environment.

The participants will deepen their existing CAD knowledge and learn new PDM knowledge, so that these may be directly applied and used in the focus project.
- CAD refresh (Modelling, Assembling, Drafting, etc.) and CAD mythology for construction (Top-Down modelling)
- Introduction to the Team Center (Siemens PDM System)
- TeamCenter data flow, in particular the process of creating and managing new Items and Parts, the approval procedure and creating different versions of Parts

The participants will learn and experiment with procedures by working on concrete examples so that they will subsequently be able to begin with independent product construction.

The following topics will be dealt with in depth in the lectures supporting the focus project (Praxiskurs): CAD-Methodology, FE calculations, motion simulation and construction methodology.
Content
1. Afternoon: CAD refresher and top down modelling
   - To refresh already existing knowledge of CAD functionality.
     i. Sketch and features as well as manipulation and optimizing models.
     ii. Assembling
     iii. Drafting
     iv. Organisation, working methods, conventions.
   - Top down modelling CAD
     i. Introduction to top down modelling and concept modelling

2. Afternoon: Introduction to TC (Team Center)
   - Introduction: Short introduction to PLM (What is the idea of PLM? PLM is more than the pure management of drawings!).
     - Lesson 1 - Team Center Rich Client Interface
     - Lesson 2 - TC data types
     - Lesson 3 - Construction from data in TC
     - Lesson 4 - Searching for and examining data.

3. Afternoon: TC application
   - Lesson 5 - Unit lists (PSE)
   - Lesson 6 - Cross-referencing
   - Lesson 7 - Data release
   - Lesson 8 - Product data examination

Prerequisites / notice
- at least two students of a Focus-Team should sign in for this course, if teh use of Siemens TeamCenter PLM is given for the Team.
- only for students participating in a Focus Project in the same semester
- not more than 25 students

151-0061-10L Engineering Tool IV/V: Scientific Writing with LaTeX and Vector Graphics
All Engineering Tool courses are for MAVT-Bachelor students only.

Number of participants limited to 40.

Abstract
This course provides insights into the structure and compilation of scientific papers and publications using LaTeX as well as open source software for image editing and the creation of vector graphics. LaTeX is a typesetting tool that separates text format and layout. It is widely used for reports and publications in the scientific domain.

Objective
By looking at specific examples during class you will obtain an overview on composing scientific papers (e.g. bachelor theses, semester theses, master theses) using LaTeX and acquire the most important commands to typeset complex formulas, tables and graphics.

Content
-- layout of scientific reports
-- writing with LaTeX (structure, formatting, formulas, tables, graphics, references, table of contents, hyperlinks, packages) based on a template for bachelor/ semester/ master theses.
-- graphic design and illustration using open source software and Matlab
-- including PDF files in the report (project description, data sheets)
-- managing bibliography databases

Literature
http://www.relab.ethz.ch/education/courses/engineering-tools-latex.html

Prerequisites / notice
Particular:
The exercises will be done on your personal laptop (at least one laptop per two students). The entire LaTeX package, Inkscape and Gimp should be installed in advance.

151-0062-10L Engineering Tool V: Computer-Aided Design Methods
All Engineering Tool courses are for MAVT-Bachelor students only.

Number of participants limited to 25.

Abstract
Participants will learn about the Computer-Aided Design fundamentals and methods that are necessary to model complex technical products. The focus will be placed on feature-based and parametric modelling that is common to all modern CAD tools used in mechanical engineering design.

Objective
CAD knowledge and skills will be further developed to enable students to recognize both the advantages and the limitations of current Computer-Aided Design tools. Examples of how to build feature-based and parametric models including design automation will be given along with common pitfalls. After taking the course students should be able to independently create effective feature-based and parametric models of mechanical parts.

Content
1. CAD Methods and Feature-Based Design (2 afternoons):
   * CAD in the context of the design process
   * Feature types and their relation to mechanical design
   * Strategies for building feature-based assemblies
   * Integration of digital part libraries
   * Common issues and difficulties with feature interaction
2. CAD and Parametric Modelling (1 afternoon):
   * Designing and building parametric models
   * Design automation to create design variants
   * Common issues and difficulties with parametric modelling

151-0067-10L Engineering Tool IV: Sketching and Visualization of Technical Concepts
All Engineering Tool courses are for MAVT-Bachelor students only.

Number of participants limited to 20.

Abstract
This course is offered by the Design and Technology Lab Zurich. Effective visualizations of ideas are essential to communicate technical concepts. This course focusses on the basics of a coherent draft design through forms of sketches using various simple techniques.

Objective
Mastering various simple techniques for the visualization of technical ideas.
Basics in: Perspective, line drawing, proportions, implementation of the plan views of perspective will be distributed. It requires no further books.

Max 20 participants

Material: Paper and pens

151-0091-10L  Engineering Tool IV: Scientific Writing  W  0.4 credits  1K  U. Brändle, M. Paschke

All Engineering Tool courses are for MAVT-Bachelor students only.

Number of participants limited to 50.

Participants acquire scientific writing basics as a core competency to communicate with different audiences. They apply important methods and tools to refine a scientific question, research and evaluate the necessary information, quote and paraphrase, and to plan the structure of their own text.

Students are able to:
- derive and structure ideas for a text starting from a scientific question using simple techniques
- find literature sources, check their relevance and completeness, organize them with a suitable tool and cite correctly
- apply a reading technique for summarizing a text
- distinguish plagiarism, quotation and paraphrase in texts using the presented criteria and correctly cite or paraphrase external content
- use and cite information from the Internet correctly
- plan and structure specialized texts that refer to different target groups

KURSPROGRAMM
1. Halbtag: Recherchieren und Lesen
   (1) Auf Vorhandenem aufbauen
   (2) Ideen generieren
   (3) Recherchieren
   (4) Quellen beurteilen

2. Halbtag: Paraphrasieren nicht Plagiarisieren (1 Nachmittag, 3 Stunden, 15 min Pause)
   (1) Verantwortlich sein: der Wert des eigenständigen Denkens
   (2) Regeln und Anweisungen: was ist ein Plagiat, wie wird es an der ETHZ gehandhabt, Eigenständigkeitserklärung, Prüfwerkzeuge
   (3) Zitieren und Paraphrasieren - so geht's
   (4) Paraphrasieren oder Zitieren?
   (5) Lesen und verstehen
   (6) Vom Umgang mit Quellen und Material aus dem Internet

3. Halbtag: Einen Text strukturieren und generieren
   (1) Verwendung einer Standard-Textstruktur als Vorlage für ein Outline
   (2) Ein Grundgerüst mit Abschnitten erstellen
   (3) Eine Textabschnitt schreiben

LEHRFORMEN
- Inputs: Kurzvorträge
- Übungen: während des Nachmittags selbständig in Moodle anhand von Fallstudien
- Feedback und Diskussion: Lösungen der Studierenden via Moodle an Dozentenbeamer und Besprechen durch die Dozierenden

Zu allen Inhaltssteilen gibt es Übungsteile in Moodle, für die ein Laptop mit funktionierendem Internetanschluss benötigt wird.


Workshop Training

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0003-00L</td>
<td>Workshop Training</td>
<td>O</td>
<td>5</td>
<td>external organisers</td>
<td></td>
</tr>
</tbody>
</table>

Students are required to conduct a workshop training outside ETH Zurich for a minimum duration of five weeks. The students learn how to operate workshop equipment, and acquire first experience in the realization of an engineering project. They summarize the workshop practice in a work and project description.

Objective
The students learn how to operate workshop equipment, and acquire first experience in the realization of an engineering project.

Prerequisites / notice
The minimum duration of the workshop practice is five weeks. The practice may be done prior to the start of the study.

Laboratory Practice

Students attend at least 10 Laboratory Practices during the 4th and 5th semester. 4 of these must be Physics laboratories. All laboratory work is graded "pass" or "fail". After completion of 10 laboratory training units, 2 credit points will be issued.

Please register online at www.mavt.ethz.ch/praktika

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0029-10L</td>
<td>Laboratory Practice</td>
<td>O</td>
<td>2</td>
<td>4P</td>
<td>Lecturers</td>
</tr>
</tbody>
</table>

Selected laboratory experiments in physics, mechanical and process engineering. With the Laboratory Training held during the fourth and fifth semester, the students learn how to handle and apply measurement methods and devices. Students are offered a diversified choice of laboratory experiments at least ten of which must be completed. Four of the chosen experiments must be in physics.

Objective
With the Laboratory Training held during the fourth and fifth semester, the students learn how to handle and apply measurement methods and devices.

GESS Science in Perspective

Recommended GESS Science in Perspective (Type B) for D-MAVT.

see GESS Science in Perspective: Type A: Enhancement of Reflection Capability

see GESS Science in Perspective: Language Courses ETH/UZH
Bachelor's Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0001-10L</td>
<td>Bachelor's Thesis</td>
<td>W</td>
<td>14</td>
<td>32D</td>
<td>Professors</td>
</tr>
</tbody>
</table>

The Bachelor's Thesis can be only started when the First Year Examinations, the Additional First Year Courses, the Examination Block 1 and 2 are passed. It is insistently recommended for students to only begin the Bachelor's Thesis if 150 credit points have been achieved. The thesis corresponds to a work load of 420 hours and can be done in part- or full-time.

Potential supervisors for the Bachelor's Thesis:
- All D-MAVT professors (https://www.mavt.ethz.ch/the-department/people/professors.html)
- Professors in other departments who are accredited at D-MAVT (https://www.mavt.ethz.ch/the-department/people/accredited-professors.html)
- D-MAVT titular professors (https://www.mavt.ethz.ch/the-department/people/titular-professors.html). For enrollment, please contact the D-MAVT Student Administration.

Abstract
The bachelor's thesis is the culmination of the program. The students develop, enhance, and demonstrate their methodological abilities to independently tackle and solve a given research problem.

Objective
The students develop, enhance and demonstrate their methodological abilities to independently tackle and solve a given research problem.

Content
The topics for the bachelor's thesis are published by the professorship or they can be set in consultation between the professors and the students. Thesis projects in cooperation with the industry are also possible.

Prerequisites / notice
Supervisors should normally be part of the D-MAVT professorship or may be professors accredited by D-MAVT.

151-0071-10L Bachelor's Thesis (Focus Spezialization Management, Technology and Economics) 14 credits 32D Professors


Prerequisites for the Bachelor's Thesis MTEC is the Focus Spezialization Management, Technology and Economics.

Abstract
The bachelor's thesis is the culmination of the program. The students develop, enhance and demonstrate their methodological abilities to independently tackle and solve a given research problem.

Objective
The students develop, enhance and demonstrate their methodological abilities to independently tackle and solve a given research problem.

Content
The topics for the bachelor's thesis are defined by the professorship or can be set in consultation between the professors and the students.

Prerequisites / notice
Exclusively D-MAVT students who have enrolled for the focus specialization Management, Technology and Economy are eligible for this type of bachelor's thesis. Supervisors are normally part of the D-MTEC professorship. Further prerequisites have to be discussed with the responsible professor. The bachelor's thesis must be completed within 14 weeks which is an equivalent half-time workload during a semester.

Mechanical Engineering Bachelor - Key for Type

<table>
<thead>
<tr>
<th>O</th>
<th>Compulsory</th>
<th>E-</th>
<th>Recommended, not eligible for credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
</tbody>
</table>

Key for Hours

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
<th>P</th>
<th>practical/laboratory course</th>
</tr>
</thead>
<tbody>
<tr>
<td>G</td>
<td>lecture with exercise</td>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
<td>R</td>
<td>revision course / private study</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

ECTS
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
### Turbulent Flows

**Number:** 151-0109-00L  
**Title:** High Performance Computing for Science and Engineering (HPCSE) I

<table>
<thead>
<tr>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>This course gives an introduction into algorithms and numerical methods for parallel computing for multi and many-core architectures and for applications from problems in science and engineering.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction to HPC for scientists and engineers</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Abstract</th>
</tr>
</thead>
<tbody>
<tr>
<td>The course will teach fundamental concept of Uncertainty Quantification and Propagation (UQ+P) for computational models of systems in Engineering and Life Sciences. Emphasis will be placed on practical and computational aspects of UQ+P including the implementation of relevant algorithms in multicore architectures.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics that will be covered include: Uncertainty quantification under parametric and non-parametric modelling uncertainty, Bayesian inference with model class assessment, Markov Chain Monte Carlo simulation, prior and posterior reliability analysis.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Lecture notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>The class will be largely based on the book: Data Analysis: A Bayesian Tutorial by Devinderjit Sivia as well as on class notes and related literature that will be distributed in class.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Literature</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Data Analysis: A Bayesian Tutorial by Devinderjits Sivia</td>
</tr>
<tr>
<td>2. Probability Theory: The Logic of Science by E. T. Jaynes</td>
</tr>
<tr>
<td>3. Class Notes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Prerequisites / notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fundamentals of Probability, Fundamentals of Computational Modeling</td>
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<table>
<thead>
<tr>
<th>Number of participants limited to 60.</th>
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<tbody>
<tr>
<td>Does not take place this semester.</td>
</tr>
<tr>
<td>Number of participants limited to 60.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>P. Koumoutsakos</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Prerequisites / notice</th>
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</thead>
<tbody>
<tr>
<td>Prerequisites: Fluidodynamics I, Numerical Mathematics, programming skills.</td>
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</table>

<table>
<thead>
<tr>
<th>Language: German on request.</th>
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</thead>
</table>

| Number: 151-0107-20L  
**Title:** Quantitative Flow Visualization |

<table>
<thead>
<tr>
<th>Content</th>
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</thead>
<tbody>
<tr>
<td>The course provides an introduction to digital image analysis in modern flow diagnostics. Different techniques which are discussed include image velocimetry, laser induced fluorescence, liquid crystal thermography and interferometry. The physical foundations and measurement configurations are explained. Image analysis algorithms are presented in detail and programmed during the exercises.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Objective</th>
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</thead>
<tbody>
<tr>
<td>Development of basic programming skills for (generic) imaging applications.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Abstract</th>
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</thead>
<tbody>
<tr>
<td>Understanding of hardware and software requirements and solutions.</td>
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</table>

<table>
<thead>
<tr>
<th>Content</th>
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</thead>
<tbody>
<tr>
<td>Fundamentals of optics, flow visualization and electronic image acquisition.</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequently used image processing techniques (filtering, correlation processing, FFTs, color space transforms).</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Lecture notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class notes, handouts</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Prerequisites / notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prerequisites: Fluidodynamics I, Numerical Mathematics, programming skills.</td>
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</table>

<table>
<thead>
<tr>
<th>Language: German on request.</th>
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</table>

| Number: 151-0109-00L  
**Title:** Turbulent Flows |

<table>
<thead>
<tr>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contents: - Laminar and turbulent flows, instability and origin of turbulence - Statistical description: averaging, turbulent energy, dissipation, closure problem - Scallops. Homogeneous isotropic turbulence, correlations, Fourier representation, energy spectrum - Free turbulence: wake, jet, mixing layer - Wall turbulence: Channel and boundary layer - Computation and modelling of turbulent flows</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic physical phenomena of turbulent flows, quantitative and statistical description, basic and averaged equations, principles of turbulent flow computation and elements of turbulence modelling</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Properties of laminar, transitional and turbulent flows.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Lecture notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecture notes are available.</td>
</tr>
</tbody>
</table>
### Literature

**151-0113-00L**

**Applied Fluid Dynamics**

**Abstract**

The methods of fluid dynamics play an important role in the description of a chain of events, involving the release, spreading and dilution of dangerous fluids in the environment.

**Objective**

Generally applicable methods in fluid dynamics and gas dynamics are illustrated and practiced using selected current examples.

**Content**

Often experts fall back on the methodology of fluid dynamics when involved in the construction of environmentally friendly processing and incineration facilities, as well as when choosing safe transport and storage options for dangerous materials. As a result of accidents, but also in normal operations, dangerous gases and liquids may escape and be transported further by wind or flowing water.

**Lecture notes**

Not available

**Prerequisites / notice**

Requirements: successful attendance at lectures "Fluidodynamik I und II", "Thermodynamik I und II"

### Literature

S. Glasston & A. Sesonke: Nuclear Reactor Engineering, Reactor System Engineering, Ed. 4, Vol. 2., Springer-Science+Business Media, The course is based mostly on notes developed by the instructor.

**Copy of the slides presented.**

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**151-0163-00L**

**Nuclear Energy Conversion**

**Abstract**

Physical fundamentals of the fission reaction and the sustainable chain reaction, thermal design, construction, function and operation of nuclear reactors and power plants, light water reactors and other reactor types, conversion and breeding

**Objective**

Students get an overview on energy conversion in nuclear power plants, on construction and function of the most important types of nuclear reactors with special emphasis to light water reactors. They obtain the mathematical/physical basis for quantitative assessments concerning most relevant aspects of design, dynamic behaviour as well as material and energy flows.

**Content**

Nuclear physics of fission and chain reaction. Thermodynamics of nuclear reactors. Design of the rector core. Introduction into the dynamic behaviour of nuclear reactors. Overview on types of nuclear reactors, diffuser of nuclear reactors and fast breeders. Construction and operation of nuclear power plants with pressurized and boiling water reactors, role and function of the most important safety systems, special features of the energy conversion. Development tendencies of reactor technology.

**Lecture notes**

Hand-outs will be distributed. Additional literature and information on the website of the lab: https://www.ethz.ch/content/specialinterest/mavt/energy/technology/lab-of-nuclear-energy-systems/en/studium/teaching-materials/151-0163-00l-nuclear-energy-conversion.html

**Literature**


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**151-0182-00L**

**Fundamentals of CFD Methods**

**Abstract**

This course is focused on providing students with the knowledge and understanding required to develop simple computational fluid dynamics (CFD) codes to solve the incompressible Navier-Stokes equations and to critically assess the results produced by CFD codes. As part of the course, students will write their own codes and verify and validate them systematically.

**Objective**

1. Students know and understand basic numerical methods used in CFD in terms of accuracy and stability.
2. Students have a basic understanding of a typical simple CFD code.
3. Students understand how to assess the numerical and physical accuracy of CFD results.

**Content**

1. Governing and model equations. Brief review of equations and properties
2. Overview of basic concepts: Overview of discretization process and its consequences
3. Overview of numerical methods: Finite-difference and finite-volume methods
4. Analysis of spatially discrete equations: Consistency, accuracy, stability, convergence of semi-discrete methods
5. Time-integration methods: LMS and RK methods, consistency, accuracy, stability, convergence
6. Analysis of fully discrete equations: Consistency, accuracy, stability, convergence of fully discrete methods
7. Solution of one-dimensional advection equation: Motivation for and consequences of upwinding, Godunov's theorem, TVD methods, DRP methods.
8. Solution of two-dimensional advection equation: Dimension-by-dimension methods, dimensional splitting, multidimensional methods
9. Solution of one- and two-dimensional diffusion equations: Implicit methods, ADI methods
10. Solution of one-dimensional advection-diffusion equation: Numerical vs physical viscosity, boundary layers, non-uniform grids
11. Solution of incompressible Navier-Stokes equations: Incompressibility constraint and consequences, fractional-step and pressure-correction methods
12. Solution of incompressible Navier-Stokes equations on unstructured grids

**Lecture notes**

The course is based mostly on notes developed by the instructor.

**Literature**

- R. L. Murray: Nuclear Energy (Sixth Edition), An Introduction to the Concepts, Systems, and Applications of Nuclear Processes, Elsevier

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**151-0185-00L**

**Radiation Heat Transfer**

**Abstract**

Advanced course in radiation heat transfer

**Objective**

Fundamentals of radiative heat transfer and its applications. Examples are combustion and solar thermal/thermochemical processes, and other applications in the field of energy conversion and material processing.

**Content**


**Lecture notes**

Copy of the slides presented.

**Literature**

The course provides an introduction to theoretical foundations and practical usage of the Lattice Boltzmann Method for fluid dynamics. The course first reviews the governing equations and combustion chemistry, setting the ground for the analysis of homogeneous gas-phase mixtures, laminar diffusion and premixed flames. Catalytic combustion and its coupling with homogeneous combustion are dealt in detail, and turbulent combustion modeling approaches are presented. Available numerical codes will be used for modeling.

Lecture notes
Lecture notes

**151-0207-00L**

**Abstract**
Theory and Modeling of Reactive Flows

The course first reviews the governing equations and combustion chemistry, setting the ground for the analysis of homogeneous gas-phase mixtures, laminar diffusion and premixed flames. Catalytic combustion and its coupling with homogeneous combustion are dealt in detail, and turbulent combustion modeling approaches are presented. Available numerical codes will be used for modeling.

**Objective Content**
The analysis of realistic reactive flow systems necessitates the use of detailed computer models that can be constructed starting from first principles i.e. thermodynamics, fluid mechanics, chemical kinetics, and heat and mass transport. In this course, the focus will be on combustion theory and modeling. The reacting flow governing equations and the combustion chemistry are firstly reviewed, setting the ground for the analysis of homogeneous gas-phase mixtures, laminar diffusion and premixed flames. Heterogeneous (catalytic) combustion, an area of increased importance in the last years, will be dealt in detail along with its coupling with homogeneous combustion. Finally, approaches for the modeling of turbulent combustion will be presented. Available numerical codes will be used to compute the above described phenomena. Familiarity with numerical methods for the solution of partial differential equations is expected.

**Prerequisites / notice**
Handouts
NEW course

**151-0213-00L**

**Abstract**
Fluid Dynamics with the Lattice Boltzmann Method

The course provides an introduction to theoretical foundations and practical usage of the Lattice Boltzmann Method for fluid dynamics simulations. Methods like molecular dynamics, DSMC, lattice Boltzmann etc are being increasingly used by engineers all over and these methods require knowledge of kinetic theory and statistical mechanics which are traditionally not taught at engineering departments. The goal of this course is to give an introduction to ideas of kinetic theory and non-equilibrium thermodynamics with a focus on developing simulation algorithms and their realizations.

During the course, students will be able to develop a lattice Boltzmann code on their own. Practical issues about implementation and performance on parallel machines will be demonstrated hands on. The central element of the course is the completion of a lattice Boltzmann code (using the framework specifically designed for this course).

The course will also include a review of topics of current interest in various fields of fluid dynamics, such as multiphase flows, reactive flows, microflows among others.

Optionally, we offer an opportunity to complete a project of student's choice as an alternative to the oral exam. Samples of projects completed by previous students will be made available.

**Content**
The course builds upon three parts:
I Elementary kinetic theory and lattice Boltzmann simulations introduced on simple examples.
II Theoretical basis of statistical mechanics and kinetic equations.
III Lattice Boltzmann method for real-world applications.

The content of the course includes:

1. Background: Elements of statistical mechanics and kinetic theory:
   - Particle's distribution function, Liouville equation, entropy, ensembles; Kinetic theory: Boltzmann equation for rarefied gas, H-theorem, hydrodynamic limit and derivation of Navier-Stokes equations, Chapman-Enskog method, Grad method, boundary conditions; mean-field interactions, Vlasov equation;
   - Kinetic models: BGK model, generalized BGK model for mixtures, chemical reactions and other fluids.

2. Basics of the Lattice Boltzmann Method and Simulations:
   - Minimal kinetic models: lattice Boltzmann method for single-component fluid, discretization of velocity space, time-space discretization, boundary conditions, forcing, thermal models, mixtures.

3. Hands on:
   - Development of the basic lattice Boltzmann code and its validation on standard benchmarks (Taylor-Green vortex, lid-driven cavity flow etc).

4. Practical issues of LBM for fluid dynamics simulations:
   - Lattice Boltzmann simulations of turbulent flows; numerical stability and accuracy.

5. Microflow:
   - Rarefaction effects in moderately dilute gases; Boundary conditions, exact solutions to Couette and Poiseuille flows; micro-channel simulations.

6. Advanced lattice Boltzmann methods:
   - Entropic lattice Boltzmann scheme, subgrid simulations at high Reynolds numbers; Boundary conditions for complex geometries.

7. Introduction to LB models beyond hydrodynamics:
   - Relativistic fluid dynamics; flows with phase transitions.

Lecture notes
Lecture notes on the theoretical parts of the course will be made available. Selected original and review papers are provided for some of the lectures on advanced topics. Handouts and basic code framework for implementation of the lattice Boltzmann models will be provided.
The objective of this course is to introduce the students to the fundamentals, technologies, modern day application, and economics of wind energy. These subjects are introduced through a discussion of the basic principles of wind energy generation and conversion, and a detailed description of the broad range of relevant technical, economic and environmental topics.

The objective of this course is to introduce the students to the fundamentals, technologies, modern day application, and economics of wind energy.

This mechanical engineering course focuses on the technical aspects of wind turbines; non-technical issues are not within the scope of this technically oriented course. On completion of this course, the student shall be able to conduct the preliminary aerodynamic and structural design of the wind turbine blades. The student shall also be more aware of the broad context of drivetrains, dynamics and control, electrical systems, and meteorology, relevant to all types of wind turbines.

The course addresses mainly graduate students (MSc/Ph D) but BSc students can also attend.

Prerequisites / notice

Course material will be communicated to the students prior to the start of each class for download.


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151-0368-00L  
**Aeroelasticity**  
W 4 credits  2V+1U  F. Campanile  

**Abstract**  
Introduction to the basics and methods of Aeroelasticity. An overview of the main static and dynamic phenomena arising from the interaction between structural and aerodynamic loads.

**Objective**  
The course will give you a physical basic overview of current-structure phenomena. Furthermore you will get to know the most important phenomena in the statistical and dynamical aeroelastic as well as an introduction to the methods for mathematical descriptions and for the wording of quantitative forecasts.

**Content**  

**Literature**  

151-0709-00L  
**Stochastic Methods for Engineers and Natural Scientists**  
W 4 credits  3G  D. W. Meyer-Massetti, N. Noiray  

**Abstract**  
The course provides an introduction into stochastic methods that are applicable for example for the description and modeling of turbulent and surface flow. Moreover, mathematical techniques are presented that are used to quantify uncertainty in various engineering applications.

**Objective**  
By the end of the course you should be able to mathematically describe random quantities and their effect on physical systems. Moreover, you should be able to develop basic stochastic models of such systems.

**Content**  
- Probability theory, single and multiple random variables, mappings of random variables  
- Stochastic differential equations, Itô calculus, PDF evolution equations  
- Polynomial chaos and other expansion methods  

All topics are illustrated with application examples from engineering.

**Lecture notes**  
Detailed lecture notes will be provided.

**Literature**  

151-0851-00L  
**Robot Dynamics**  
W 4 credits  2V+1U  M. Hutter, R. Siegwart, T. Stasny  

**Abstract**  
We will provide an overview on how to kinematically and dynamically model typical robotic systems such as robot arms, legged robots, rotary wing systems, or fixed wing.

**Objective**  
The primary objective of this course is that the student deepens an applied understanding of how to model the most common robotic systems. The student receives a solid background in kinematics, dynamics, and control of multi-body systems. On the basis of the state of the art applications, he/she will learn all necessary tools to work in the field of design or control of robotic systems.

**Content**  
The course consists of three parts: First, we will refresh and deepen the student’s knowledge in kinematics, dynamics, and control of multi-body systems. In this context, the learning material will build upon the courses for mechanics and dynamics available at ETH, with the particular focus on their application to robotic systems. The goal is to foster the conceptual understanding of similarities and differences among the various types of robots. In the second part, we will apply the learned material to classical robotic arms as well as legged systems and discuss kinematic constraints and interaction forces. In the third part, focus is put on modeling fixed wing aircraft, along with related design and control concepts. In this context, we also touch aerodynamics and flight mechanics to an extent typically required in robotics. The last part finally covers different helicopter types, with a focus on quadrotors and the coaxial configuration which we see today in many UAV applications. Case studies on all main topics provide the link to real applications and to the state of the art in robotics.

**Prerequisites / notice**  
The contents of the following ETH Bachelor lectures or equivalent are assumed to be known: Mechanics and Dynamics, Control, Basics in Fluid Dynamics.

151-0911-00L  
**Introduction to Plasmonics**  
W 4 credits  2V+1U  D. J. Norris  

**Abstract**  
This course provides fundamental knowledge of surface plasmon polaritons and discusses their applications in plasmonics.

**Objective**  
Electromagnetic oscillations known as surface plasmon polaritons have many unique properties that are useful across a broad set of applications in biology, chemistry, physics, and optics. The field of plasmonics has arisen to understand the behavior of surface plasmon polaritons and to develop applications in areas such as catalysis, imaging, photovoltaics, and sensing. In particular, metallic nanoparticles and patterned metallic interfaces have been developed to utilize plasmonic resonances. The aim of this course is to provide the basic knowledge to understand and apply the principles of plasmonics. The course will strive to be approachable to students from a diverse set of science and engineering backgrounds.

**Content**  
Fundamentals of Plasmonics  
- Basic electromagnetic theory  
- Optical properties of metals  
- Surface plasmon polaritons on surfaces  
- Surface plasmon polariton propagation  
- Localized surface plasmons  

Applications of Plasmonics  
- Waveguides  
- Extraordinary optical transmission  
- Enhanced spectroscopy  
- Sensing  
- Metamaterials

**Lecture notes**  
Class notes and handouts

**Literature**  
Physics I, Physics II

151-0917-00L  
**Mass Transfer**  
W 4 credits  2V+2U  R. Büchel, S. E. Pratsinis  

**Abstract**  
This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore the application of these principles to important engineering problems is demonstrated.

**Objective**  
This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore the application of these principles to important engineering problems is demonstrated.
### 1. Grundlagen der Flugtechnik (Basics of flight science, script in german language)

P. Rudolf von Rohr

- Structural Reliability and Risk Analysis
- Process Design and Safety

#### Objective

The goal of this course is to provide the students with a thorough understanding of the key concepts behind structural reliability and risk assessment. After this course the students will have refreshed their knowledge of probability theory and statistics to model uncertainties in view of engineering applications. They will be able to analyze the reliability of a structure and to use risk assessment methods for decision making under uncertain conditions. They will be aware of the state-of-the-art computational methods and software in this field.

#### Literature


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### Rate-Controlled Separations in Fine Chemistry

W 4 credits 3G M. Mazzotti

#### Abstract

The students are supposed to obtain detailed insight into the fundamentals of separation processes that are frequently applied in modern life science processes in particular, fine chemistry and biotechnology.

#### Literature


#### Prerequisites / notice

- Requirements: Thermal separation Processes I (151-0926-00) and Modelling and mathematical methods in process and chemical engineering (151-0940-00)

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### Process Design and Safety

W 4 credits 2V+1U P. Rudolf von Rohr

#### Abstract

The goal of the lecture is to expound design characteristics of systems for process engineering applications. The students are supposed to obtain detailed insight into the fundamentals of separation processes that are frequently applied in modern life science processes in particular, fine chemistry and biotechnology.

#### Literature


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### Introduction to Aircraft and Car Aerodynamics

W 4 credits 3G J. Wildi

#### Abstract

The course presents the underlying probabilistic modelling and computational methods for reliability and risk assessment. The students will have refreshed their knowledge of probability theory and statistics to model uncertainties in view of engineering applications. They will be able to analyze the reliability of a structure and to use risk assessment methods for decision making under uncertain conditions. They will be aware of the state-of-the-art computational methods and software in this field.
This course will provide a solid foundation for understanding physical principles of THz applications. We will discuss various building blocks such as random variables and vectors, dependence and correlation are recalled. Basic statistical inference methods used for building a probabilistic model from the available data, e.g. the maximum likelihood method, are presented.

The first part of the course is a reminder on probability theory that is used as a main tool for reliability and risk analysis. Classical concepts whenever we deviate from the main material discussed in these books, softcopy of lectures notes will be provided.

The second part is related to structural reliability analysis, i.e. methods that allow one to compute probabilities of failure of a given system with respect to prescribed criteria. The framework of reliability analysis is first set up. Reliability indices are introduced together with the first order-second moment method (FOSM) and the first order reliability method (FORM). Methods based on Monte Carlo simulation are then reviewed and illustrated through various examples. By-products of reliability analysis such as sensitivity measures and partial safety coefficients are derived and their links to structural design codes is shown. The reliability of structural systems is also introduced as well as the methods used to reassess existing structures based on new information.

The course also includes a tutorial using the UQLab software dedicated to real world structural reliability analysis.

Whenever we deviate from the main material discussed in these books, softcopy of lectures notes will be provided.

The third part of the course addresses risk assessment methods. Techniques for the identification of hazard scenarios and their representation by fault trees and event trees are described. Risk is defined with respect to the concept of expected utility in the framework of decision making. Elements of Bayesian decision making, i.e. pre-, post and pre-post risk assessment methods are presented.

The course includes a guided tour at Zurich Airport (baggage sorting system, apron, ATC Tower).

This course will be taught as Aviation I. A subsequent course is under evaluation.

Examination: written, 60 min, open books (Examination in German; Answers may be given in English)

Lecture notes Slides are provided prior to each class

Prerequisites / notice Literature We will also use English papers

| Content | Engineers are confronted every day to decision making under limited amount of information and uncertain conditions. When designing new structures and systems, the design codes such as SIA or Euro- codes usually provide a framework that guarantees safety and reliability. However the level of safety is not quantified explicitly, which does not allow the analyst to properly choose between design variants and evaluate a total cost in case of failure. In contrast, the framework of risk analysis allows one to incorporate the uncertainty in decision making. |
| Lecture notes | Slides of the lectures are available online every week. A printed version of the full set of slides is proposed to the students at the beginning of the semester. |
| Prerequisites / notice | Basic course on probability theory and statistics |

| 101-0499-00L | Basics In Air Transport | W | 4 credits |
| Literature | Yun-Shik Lee, Principles of Terahertz Science and Technology, Springer 2009 |
| Prerequisites / notice | We will also use English papers |

| 227-0455-00L | Terahertz: Technology & Applications | W | 3 credits |
| Literature | S. Marelli, R. Schöbi, B. Sudret, UQLab user manual - Structural reliability (rare events estimation), Report UQLab-V0.92-107. |
| Prerequisites / notice | Good foundation in electromagnetics & knowledge of microwave or optical communication is helpful. |

Abstract The course explains main principles of air transport in general and elaborates on simple interdisciplinary topics. Since working on broad topics like aerodynamics, manufacturers, airport operation, business aviation, business models etc. the student gets a good overview in air Transportation. Understand and explain basics, principles and contexts in the broader air transport industry. Lay the foundation of working in or with the air transport industry. Ideal foundation for Aviation II - Management of Air Transport

Objective Content Weekly: 1h independent preparation; 2h lectures and 1 h training with an expert in the respective field

Concept: This course will be taught as Aviation I. A subsequent course is under evaluation.

Content: Transport as part of the overall transportation scheme; Aerodynamics; Aircraft (A/C) Designs & Structures; A/C Operations; Law Enforcement; Maintenance & Manufacturers; Airport Operations & Planning; Customs & Security; ATC & Airspace; Air Freight; General Aviation; Business Jet Operations; Business models within Airline Industry; Military Operations.

Technical visit: This course includes a guided tour at Zurich Airport (baggage sorting system, apron, ATC Tower).

Examination: written, 60 min, open books (Examination in German; Answers may be given in English)

| 227-0950-00L | Acoustics | Z | 0 credits |
| Literature | - Yun-Shik Lee, Principles of Terahertz Science and Technology, Springer 2009 |
| Prerequisites / notice | Good foundation in electromagnetics & knowledge of microwave or optical communication is helpful. |

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Abstract
Current topics in Acoustics presented mostly by external speakers from academia and industry.

Objective
see above

529-0193-00L Renewable Energy Technologies I

W 4 credits 3G A. Wokaun, A. Steinfeld

Abstract
Scenarios for world energy demand and CO2 emissions, implications for climate. Methods for the assessment of energy chains. Potential and technology of renewable energies: Biomass (heat, electricity, biofuels), solar energy (low-temp. heat, solar thermal and photovoltaic electricity, solar chemistry). Wind and ocean energy, heat pumps, geothermal energy, energy from waste, CO2 sequestration.

Objective
Scenarios for the development of world primary energy consumption are introduced. Students know the potential and limitations of renewable energies for reducing CO2 emissions, and their contribution towards a future sustainable energy system that respects climate protection goals.

Content

Lecture notes
Lecture notes will be distributed electronically during the course.

Literature

Prerequisites / notice
Fundamentals of chemistry, physics and thermodynamics are a prerequisite for this course.

Topics are available to carry out a Project Work (Semesterarbeit) on the contents of this course.

636-0001-00L Separations in Biotechnology and Bioprocess

Economy

W 6 credits 3G S. Panke

Abstract
Separations play an integral part of any biotechnological process. This course aims at enabling students specifically with a chemistry/biology background to select & design suitable separation protocols & processes for typical biotechnological products such as monoclonal antibodies, antibiotics, and fine chemicals and at providing a basic set of purifications & judge on process economy.

Objective
Students should be able to select for a given biotechnological product a suitable set of purification operations and judge on process economy.

Content
Introduction membrane operations adsorption and chromatography crystallization overall process economics

Lecture notes
Handouts during course

636-0507-00L Synthetic Biology II

Abstract
7 months biological design project, during which the students are required to give presentations on advanced topics in synthetic biology (specifically genetic circuit design) and then select their own biological system to design. The system is subsequently modeled, analyzed, and experimentally implemented. Results are presented at an international student competition at the MIT (Cambridge).

Objective
The students are supposed to acquire a deep understanding of the process of biological design including model representation of a biological system, its thorough analysis, and the subsequent experimental implementation of the system and the related problems.

Content
Presentations on advanced synthetic biology topics (e.g. genetic circuit design, adaptation of systems dynamics, analytical concepts, large scale de novo DNA synthesis), project selection, modeling of selected biological system, design space exploration, sensitivity analysis, conversion into DNA sequence, (DNA synthesis external,) implementation and analysis of design, summary of results in form of scientific presentation and poster, presentation of results at the iGEM international student competition (www.igem.org).

Lecture notes
Handouts during course

Prerequisites / notice
The final presentation of the project is typically at the MIT (Cambridge, US). Other competing schools include regularly Imperial College, Cambridge University, Harvard University, UC Berkeley, Princeton University, CalTech, etc.

This project takes place between end of Spring Semester and beginning of Autumn Semester. Registration in April.

Please note that the number of ECTS credits and the actual work load are disconnected.

Mechanics, Materials, Structures

Number Title Type ECTS Hours Lecturers

151-0104-00L Uncertainty Quantification for Engineering & Life Sciences

W 4 credits 3G P. Koumoutsakos

Abstract
Does not take place this semester. Number of participants limited to 60.

Objective
The course will teach fundamental concept of Uncertainty Quantification and Propagation (UQ+P) for computational models of systems in Engineering and Life Sciences. Emphasis will be placed on practical and computational aspects of UQ+P including the implementation of relevant algorithms in multicore architectures.

Content
Topics that will be covered include: Uncertainty quantification under parametric and non-parametric modelling uncertainty, Bayesian inference with model class assessment, Markov Chain Monte Carlo simulation, prior and posterior reliability analysis.

Lecture notes
The class will be largely based on the book: Data Analysis: A Bayesian Tutorial by Devinderjit Sivia as well as on class notes and related literature that will be distributed in class.

Literature
1. Data Analysis: A Bayesian Tutorial by Devinderjit Sivia
2. Probability Theory: The Logic of Science by E. T. Jaynes
3. Class Notes

Prerequisites / notice
Fundamentals of Probability, Fundamentals of Computational Modeling

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**151-0107-20L**  
High Performance Computing for Science and Engineering (HPCSE) I  

**Abstract**  
This course gives an introduction into algorithms and numerical methods for parallel computing for multi and many-core architectures and for applications from problems in science and engineering.

**Objective**  
Introduction to HPC for scientists and engineers  
Fundamental of:  
1. Parallel Computing Architectures  
2. MultiCores  
3. ManyCores

**Content**  
Programming models and languages:  
1. C++ threading (2 weeks)  
2. OpenMP (4 weeks)  
3. MPI (5 weeks)

Computers and methods:  
1. Hardware and architectures  
2. Libraries  
3. Particles: N-body solvers  
4. Fields: PDEs  
5. Stochastics: Monte Carlo

**Lecture notes**  
http://www.cse-lab.ethz.ch/index.php/teaching/42-teaching/classes/615-hpcse1

**151-0317-00L**  
Visualization, Simulation and Interaction - Virtual Reality II  

**Abstract**  
This lecture provides deeper knowledge on the possible applications of virtual reality, its basic technology, and future research fields. The goal is to provide a strong knowledge on Virtual Reality for a possible future use in business processes.

**Objective**  
Virtual Reality can not only be used for the visualization of 3D objects, but also offers a wide application field for small and medium enterprises (SME). This could be for instance an enabling technology for net-based collaboration, the transmission of images and other data, the interaction of the human user with the digital environment, or the use of augmented reality systems. The goal of the lecture is to provide a deeper knowledge of today's VR environments that are used in business processes. The technical background, the algorithms, and the applied methods are explained more in detail. Finally, future tasks of VR will be discussed and an outlook on ongoing international research is given.

**Content**  
Introduction into Virtual Reality; basics of augmented reality; interaction with digital data, tangible user interfaces (TUI); basics of simulation; compression procedures of image-, audio-, and video signals; new materials for force feedback devices; introduction into data security; cryptography; definition of free-form surfaces; digital factory; new research fields of virtual reality

**Lecture notes**  
The handout is available in German and English.

**Prerequisites / notice**  
Prerequisites:  
"Visualization, Simulation and Interaction - Virtual Reality I" is recommended.

**Didactical concept:**  
The course consists of lectures and exercises.

**151-0349-00L**  
Fatigue Strength of Materials, Components and Structures  

**Abstract**  
Fatigue of materials is playing a key role in light weight structures. All applications are affected that are exposed to oscillating loads. The lecture will present the most important methods for analyzing the fatigue strength under service load conditions. This starts with the conventional assessment of a components endurance limit and ends with the application of the damage tolerance philosophy.

**Objective**  
Goals of the lecture  
An introduction to the most important terms and phenomena related to fatigue damages of metallic components will be given and explained by practical examples. Methods for assessment of endurance strength, finite life fatigue strength, crack initiation and crack growth will be discussed. The lecture shall demonstrate how to solve fatigue problems in practice. Examples like the ICE disaster at Eschede or structural problems of the Combino tram demonstrate the significance of this subject. The fatigue behavior of lightweight structures for vehicles and aircrafts has to be considered during the component design process. Designing the static strength of a component alone is not sufficient since fatigue damages of such components may cause extremely high costs. Structural components of modern aircraft like Airbus A380 or A400M are designed with respect to crack growth using the damage tolerance philosophy. Understanding fatigue strength and its phenomena requires broad knowledge of material behavior, services loads, manufacturing effects as well as of analysis and test methods. Fatigue strength is a highly interdisciplinary area of work. For this the most important tools and methods shall be presented.
Content
1. INTRODUCTION, OVERVIEW, MOTIVATION
1.1 Preface (General introduction and history survey) (Schijve; Chapter 1)
1.2 Standards and Guidelines
1.3 Examples of damage events
   Comet-Accident (Pressure cycles, stress concentration)
   Aloha-Incident at Hawaii (Multiple site damage)
   Accident of an aerial passenger tramway (Fretting corrosion on axle)
   ICE-Accident (Wheel failure)
1.4 Presentations
   DVD "MTW Materialermüdung (1995, 21')",
   DVD "F/A-18 Full Scale Fatigue Test (2004, 12')",
   DVD "Sicherheit von Seilbahnen (1996, 7')" with discussion

2. LOADING
2.1 Fatigue strength overview
2.2 Significance of operational loading
2.3 Types of load histories (Schijve; Chapter 9)
2.4 Terms and definitions (Schijve; Chapter 9)
2.5 Measurement of operational loadings (Schijve; Chapter 9)
2.6 Counting algorithms (Schijve; Chapter 9)
2.7 Frequency distributions or spectra (Schijve; Chapter 9)
2.8 Impact of spectrum shape
2.9 Design Spectra (Schijve; Chapter 13)

3. MATERIAL
3.1 Fatigue strength overview
3.2 Evaluation of material properties for cyclic loading (Schijve; Chapter 13)
3.3 Fatigue properties (Schijve; Chapter 6)
3.4 Wöhler-Diagram (Schijve; Chapter 6, 7)
3.5 Scatter of fatigue properties (Schijve; Chapter 12)
3.6 Mean stress effect (Schijve; Chapter 6)
3.7 Damage mechanisms & material selection (Schijve; Chapter 2)
3.8 Environmental effects (Schijve; Chapter 16, 17)
3.9 Specific fatigue properties (Schijve; Chapter 6)

4. STRUCTURAL COMPONENT
4.1 Fatigue strength overview
4.2 Notches (Schijve; Chapter 3, 7)
4.3 Residual stresses (Schijve; Chapter 4)
4.4 Size effect
4.5 Surface condition and surface layers (Schijve; Chapter 7, 14)
4.6 Fretting corrosion (Schijve; Chapter 15)
4.7 Summary of fatigue strength improving methods (Schijve; Chapter 14)

5. SAFETY FACTORS (Schijve; Chapter 19)

6. FATIGUE STRENGTH ASSESSMENT
6.1 Fatigue strength overview
6.2 Assessment concepts for fatigue lifetime prediction
6.3 Assessment of the endurance strength
6.4 Finite life fatigue strength assessment using the nominal stress concept (Schijve; Chapter 10)
6.5 Local stress-strain concept (Schijve; Chapter 10)
6.6 Fracture mechanics concept (Schijve; Chapter 5, 8, 11)
6.7 Accuracy of concepts for fatigue lifetime assessment

7. STRUCTURAL INTEGRITY CONCEPTS
7.1 Safe life design (Mirage III, Pressure Vessel)
7.2 Fail safe design (modem aircraft construction)
7.3 Damage tolerance (approach according to US Air Force)
7.4 F/A-18 design philosophy
7.5 Summary

8. EXPERIMENTAL FATIGUE STRENGTH
8.1 In case of interesting current tests laboratory visitation at Empa

Lecture notes
All lecture chapters are on Powerpoint presentations. The chapters will be available as presentation handouts at the first day for a fee of CHF 20.-

Literature
Recommended books as supplement to the lecture:

Schijve, Jaap
Fatigue of Structures and Materials

Broek, David
The Practical Use of Fracture Mechanics

Prerequisites / notice
Depending on actual fatigue tests a Laboratory visitation at Empa in Dübendorf may be organized.

151-0353-00L Mechanics of Composite Materials W 4 credits 2V+1U G. Kress

Abstract
The course Mechanics of Composite Materials is dedicated to modeling problems following from the complex mechanical behavior of these anisotropic material structures. and modeling of continuous fibre reinforced composites. Participants will be able to design parts for the mechanical, automotive and aerospace industry.

Objective
Understanding of the mechanical properties of fibre reinforced composites with regard to analysis and design of lightweight structures for mechanical, transportation and aerospace applications.
Objective: Cable cars make use of extensive mechanical systems, which become operational only in the course of their operational location, are exposed to difficult meteorological and topographical conditions. In order to guarantee the requisite safety and reliability of the equipment, the components and their interaction in the system must fulfill stringent functional requirements. This is particularly the case because of the significant distance (2-4km) between the individual structures. The lectures with related exercises offer an excellent opportunity to apply the learned theoretical basic principles of mechanics and engineering in plant construction. Not only the function and resistance of individual components will be studied, but also complex interactions, which are imperative for the safe and smooth running of the equipment. It also includes the teaching of the basics of project planning and design, as well as the evaluation of systems in a distinctly interdisciplinary manner. For the manufacturer of a cable car installation the integration of sub-assemblies making use of very different technologies always poses a particular challenge. For this reason, the methodology for the handling of these typical engineering assignments is important and makes up a significant part of the lecture content.

Content:

- Cable cars and cable cranes: Construction methods and areas of application. The use of mechanical principles in system engineering.
- Swiss building and business regulations, planning and equipment with special consideration for business and the environment: steel cables (construction, evaluation, damage, inspection), drive mechanisms, brakes, vehicles, construction over an extended area. Calculation of the supporting cable with weight strain and with fixed mountings on both sides. Excursions.

Abstract:

Ropeways represent a public transport system where steel wired ropes play a central role. Such systems come to a favorite transport solution when the costs for conventional systems become out of scale due to difficult and impossible terrestrial surface (alpine terrain).

Additionally ropeways are environment friendly, very energy efficient and offer a very high safety level.

Inhalt:

1. Basic problem of continuum mechanics and energy principles: structural theories, homogenization theories; finite elements; fracture mechanics
2. Structural theories for planar structures and stability: plane-stress, plate theory, buckling of plates (non-linear plate theory)
3. Strength of material theories and material properties: ductile behaviour, plasticity, von Mises, Tresca, principal stress criterion; brittle behaviour; viscoplastic behaviour, creep resistance.
4. Structural design: fatigue and dynamic structural analysis.

Lecture notes:

SEILBAHNEN I

Literature:

The lecture material is covered by the script and further literature is referenced in there.
**Course:** Scientific Visualization for Engineering Applications

**Abstract:** The course offers an introduction to the basic principles and most prominent methods of scientific visualization in science and engineering applications. The presentation will cover mathematical models and algorithms that support the depiction of 2D, 3D, and time-dependent datasets comprised of scalar, vector, and tensor attributes.

**Objective:** The course offers a self-contained introduction scientific visualization with an emphasis on basic principles and techniques that are most relevant to scientific and engineering applications.

The specific learning objectives are the following:

1. Basics: elementary notions of computer graphics and visual perception
2. Data processing: Relevant spatial data structures and smooth data reconstruction
3. Colors: Proper usage of colors in visualization
4. Scalar visualization: Level sets, salient surfaces, volume rendering and transfer function design
5. Vector visualization: Integral curves and surfaces, dense representation
6. Tensor visualization: Glyphs and integral curves
7. Flow visualization: automatic feature extraction and structure characterization
8. Visual abstraction: topological skeleton

**Content:**
- Graphics primer
- Data structures and spatial queries
- Smooth data reconstruction
- Color perception
- Color mapping
- Isosurfaces (level sets)
- Ridges
- Direct volume rendering and transfer function design
- Integral curves and surfaces
- Texture-based flow representations
- Tensor glyphs and curves
- Topological methods for scalar, vector, and tensor fields
- Multitifed techniques
- Visualization software

**Literature:**
- Visualization software

**Prerequisites / notice:** Basic programming knowledge

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**Course:** Railway Vehicle Dynamics

**Abstract:** After an introduction in to the railway vehicle design, the modelling of the contact between wheel and rail, the building of a simulation model and the fundamentals of the track guiding will be explained. The applications of simulations in the development of railway vehicles will be presented and illustrated on examples.

**Objective:** Development of the theoretical basics regarding the track guiding and the vehicle running dynamics. Understanding the background of multi-body dynamics simulation tools and their application in the development of railway vehicles.

**Content:**
- Introduction in to railway vehicle technology: Vehicle concepts, bogies, suspension systems, brakes, drives.
- Use of multi-body simulations in the railway vehicle industry. Simulation programmes.
- Vehicle model: Model building, modelling of coil springs, rubber to metal springs, air springs and suspension components with friction.
- Wheel/rail contact: Contact geometry, contact area, normal forces, tangential forces.
- Track models. Modelling of track irregularities.
- Linearization of the contact geometry wheelset-track.
- Fundamentals of track guiding.
- Eigenbehaviour, calculation of eigenvalues.
- Linearised and nonlinear calculation of running stability: Methods and assessment criteria. Influence of vehicle design on the running stability.
- Ride comfort assessment.
- Testing and simulations for the acceptance of running characteristics of railway vehicles. Validation of simulation models for the application in context of vehicle acceptance.

**Literature:**

**Prerequisites / notice:** N/A

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**Course:** Continuum Mechanics I

**Abstract:** The lecture deals with constitutive models that are relevant for design and calculation of structures. These include anisotropic linear elasticity, linear viscoelasticity, plasticity, viscoplasticity. Homogenization theories and laminate theory are presented. Theoretical models are complemented by examples of engineering applications and experiments.

**Objective:** Basic theories for solving continuum mechanics problems of engineering applications, with particular attention to material models.

**Content:**

**Literature:**

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Wave Propagation in Solids

**Abstract**

Plane Waves, harmonic waves, Fourier analysis and synthesis, dispersion, distortion, damping, group and phase velocity, transmission and reflection, impact, waves in linear elastic continua, elastic plastic waves, experimental and numerical methods in wave propagation.

**Objective**

Students learn, which technical problems must be approached using the methods used in wave propagation in solids. Furthermore, they learn to use these methods and develop an intuitive feeling for phenomena that can be expected in various situations.

**Content**

Wave Propagation in solids including applications.

**Literature**

Various books will be recommended pertaining to the topics covered.

**Prerequisites**

Language according to the wishes of students.

**Lecture notes**

Copies of the presented slides will be made available on-line through ILIAS. You will be invited to a private blog which will stimulate the discussion of the lecture and the exercises.

Nonlinear Dynamics and Chaos I

**Abstract**

Basic facts about nonlinear systems: existence, uniqueness, and dependence on initial data.

**Objective**

This course is intended for Masters and Ph.D. students in engineering sciences, physics and applied mathematics who are interested in the behavior of nonlinear dynamical systems. It offers an introduction to the qualitative study of nonlinear physical phenomena modeled by differential equations or discrete maps. We discuss applications in classical mechanics, electrical engineering, fluid mechanics, and biology. A more advanced Part II of this class is offered every other year.

**Content**

1. Basic facts about nonlinear systems: Existence, uniqueness, and dependence on initial data.
2. Near equilibrium dynamics: Linear and Lyapunov stability
3. Bifurcations of equilibria: Center manifolds, normal forms, and elementary bifurcations
4. Nonlinear dynamical systems on the plane: Phase plane techniques, limit sets, and limit cycles.
5. Time-dependent dynamical systems: Floquet theory, Poincare maps, averaging methods, resonance

**Lecture notes**

The class lecture notes will be posted electronically after each lecture. Students should not rely on these but prepare their own notes during the lecture.

**Prerequisites / notice**

- Prerequisites: Analysis, linear algebra and a basic course in differential equations.

- Exam: two-hour written exam in English.

- Homework: A homework assignment will be due roughly every other week. Hints to solutions will be posted after the homework due dates.

Optical Methods in Experimental Mechanics

**Abstract**

The lecture introduces a variety of optical methods to assess the mechanical behaviour of a structure, to determine material parameters, or to validate results from numerical analysis. Focus is on camera-based techniques for deformation, strain and stress analysis. Applications and limitations will be discussed. The lecture includes two afternoons of hands-on experience at Empa in Dübendorf.

**Objective**

The students are able to design simple optical set-ups and describe the process of image formation. They understand the working principle of various camera-based techniques for shape, deformation and strain measurement. Most notably they can explain how the measurand is transformed into an interference signal, a change of polarization or surface temperature. They know the main application fields of the individual techniques. They are able to choose the most appropriate technique for solving a measurement task and to estimate its expected resolution. Through the hands-on experience the students gain a deeper and sustained understanding of the content by applying the theoretical foundations to dedicated measurement tasks.

**Content**

After an introduction into optics and image acquisition the lecture explains how to transform mechanical quantities such as strain, stress or deformation into an image content. The imaging measurement techniques make use of a variety of optical principles:

- Triangulation (Digital Image Correlation, Fringe Projection)
- Interference (Speckle Pattern Interferometry, Shearography)
- Diffraction (Moiré-Interferometry, Fiber Bragg Gratings)
- Birefringence (Photelasticity)
- Infrared radiation (Thermal Stress Analysis)

In addition, dynamic measurements and vibration analysis are explained in the context of modal analysis or transient events. The calibration of imaging optical methods and their application to the validation of numerical simulations are described.

The content is structured as follows:
1. Imaging methods: an introduction
2. Digital Image Correlation
3. White light moiré methods
4. Interferometry
5. Deformation analysis: Speckle pattern interferometry
6. Strain analysis: Shearography
7. Modal analysis
8. Measurement of transient deformations
9. Stress analysis: Photoelasticity
10. Stress analysis: Thermoelasticity
11. Validation of FEA results and calibration of optical full-field methods
12. Fibre based methods

**Lecture notes**

Copies of the presented slides will be made available on-line through ILIAS. You will be invited to a private blog which will stimulate the discussion of the lecture and the exercises.


This course will provide the students with an insight into the properties and physical phenomena which lead to the features of adaptive materials. The study of adaptive materials covers topics that range from chemistry to theoretical mechanics. Adaptive materials offer appealing ways to extend the design space of structures by introducing time-variable properties into them. In this course, the physical working principles of selected adaptive materials are analyzed and simple models for describing their behavior are presented. Some applications are illustrated, also with laboratory experiments where possible.

Adaptive materials offer appealing ways to extend the design space of structures by introducing time-variable properties into them. In this course, the physical working principles of selected adaptive materials are analyzed and simple models for describing their behavior are presented. Some applications are illustrated, also with laboratory experiments where possible. The aim of this course is to convey knowledge about adaptive materials, their properties and the physical mechanisms that govern their function, so as to develop the skills to deal with this interdisciplinary subject.

The exercises address practical examples. One larger case study is to be solved. Every week exercises will be distributed. Solving them is warmly recommended.

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Thermo-mechanical coupling: Shape memory alloys / polymers

Electromechanical coupling (1): DEA, EBL, electrorheological fluids

Shape control / morphing: Use, requirements, challenges

Morphing applications of variable stiffness structures: Lab work

Electromechanical coupling (2): Piezoelectric, electrostrictive effect

Vibration Reduction: Measurement, passive, semi-active (active) damping methods

Vibration reduction applications of piezoelectric materials: Lab work

Metamaterials: Definition of metamaterials - electromagnetic, acoustical and other metamaterials

Magneto-mechanical coupling: Magnetostriictive effect, mSMA, magneto rheological fluids, ferrofluids

Energy harvesting and sensing: Energy harvesting with EAP and piezoelectric materials, transducers as sensors: Piezo, resistive,...

Lecture notes (manuscript and handouts) will be provided.

Adaptive Materials for Structural Applications

Adaptive materials offer appealing ways to extend the design space of structures by introducing time-variable properties into them. In this course, the physical working principles of selected adaptive materials are analyzed and simple models for describing their behavior are presented. Some applications are illustrated, also with laboratory experiments where possible.

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System Modeling


This lecture aims to enhance the knowledge and competency of students regarding their innovation capability. An overview on prerequisites of and different skills for creativity and innovation in individual & team settings is given. The focus of this lecture is clearly on building competencies - not just acquiring knowledge.

- Basic knowledge about creativity and skills
- Knowledge about individual prerequisites for creativity
- Development of individual skills for creativity
- Knowledge about teams
- Development of team-oriented skills for creativity
- Knowledge and know-how about transfer to idea generation teams

Literature

A good overview on the optical methods is presented in the following text books:


Basic knowledge of optics and interferometry as taught in basic physics courses are advantageous. Every week exercises will be distributed. Solving them is warmly recommended.

The two afternoons with hands-on experience are central elements of the lecture.

Adaptive Materials for Structural Applications

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Energy harvesting and sensing: Energy harvesting with EAP and piezoelectric materials, transducers as sensors: Piezo, resistive,...

Lecture notes (manuscript and handouts) will be provided.
The student learns the application of the event-driven and computer-based simulation for layout and operational improvement of production facilities by means of practical examples. The student should make his first experiences in the use of computer-based simulation.

Operating simulation in the productions, logistic and scheduling will be shown by means of practical examples. The knowledge is enhanced by practice-oriented exercises and an excursion. A guest speaker will present a practical example. The knowledge will be distributed simultaneously during lecture (+ PDF).

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The course “Machine tool metrology” deals with the principal design of machine tools, their spindles and linear axes, with possible geometric, kinematic, thermal and dynamic errors of machine tools and testing these errors, with the influence of errors on the workpiece (error budgeting), with testing of drives and numerical control, as well as with checking the machine tool capability. The course is recommended for all Bachelor-Students in the 5th semester and Master-Students in the 7th semester. The knowledge is enhanced by practice-oriented exercises and an excursion. A guest speaker will present a practical example. The knowledge will be distributed simultaneously during lecture (+ PDF).

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<table>
<thead>
<tr>
<th>Content</th>
<th>Notice</th>
<th>Prerequisites / notice</th>
<th>Lecture notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metrology for production, machine tool metrology</td>
<td>yes</td>
<td>Documents are provided during the course. English handouts available on request.</td>
<td>Help for English speaking students on request. Parts of the lecture are held out during the individual lessons (CHF 20.-).</td>
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<tr>
<td>Basics, like principal machine tool design and machine tool coordinate system</td>
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<td>Principal design and errors of linear and rotational axes</td>
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<td>Error budgeting, influence of machine errors on the workpiece</td>
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<td>Geometric and kinematic testing of machine tools</td>
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<td>Reversal-masurement techniques, multi-dimensional machine tool metrology</td>
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<td>Thermal influences on machine tools and testing these influences</td>
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<td>Test uncertainty, simulation</td>
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<td>Dynamics of mechanical systems, dynamic error sources</td>
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<td>Machine tool dynamics and the engineering tools modal analysis and finite element method (FEM)</td>
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<td>Testing of drives and numerical control</td>
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<tr>
<td>Machine tool capability</td>
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<table>
<thead>
<tr>
<th>151-0721-00L</th>
<th>Production Machines II</th>
<th>W</th>
<th>4 credits</th>
<th>2V+1U</th>
<th>K. Wegener, F. Kuster, S. Weikert</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>Control, closed loop control, processing of geometrical data, main drives, noise, flexibility, rationalization and automation, modern machine concepts, thermal and dynamic behavior</td>
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<tr>
<td>Objective</td>
<td>Deeper competence for evaluation and development of production machines, sensitization for unconventional kinematics with their advantages and drawbacks.</td>
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<tr>
<td>Content</td>
<td>Control (PLC, NC), closed loop control, processing of geometrical data, main drives, noise emission, flexibility, rationalization and automation, modern machine concepts like high speed machines, alternative kinematics, ultra precision machines, thermal and dynamic behavior of machine tools, flexibility, rationalization and automation, practical case studies</td>
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<tr>
<td>Lecture notes</td>
<td>yes</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Help for English speaking students on request.</td>
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<tr>
<th>151-0723-00L</th>
<th>Manufacturing of Electronic Devices</th>
<th>W</th>
<th>4 credits</th>
<th>3G</th>
<th>A. Kunz, A. Guber, R.D. Moryson, F. Reichert</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>The lecture follows the value added process sequence of electric and electronic components. It contains: Development of electric and electronic circuits, design of electronic circuits on printed circuit boards as well as in hybrid technology, integrated test technology, planning of production lines, production of highly integrated electronic on a wafer as well as recycling.</td>
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<tr>
<td>Objective</td>
<td>Knowledge about the value added process sequence for electronics manufacturing, planning of electric and electronic product as well as their production, planning of production lines, value added process sequence for photovoltaics.</td>
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<tr>
<td>Content</td>
<td>Nothing works without electronics! Typical products in mechanical engineering such as machine tools, as well as any kind of vehicle contain a significant amount of electric or electronic components of more than 60%. Thus, it is important to master the value added process sequence for electric and electronic components. The lecture starts with a brief introduction of electronic components and the planning of integrated circuits. Next, an overview will be provided about electronic functional units assembled from these electronic components, on printed circuit boards as well as in hybrid technology. Value added process steps are shown as well as their quality check and their combination for planning a complete manufacturing line. The lecture further describes the manufacturing of integrated circuits, starting from the wafer via the structuring and bonding to the packaging. As an example, the manufacturing of micro-electromechanic and electro-optical systems and actuators is described. Due to similar processes in the electronic production, the value added process sequence for photovoltaics will described too.</td>
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<td>Lecture notes</td>
<td>Help for English speaking students on request.</td>
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<td>Prerequisites / notice</td>
<td>Lecture notes are handed out during the individual lessons (CHF 20.-).</td>
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<tr>
<th>151-0727-00L</th>
<th>Colloquium on Manufacturing Technology</th>
<th>W</th>
<th>4 credits</th>
<th>3K</th>
<th>K. Wegener, F. Kuster</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>Future training on selected current topics of the manufacturing technology. Per afternoon a selected topic is presented in several lectures, by the majority by experts from the industry. The students prepare a summary of the lectures given and prepare themselves on the basis of these lectures and own information search.</td>
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<tr>
<td>Objective</td>
<td>Continuous further training to current topics of the manufacturing technique. Exchange of experience and knowledge with the industry and other universities.</td>
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<tr>
<td>Content</td>
<td>Selected actual topics on manufacturing methods and tools, machine tools, NC-control and drives, components and measuring methods and devices. Topics are changing every year.</td>
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<tr>
<td>Lecture notes</td>
<td>no Script</td>
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<tr>
<td>Prerequisites / notice</td>
<td>- Students must have participated and passed the courses Manufacturing, Production Machines I and Forming Technology III - Forming Processes.</td>
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<td>- Further training with specialized lectures and large participation from the industry.</td>
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<tr>
<td>Language</td>
<td>Help for English speaking students on request.</td>
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<tr>
<th>151-0731-00L</th>
<th>Forming Technology I - Basic Knowledge</th>
<th>W</th>
<th>4 credits</th>
<th>2V+2U</th>
<th>P. Hora</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>The fundamentals of forming technology are presented to Mechanical, Production and Material Engineers. The content of the lecture is: Overview of manufacturing with forming techniques, deformation specific description of material properties and their experimental measurement, material laws, residual stresses, heat balance, tribological aspects of forming processes, workpiece and tool failure. Forming technology represents with its 70% global share in manufactured metal volume with respect to yield and cost, the most important manufacturing process in metal-working industries. Typical applications of forming technology range from the manufacturing of sheet metal components in auto bodies to applications in food and pharma packaging, fabrication of implants in medical technologies and to the fabrication of leads in microelectronic components. This course introduces the fundamentals which are essential to evaluate metal-forming processes and its industrial applications. This includes, together with the acquirements of the most important forming processes, the characterization of plastic material behavior and manufacturing limits.</td>
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<tr>
<td>Objective</td>
<td>Overview of the most important processes of metal-forming technology and its field of applications, characterization of the plastic metal-forming behavior, basic principles of plastic-mechanical calculations, metal-forming residual stresses, thermo-mechanical coupling of metal-forming processes, influence of tribology, Work piece failure through cracking and folding, tool failure through rupture and mechanical wear, metal-forming tools, sheet forming and massive forming processes, handling systems, metal-forming machinery.</td>
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<tr>
<td>Content</td>
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<tr>
<td>Lecture notes</td>
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<tr>
<th>151-0733-00L</th>
<th>Forming Technology III - Forming Processes</th>
<th>W</th>
<th>4 credits</th>
<th>2V+2U</th>
<th>P. Hora</th>
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</table>
Most problems in engineering are of nonlinear nature. The nonlinearities are caused basically due to the nonlinear material behavior, contact conditions and instability of structures. The principles of the nonlinear Finite-Element-Method (FEM) will be introduced in the scope of this lecture for treating such problems.

Principles of Nonlinear Finite-Element-Methods

W 5 credits 2V+2U N. Manopulo, B. Berisha, P. Hora

The course "Leading and Coaching Focus Project Teams (Basic Course)" (HS) is examined together with the course "Leading and Coaching Focus Project Teams (Advanced Course)" for Spring Semester with 4 ECTS.

Leading and Coaching Focus Project Teams (Basic Course)

W 0 credits 2G+0.5A R. P. Haas, I. Goller

The course "Leading and Coaching Focus Project Teams (Basic Course)" for Autumn Semester is examined together with the course "Leading and Coaching Focus Project Teams (Advanced Course)" for Spring Semester with 4 ECTS.

Dynamic Behavior of Materials and Structures

W 4 credits 2V+2U D. Mohr

Does not take place this semester.

Acquaintance with forming processes. Determination of forming processes. Interpretation of forming manufacturing contact conditions and instability of structures. The principles of the nonlinear Finite-Element-Method (FEM) will be introduced in the scope of this lecture for treating such problems.

Prerequisites /
Literature
Course in continuum mechanics (mandatory), finite element method (recommended)

Lecture notes
Slides of the lectures, relevant journal papers and users manuals will be provided.

Notice
Various books will be recommended covering the topics discussed in class.

Abstract
The study of metal working processes: sheet metal forming, folding die cutting, cold bulk metal forming, ro extrusion, plunging, open die forging, drop forging, forging, active principle; elementary methods to estimate stress and strain; fundamentals of process design; manufacturing limits and machining accuracy; tools and operation; machinery and machine usage.

Objective
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Notice
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Data: 06.03.2019 12:57 Autumn Semester 2016 Page 1049 of 1571
The goal of the lecture is to provide the students with the fundamentals of the non linear Finite Element Method (FEM). The lecture focuses on the principles of the nonlinear Finite-Element-Method based on explicit and implicit formulations. Typical applications of the nonlinear Finite-Element-Methods are simulations of:

- Crash
- Collapse of structures
- Materials in Biomechanics (soft materials)
- General forming processes

Special attention will be paid to the modeling of the nonlinear material behavior, thermo-mechanical processes and processes with large plastic deformations. The ability to independently create a virtual model which describes the complex non linear systems will be acquired through accompanying exercises. These will include the Matlab programming of important model components such as constitutive equations.

- Fundamentals of continuum mechanics to characterize large plastic deformations
- Elasto-plastic material models
- Updated-Lagrange (UL), Euler and combined Euler-Lagrange (ALE) approaches
- FEM implementation of constitutive equations
- Element formulations
- Implicit and explicit FEM methods
- FEM formulations of coupled thermo-mechanical problems
- Modeling of tool contact and the influence of friction
- Solvers and convergence
- Modeling of crack propagation
- Introduction of advanced FE-Methods

Overview of the most important concepts of image formation, perception and analysis, and Computer Vision. Gaining own experience.

Mass Transfer
This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore the application of these principles to important engineering problems is demonstrated.

Fick's laws; application and significance of mass transfer; comparison of Fick's laws with Newton's and Fourier's laws; derivation of Fick's laws; diffusion; concentration fluxes; velocity profiles; boundary layer theory; laminar and turbulent flows; mass transfer coefficients (Nu and Sh numbers); mass transfer across interfaces; Reynolds- and Chilton-Colburn analogies for mass-, heat- and momentum transfer in turbulent flows; film-, penetration-, and surface renewal theories; simultaneous mass, heat and momentum transfer (boundary layers); homogenous and heterogeneous reversible and irreversible reactions; diffusion-controlled reactions; mass transfer and first order heterogenous reaction. Applications.

Image Analysis and Computer Vision
The course is structured in three main blocks, each of them addressing a specific grand challenge in engineering design. Each block is composed of an introductory lecture and two to three invited talks, considering a good mix between speakers coming from academia and industry. Each talk is introduced and moderated by the students.

The aim of the course is to introduce students to the various topics in the field of Computer Vision. Topics are bundled in three main grand challenges and include an introductory lecture held by one of the responsible Professors and 2-3 invited talks of 45 min. each, addressing specific issues. The course turns to the steps that are necessary to arrive at the discrete images that serve as input to algorithms. The next part describes necessary preprocessing steps of image analysis, that enhance image quality and/or detect specific features. Linear and non-linear filters are introduced for that purpose. The course will continue by analyzing procedures allowing to extract additional types of basic information necessary preprocessing steps of image analysis, that enhance image quality and/or detect specific features. Linear and non-linear filters are introduced for that purpose. The course will continue by analyzing procedures allowing to extract additional types of basic information. A set of computer and programming exercises.

The principle of the nonlinear Finite-Element-Method based on explicit and implicit formulations. Typical applications of the nonlinear Finite-Element-Methods are demonstrations of:

- General forming processes
- Crash
- Collapse of structures
- Materials in Biomechanics (soft materials)

Two tests are offered for practicing the course material. Participation is mandatory.

Grand Challenges in Engineering Design
The course is structured in three main blocks, each of them addressing a specific grand challenge in engineering design. Each block is composed of an introductory lecture and two to three invited talks, considering a good mix between speakers coming from academia and industry. Each talk is introduced and moderated by the students.

The aim of the course is to introduce students to the various topics in the field of Computer Vision. Topics are bundled in three main grand challenges and include an introductory lecture held by one of the responsible Professors and 2-3 invited talks of 45 min. each, addressing specific issues. The course turns to the steps that are necessary to arrive at the discrete images that serve as input to algorithms. The next part describes necessary preprocessing steps of image analysis, that enhance image quality and/or detect specific features. Linear and non-linear filters are introduced for that purpose. The course will continue by analyzing procedures allowing to extract additional types of basic information. A set of computer and programming exercises.

The principle of the nonlinear Finite-Element-Method based on explicit and implicit formulations. Typical applications of the nonlinear Finite-Element-Methods are demonstrations of:

- General forming processes
- Crash
- Collapse of structures
- Materials in Biomechanics (soft materials)
Abstract
Basic characteristics of railway vehicles and their interfaces with the railway infrastructure:
- Transportation tasks and vehicle types
- Running dynamics
- Mechanical part of rail vehicles
- Brakes
- Traction chain and auxiliary supply
- Railway power supply
- Signaling systems
- Traffic control and maintenance

Objective
- Overview of the technical characteristics of railway systems
- Know-how about the design and construction principles of rail vehicles
- Interrelationship between different fields of engineering sciences (mechanics, electro and information technology, transport systems)
- Understanding tasks and opportunities of engineers working in an environment which has strong economical and political boundaries
- Insight into the activities of the railway vehicle industry and railway operators in Switzerland
- Motivation of young engineers to start a career in the railway industry or with railway operators

Content
EST I (Frühjahrsemester) - Begriffen, Grundlagen, Merkmale

1 Einführung:
1.1 Geschichte und Struktur des Bahnsystems
1.2 Fahrdynamik

2 Vollbahnfahrzeuge:
2.1 Mechanik: Kasten, Drehgestelle, Lauftechnik, Adhäsion
2.2 Bremsen
2.3 Traktionsantriebssysteme
2.4 Hilfsbetriebe und Komfortanlagen
2.5 Steuerung und Regelung

3 Infrastruktur:
3.1 Fahrweg
3.2 Bahnstromversorgung
3.3 Sicherungsanlagen

4 Betrieb:
4.1 Interoperabilität, Normen und Zulassung
4.2 RAMS, LCC
4.3 Anwendungsbeispiele

Voraussichtlich ein oder zwei Gastreferate

Geplante Exkursionen:
- Betriebszentrale SBB, Zürich Flughafen
- Reparatur und Unterhalt, SBB Zürich Altstetten
- Fahrzeugfertigung, Stadler Bussnang

Lecture notes
Abgabe der Unterlagen (gegen eine Schutzgebühr) zu Beginn des Semesters. Rechtzeitig eingeschriebene Teilnehmer können die Unterlagen auf Wunsch und gegen eine Zusatzgebühr auch in Farbe beziehen.

Prerequisites / notice
Dozent: Dr. Markus Meyer, Emkamatik GmbH

Voraussichtlich ein oder zwei Gastvorträge von anderen Referenten.

EST I (Herbstsemester) kann als in sich geschlossene einsemestrige Vorlesung besucht werden. EST II (Frühjahrssemester) dient der weiteren Vertiefung der Fahrzeugtechnik und der Integration in die Bahninfrastruktur.

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252-0535-00L  Machine Learning  W  8 credits  3V+2U+2A  J. M. Buhmann

Abstract
Machine learning algorithms provide analytical methods to search data sets for characteristic patterns. Typical tasks include the classification of data, function fitting and clustering, with applications in image and speech analysis, bioinformatics and exploratory data analysis. This course is accompanied by practical machine learning projects.

Objective
Students will be familiarized with the most important concepts and algorithms for supervised and unsupervised learning; reinforce the statistics knowledge which is indispensable to solve modeling problems under uncertainty. Key concepts are the generalization ability of algorithms and systematic approaches to modeling and regularization. A machine learning project will provide an opportunity to test the machine learning algorithms on real world data.

Content
The theory of fundamental machine learning concepts is presented in the lecture, and illustrated with relevant applications. Students can deepen their understanding by solving both pen-and-paper and programming exercises, where they implement and apply famous algorithms to real-world data.

Topics covered in the lecture include:
- Bayesian theory of optimal decisions
- Maximum likelihood and Bayesian parameter inference
- Classification with discriminant functions: Perceptrons, Fisher’s LDA and support vector machines (SVM)
- Ensemble methods: Bagging and Boosting
- Regression: least squares, ridge and LASSO penalization, non-linear regression and the bias-variance trade-off
- Non parametric density estimation: Parzen windows, nearest neighbour
- Dimension reduction: principal component analysis (PCA) and beyond

Lecture notes
No lecture notes, but slides will be made available on the course webpage.

Literature
The course introduces the students to the long-standing tradition of actively involving users of technology and other knowledge-intensive 
products in the development and production process, and through own cases they develop an entrepreneurial understanding of product development under distributed, user-centered, or open innovation strategies.

Objective
At the end of the course the students will be able to build a rendering system. The students will study the basic principles of rendering and image synthesis. In addition, the course is intended to stimulate the students' curiosity to explore the field of computer graphics in subsequent courses or on their own.

Content
This course covers fundamental concepts of modern computer graphics. Students will learn about 3D object representations and the details of how to generate photorealistic images from digital representations of 3D scenes. Starting with an introduction to 3D shape modeling and representation, texture mapping and ray tracing, we will move on to acceleration structures, the physics of light transport, appearance modeling and global illumination principles and algorithms. We will end with an overview of modern image-based image synthesis techniques, covering topics such as lightfields and depth-image based rendering.

Literature
Haasen, Physikalische Grundlagen der Materialkunde, Springer Verlag

351-0555-00L
Open- and User Innovation

Abstract
The course introduces the students to the long-standing tradition of actively involving users of technology and other knowledge-intensive products in the development and production process, and through own cases they develop an entrepreneurial understanding of product development under distributed, user-centered, or open innovation strategies.

Objective
The programming assignments will be in C++. This will not be taught in the class.

Content
The course requires solid basic knowledge in analysis, statistics and numerical methods for CSE as well as practical programming experience for solving assignments.

Students should at least have followed one previous course offered by the Machine Learning Institute (e.g., CIL or LIS) or an equivalent course offered by another institution.

252-0543-01L
Computer Graphics

Abstract
This course covers some of the fundamental concepts of computer graphics, namely 3D object representations and generation of photorealistic images from digital representations of 3D scenes.

Objective
At the end of the course the students will be able to build a rendering system. The students will study the basic principles of rendering and image synthesis. In addition, the course is intended to stimulate the students' curiosity to explore the field of computer graphics in subsequent courses or on their own.

Content
This course covers fundamental concepts of modern computer graphics. Students will learn about 3D object representations and the details of how to generate photorealistic images from digital representations of 3D scenes. Starting with an introduction to 3D shape modeling and representation, texture mapping and ray tracing, we will move on to acceleration structures, the physics of light transport, appearance modeling and global illumination principles and algorithms. We will end with an overview of modern image-based image synthesis techniques, covering topics such as lightfields and depth-image based rendering.

Prerequisites / notice
Prerequisites:
Fundamentals of calculus and linear algebra, basic concepts of algorithms and data structures, programming skills in C++, Visual Computing course recommended.

The programming assignments will be in C++. This will not be taught in the class.
The slides of the lectures are made available and updated continuously through the SMI website:

**2V** Production and Operations Management

Why are problems not simple? Why do some systems behave in an unintended way? How can we model and control their dynamics? The


1 credit

The course includes both lectures and exercises alternately. The goal is to understand the opportunity of user innovation for management

The students actively participate in discussions during the lectures and contribute presentations of case studies during the exercises. The combination should allow to compare theory with practical cases from various industries.

The course presents and builds upon recent research and challenges the students to devise innovation strategies that take into account the availability of user expertise, free and public knowledge, and the interaction with communities that span beyond one organization.

Grading is based on the final exam, the class presentations (including the slides) as well as class participation.

**Content**

This course on user innovation extends courses on knowledge management and innovation as well as marketing. The students are introduced to the long-standing tradition of actively involving users of technology and other knowledge-intensive products in the development and production process, and through own cases they develop an entrepreneurial understanding of product development under distributed, user-centered, or open innovation strategies. Theoretical underpinnings taught in the course include models of innovation, the structuration of technology, and an introduction to entrepreneurship.

**Literature**

The slides of the lectures are made available and updated continuously through the SMI website:

Relevant literature for the exam includes the slides and the reading assignments. The corresponding papers are either available from the author online or distributed during class.

Reading assignments: please consult the SMI website:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Type</th>
<th>Instructor(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-0445-00L</td>
<td>Production and Operations Management</td>
<td>3</td>
<td>W</td>
<td>T. Netland, P. Schönsleben</td>
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<tr>
<td></td>
<td><strong>Objective</strong></td>
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<td></td>
<td>Students learn why and how operations can be a competitive weapon; how to design, plan, control, and manage production and service processes; how to improve effectiveness and efficiency in operations; how to take advantage of new technological advancements; and how environmental and social concerns affect decisions in global production networks.</td>
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<tr>
<td></td>
<td><strong>Content</strong></td>
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<td></td>
<td>The course covers the most fundamental strategic and tactical concepts in production and operations management. The lectures cover: Introduction to POM; Operations strategy; Capacity management; Production planning and control; Production philosophies; Lean management; Performance measurement; Problem solving; Service operations; New technologies in POM; Servitization; Global production; and Triple-bottom line.</td>
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<tr>
<td></td>
<td><strong>Literature</strong></td>
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<tr>
<th>Course Code</th>
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<tbody>
<tr>
<td>363-0445-02L</td>
<td>Production and Operations Management (Additional Cases)</td>
<td>1</td>
<td>W</td>
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<td><strong>Objective</strong></td>
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<td></td>
<td>Extension to course 363-0445-00 Production and Operations Management.</td>
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<td><strong>Content</strong></td>
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<td>Additional cases to course 363-0445-00 Production and Operations Management.</td>
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<th>Course Code</th>
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<tbody>
<tr>
<td>363-0541-00L</td>
<td>Systems Dynamics and Complexity</td>
<td>3</td>
<td>W</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td></td>
<td>Finding solutions: what is complexity, problem solving cycle.</td>
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<td></td>
<td>Implementing solutions: project management, critical path method, quality control feedback loop.</td>
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<td><strong>Objective</strong></td>
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<td>A successful participant of the course is able to:</td>
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<td>- understand why most real problems are not simple, but require solution methods that go beyond algorithmic and mathematical approaches</td>
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<td>- apply the problem solving cycle as a systematic approach to identify problems and their solutions</td>
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<td>- calculate project schedules according to the critical path method</td>
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<td>- setup and run systems dynamics models by means of the Vensim software</td>
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<td>- identify feedback cycles and reasons for unintended systems behavior</td>
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<td>- analyse the stability of nonlinear dynamical systems and apply this to macroeconomic dynamics</td>
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<td><strong>Content</strong></td>
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<td></td>
<td>Why are problems not simple? Why do some systems behave in an unintended way? How can we model and control their dynamics? The course provides answers to these questions by using a broad range of methods encompassing systems oriented management, classical systems dynamics, nonlinear dynamics and macroeconomic modeling.</td>
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<td>The course is structured along three main tasks:</td>
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<tr>
<td></td>
<td>1. Finding solutions</td>
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<td>2. Implementing solutions</td>
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<td>3. Controlling solutions</td>
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<td><strong>Lecture notes</strong></td>
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<td>Weekly self-study tasks are used to apply the concepts introduced in the lectures and to come to grips with the software program VENSIM.</td>
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<td><strong>Prerequisites / notice</strong></td>
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<td>The lecture slides are provided as handouts - including notes and literature sources - to registered students only. All material is to be found on the Moodle platform. More details during the first lecture</td>
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<tr>
<th>Course Code</th>
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<th>Type</th>
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<tbody>
<tr>
<td>363-0711-00L</td>
<td>Accounting for Managers</td>
<td>3</td>
<td>W</td>
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</table>

Data: 06.03.2019 12:57  Autumn Semester 2016  Page 1053 of 1571
Abstract
Overview of financial and managerial accounting
Accounting for current and fixed assets
Liabilities and owners equity
Recording change in balance sheet
Measuring financial performance
Managing financial reporting
Full and variable costing system
Using accounting information for decision making purposes

Objective
Understand the different procedures involved in the accounting system
Record change in financial position
Measure business income
Prepare final accounts
Understand the principles of cost accounting
Calculate the different product costs
Make decisions about the acceptance or rejection of a particular product

Content
Financial Accounting: Balance sheet, income statement, double-entry accounting, journal and ledger, accounting for merchandising activities, value-added tax, adjustments before final accounts, provisions, depreciation, valuation,
Managerial Accounting: Full costing, variable costing, cost-volume profit, break-even analysis, activity-based costing

Prerequisites / notice
This course is a prerequisite for the course Financial Management.

376-1177-00L  Human Factors I
W  2 credits  2V  M. Menozzi Jäckli, R. Huang, M. Siegrist

Abstract
Every day humans interact with various systems. Strategies of interaction, individual needs, physical & mental abilities, and system properties are important factors in controlling the quality and performance in interaction processes. In the lecture, factors are investigated by basic scientific approaches. Discussed topics are important for optimizing people's satisfaction & overall performance.

Objective
The goal of the lecture is to empower students in better understanding the applied theories, principles, and methods in various applications. Students are expected to learn about how to enable an efficient and qualitatively high standing interaction between human and the environment, considering costs, benefits, health, and safety as well. Thus, an ergonomic design and evaluation process of products, tasks, and environments may be promoted in different disciplines. The goal is achieved in addressing a broad variety of topics and embedding the discussion in macroscopic factors such as the behavior of consumers and objectives of economy.

Content
- Physiological, physical, and cognitive factors in sensation and perception
- Body spaces and functional anthropometry, Digital Human Models
- Experimental techniques in assessing human performance and well-being
- Human factors and ergonomics in system designs, product development and innovation
- Human information processing and biological cybernetics
- Interaction among consumers, environments, behavior, and tasks

Literature
- Gavriel Salvendy, Handbook of Human Factors and Ergonomics, 4th edition (2012), is available on NEBIS as electronic version and for free to ETH students
- Further textbooks are introduced in the lecture
- Brouchures, checklists, key articles etc. are uploaded in ILIAS

376-1219-00L  Rehabilitation Engineering II: Rehabilitation of Sensory and Vegetative Functions
W  3 credits  2V  R. Riener, R. Gasser, L. Marchal Crespo

Abstract
Rehabilitation Engng is the application of science and technology to ameliorate the handicaps of individuals with disabilities to reintegrate them into society. The goal is to present classical and new rehabilitation engineering principles applied to compensate or enhance motor, sensory, and cognitive deficits. Focus is on the restoration and treatment of the human sensory and vegetative system.

Objective
Provide knowledge on the anatomy and physiology of the human sensory system, related dysfunctions and pathologies, and how rehabilitation engineering can provide sensory restoration and substitution.

Content
Introduction, problem definition, overview
- Rehabilitation of visual function
  - Anatomy and physiology of the visual sense
  - Technical aids (glasses, sensor substitution)
  - Retina and cortex implants
- Rehabilitation of hearing function
  - Anatomy and physiology of the auditory sense
  - Hearing aids
  - Cochlea Implants
- Rehabilitation and use of kinesthetis and tactile function
  - Anatomy and physiology of the kinesthetic and tactile sense
  - Tactile/haptic displays for motion therapy (incl. electrical stimulation)
  - Role of displays in motor learning
- Rehabilitation of vestibular function
  - Anatomy and physiology of the vestibular sense
  - Rehabilitation strategies and devices (e.g. BrainPort)
- Rehabilitation of vegetative Functions
  - Cardiac Pacemaker
  - Phrenic stimulation, artificial breathing aids
  - Bladder stimulation, artificial sphincter
  - Brain stimulation and recording
  - Deep brain stimulation for patients with Parkinson, epilepsy, depression
  - Brain-Computer Interfaces
Topics covered in this course include:

- The students should get acquainted with a modern toolbox in the design of mechanical metamaterials. Equipped with the knowledge of the key design principles, the students will be able to choose the appropriate approach to create a metamaterial with a pre-defined functionality as the use of Bragg scattering, local resonances, topological band-structures, and non-linear effects.

- The goal of the course is to obtain a good understanding of some of the most fundamental mathematical optimization techniques used to solve linear programs and basic combinatorial optimization problems. The students will also practice applying the learned models to problems in engineering.

Selected Journal Articles and Web Links:


Prerequisites / notice

Target Group:

- Students of higher semesters and PhD students of
- D-MAVT, D-ITET, D-INFK, D-HEST
- Medical Faculty, University of Zurich
- Students of other departments, faculties, courses are also welcome

This lecture is independent from Rehabilitation Engineering I. Thus, both lectures can be visited in arbitrary order.

401-0647-00L Introduction to Mathematical Optimization W 5 credits 2V+1U D. Adjiashvili

Objective

Introduction to basic techniques and problems in mathematical optimization, and their applications to problems in engineering.

Content

Topics covered in this course include:

- Linear programming (simplex method, duality theory, shadow prices, ...);
- Basic combinatorial optimization problems (spanning trees, network flows, knapsack problem, ...);
- Modelling with mathematical optimization: applications of mathematical programming in engineering.

Information about relevant literature will be given in the lecture.

402-0801-66L Mechanical Metamaterials W 4 credits 2V+1U S. Huber

Objective

A mechanical metamaterial derives its static or dynamic properties not from its microscopic composition but rather through its clever engineering at larger scales. In this course we introduce the basic principles behind the design of modern mechanical metamaterials such as the use of Bragg scattering, local resonances, topological band-structures, and non-linear effects.

The students should get acquainted with a modern toolbox in the design of mechanical metamaterials. Equipped with the knowledge of the key design principles, the students will be able to choose the appropriate approach to create a metamaterial with a pre-defined functionality either for dynamic applications such as vibration isolation, wave-guiding, or the design of a heat-diode, or static properties such as stress absorption or the design of mechanisms used in robotics.
Content
1.) Wave propagation in continuous systems
2.) Wave properties
3.) Discrete systems
4.) Local resonances
5.) Topology by example
6.) Topological classification
7.) Static systems
8.) Non-linear waves

Lecture notes
Hand-outs will be available in class.

Robots, Systems and Control

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>151-0104-00L</td>
<td>Uncertainty Quantification for Engineering &amp; Life</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>P. Koumoutsakos</td>
</tr>
</tbody>
</table>

Abstract
Quantification of uncertainties in computational models pertaining to applications in engineering and life sciences. Exploitation of massively available data to develop computational models with quantifiable predictive capabilities. Applications of Uncertainty Quantification and Propagation to problems in mechanics, control, systems and cell biology.

Objective
The course will teach fundamental concept of Uncertainty Quantification and Propagation (UQ+P) for computational models of systems in Engineering and Life Sciences. Emphasis will be placed on practical and computational aspects of UQ+P including the implementation of relevant algorithms in multicore architectures.

Content
Topics that will be covered include: Uncertainty quantification under parametric and non-parametric modelling uncertainty, Bayesian inference with model class assessment, Markov Chain Monte Carlo simulation, prior and posterior reliability analysis.

Lecture notes
The class will be largely based on the book: Data Analysis: A Bayesian Tutorial by Devinderjit Sivia as well as on class notes and related literature that will be distributed in class.

Literature
1. Data Analysis: A Bayesian Tutorial by Devinderjit Sivia
2. Probability Theory: The Logic of Science by E. T. Jaynes
3. Class Notes

Prerequisites / notice
Fundamentals of Probability, Fundamentals of Computational Modeling

High Performance Computing for Science and Engineering (HPCSE) I

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>151-0107-20L</td>
<td>High Performance Computing for Science and Engineering</td>
<td>W</td>
<td>4 credits</td>
<td>4G</td>
<td>M. Troyer, P. Chatzidoukas</td>
</tr>
</tbody>
</table>

Abstract
This course gives an introduction into algorithms and numerical methods for parallel computing for multi and many-core architectures and for applications from problems in science and engineering.

Objective
Introduction to HPC for scientists and engineers
Fundamental of:
1. Parallel Computing Architectures
2. MultiCores
3. ManyCores

Content
Programming models and languages:
1. C++ threading (2 weeks)
2. OpenMP (4 weeks)
3. MPI (5 weeks)

Computers and methods:
1. Hardware and architectures
2. Libraries
3. Particles: N-body solvers
4. Fields: PDEs
5. Stochastics: Monte Carlo

Lecture notes
http://www.cse-lab.ethz.ch/index.php/teaching/42-teaching/classes/615-hpcse1
Class notes, handouts

Nonlinear Dynamics and Chaos I

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<th>Number</th>
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<tr>
<td>151-0532-00L</td>
<td>Nonlinear Dynamics and Chaos I</td>
<td>W</td>
<td>4 credits</td>
<td>2V+2U</td>
<td>G. Haller, F. Kogelbauer</td>
</tr>
</tbody>
</table>

Abstract
Basic facts about nonlinear systems; stability and near-equilibrium dynamics; bifurcations; dynamical systems on the plane; non-autonomous dynamical systems; chaotic dynamics.

Objective
This course is intended for Masters and Ph.D. students in engineering sciences, physics and applied mathematics who are interested in the behavior of nonlinear dynamical systems. It offers an introduction to the qualitative study of nonlinear physical phenomena modeled by differential equations or discrete maps. We discuss applications in classical mechanics, electrical engineering, fluid mechanics, and biology. A more advanced Part II of this class is offered every other year.

Content
(1) Basic facts about nonlinear systems: Existence, uniqueness, and dependence on initial data.
(2) Near equilibrium dynamics: Linear and Lyapunov stability
(3) Bifurcations of equilibria: Center manifolds, normal forms, and elementary bifurcations
(4) Nonlinear dynamical systems on the plane: Phase plane techniques, limit sets, and limit cycles.
(5) Time-dependent dynamical systems: Floquet theory, Poincare maps, averaging methods, resonance

Lecture notes
The class lecture notes will be posted electronically after each lecture. Students should not rely on these but prepare their own notes during the lecture.

Prerequisites / notice
- Prerequisites: Analysis, linear algebra and a basic course in differential equations.
- Exam: two-hour written exam in English.
- Homework: A homework assignment will be due roughly every other week. Hints to solutions will be posted after the homework due dates.

Dynamic Programming and Optimal Control

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0563-01L</td>
<td>Dynamic Programming and Optimal Control</td>
<td>W</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>R. D’Andrea</td>
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Abstract
Introduction to Dynamic Programming and Optimal Control.

Objective
Covers the fundamental concepts of Dynamic Programming & Optimal Control.
### Content

**Dynamic Programming Algorithm; Deterministic Systems and Shortest Path Problems; Infinite Horizon Problems, Bellman Equation; Deterministic Continuous-Time Optimal Control.**


**Requirements: Knowledge of advanced calculus, introductory probability theory, and matrix-vector algebra.**

### Literature

**Prerequisites / notice**

### 151-0567-00L

**Engine Systems**

**Abstract**
Introduction to current and future engine systems and their control systems. Understanding the structure and behavior of drive train systems and their quantitative descriptions.

**Objective**
Introduction to methods of control and optimization of dynamic systems. Application to real engines. Understand the structure and behavior of drive train systems and their quantitative descriptions.

**Content**
Physical description and mathematical models of components and subsystems (mixture formation, load control, supercharging, emissions, drive train components, etc.).

**Lecture notes**
Introduction to Modeling and Control of Internal Combustion Engine Systems

**Prerequisites / notice**
Combined homework and testbench exercise (air-to-fuel-ratio control or idle-speed control) in groups

### 151-0569-00L

**Vehicle Propulsion Systems**

**Abstract**
Introduction to current and future propulsion systems and the electronic control of their longitudinal behavior.

**Objective**
Introduction to methods of system optimization and controller design for vehicles. Understanding the structure and working principles of conventional and new propulsion systems. Quantitative description of propulsion systems.

**Content**
Understanding of physical phenomena and mathematical models of components and subsystems (manual, automatic and continuously variable transmissions, energy storage systems, electric drive trains, batteries, hybrid systems, fuel cells, road/wheel interaction, automatic braking systems, etc.).

**Lecture notes**
Vehicle Propulsion Systems -- Introduction to Modeling and Optimization

**Prerequisites / notice**
Lectures of Dr. Ch. Onder are also possible to be held in German

### 151-0573-00L

**System Modeling**

**Abstract**

**Objective**

**Content**
Introduction to generic system modeling approaches for control-oriented models based on first principles and on experimental data. Examples: mechatronic, thermodynamic, chemistry, fluid dynamic, energy, and process engineering systems. Model scaling, linearization, order reduction, and balancing. Estimation techniques (least-squares methods).

**Lecture notes**
The exercises address practical examples. One larger case study is to be solved.

**Prerequisites / notice**
Lectures of Dr. Ch. Onder are also possible to be held in German

### 151-0593-00L

**Embedded Control Systems**

**Abstract**
This course provides a comprehensive overview of embedded control systems. The concepts introduced are implemented and verified on a microprocessor-controlled haptic device.

**Objective**
Familiarize students with main architectural principles and concepts of embedded control systems.

**Content**
An embedded system is a microprocessor used as a component in another piece of technology, such as cell phones or automobiles. This intensive two-week block course the students are presented the principles of embedded digital control systems using a haptic device as an example for a mechatronic system. A haptic interface allows for a human to interact with a computer through the sense of touch.

**Subjects covered in lectures and practical lab exercises include:**
- The application of C-programming on a microprocessor
- Digital I/O and serial communication
- Quadrature decoding for wheel position sensing
- Queued analog-to-digital conversion to interface with the analog world
- Pulse width modulation
- Timer interrupts to create sampling time intervals
- System dynamics and virtual worlds with haptic feedback
- Introduction to rapid prototyping

**Lecture notes**
Lecture notes, lab instructions, supplemental material

**Prerequisites / notice**
Prerequisite courses are Control Systems I and Informatics I.

This course is restricted to 33 students due to limited lab infrastructure. Interested students please contact Marianne Schmid (E-Mail: marischm@ethz.ch)

After your reservation has been confirmed please register online at www.mystudies.ethz.ch.

Detailed information can be found on the course website

http://www.idsc.ethz.ch/education/lectures/embedded-control-systems.html

### 151-0601-00L

**Theory of Robotics and Mechatronics**

**Abstract**
This course provides an introduction and covers the fundamentals of the field, including rigid motions, homogeneous transformations, forward and inverse kinematics of multiple degree of freedom manipulators, velocity kinematics, motion planning, trajectory generation, sensing, vision, and control. Its a requirement for the Robotics Vertiefung and for the Masters in Mechatronics and Microsystems.

**Prerequisites / notice**

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Data: 06.03.2019 12:57  Autumn Semester 2016  Page 1057 of 1571
This course consists of a series of seven lectures given by researchers who have distinguished themselves in the area of Robotics, Vision Algorithms for Mobile Robotics.

Microrobotics is an interdisciplinary field that combines aspects of robotics, micro and nanotechnology, biomedical engineering, and materials science. The aim of this course is to expose students to the fundamentals of this emerging field. Throughout the course students are expected to submit assignments. The course concludes with an end-of-semester examination.

The objective of this course is to expose students to the fundamental aspects of the emerging field of microrobotics. This includes a focus on physical laws that predominate at the microscale, technologies for fabricating small devices, bio-inspired design, and applications of the field.

Main topics of the course include:
- Scaling laws at micro/nano scales
- Electrostatics
- Electromagnetism
- Low Reynolds number flows
- Observation tools
- Materials and fabrication methods
- Applications of biomedical microrobots

Lecture notes
The powerpoint slides presented in the lectures will be made available in hardcopy and as pdf files. Several readings will also be made available electronically.

Prerequisites
The lecture will be taught in English.

Objectives
- Development of team-oriented skills for creativity
- Knowledge about teams
- Knowledge about individual prerequisites for creativity

Prerequisites
Students are required to attend all seven lectures to obtain credit. If a student must miss a lecture then attendance at a related special lecture will be accepted that is reported in a one page summary of the attended lecture. No exceptions to this rule are allowed.

Abstract
This course consists of a series of seven lectures given by researchers who have distinguished themselves in the area of Robotics, Systems, and Controls.

Objective
Obtain an overview of various topics in Robotics, Systems, and Controls from leaders in the field. Please see http://www.msr.ethz.ch/education/distinguished-seminar-in-robotics--systems--controls--151-0623-0.html for a list of upcoming lectures.

Content
This course consists of a series of seven lectures given by researchers who have distinguished themselves in the area of Robotics, Systems, and Controls. MSc students in Robotics, Systems, and Controls are required to attend every lecture. Attendance will be monitored. If for some reason a student cannot attend one of the lectures, the student must select another ETH or University of Zurich seminar related to the field and submit a one page description of the seminar topic. Please see http://www.msr.ethz.ch/education/distinguished-seminar-in-robotics--systems--controls--151-0623-0.html for a suggestion of other lectures.

Prerequisites
Students are required to attend all seven lectures to obtain credit. If a student must miss a lecture then attendance at a related special lecture will be accepted that is reported in a one page summary of the attended lecture. No exceptions to this rule are allowed.

Abstract
For a robot to be autonomous, it has to perceive and understand the world around it. This course introduces you to the fundamental computer vision algorithms used in mobile robotics, in particular: feature extraction, multiple view geometry, dense reconstruction, object tracking, image retrieval, event-based vision, and visual-inertial odometry (the algorithm behind Google Tango).

Objective
Learn the fundamental computer vision algorithms used in mobile robotics, in particular: feature extraction, multiple view geometry, dense reconstruction, object tracking, image retrieval, event-based vision, and visual-inertial odometry (the algorithm behind Google Tango).

Content
For a robot to be autonomous, it has to perceive and understand the world around it. This course introduces you to the fundamental computer vision algorithms used in mobile robotics, in particular: feature extraction, multiple view geometry, dense reconstruction, object tracking, image retrieval, event-based vision, and visual-inertial odometry (the algorithm behind Google Tango).

Literature

Prerequisites
Basics of algebra and geometry, matrix calculus.

Objectives
Skills for Creativity and Innovation
This lecture aims to enhance the knowledge and competency of students regarding their innovation capability. An overview on prerequisites of and different skills for creativity and innovation in individual & team settings is given. The focus of this lecture is clearly on building competencies - not just acquiring knowledge.

Prerequisites
- Basic knowledge about creativity and skills
- Knowledge about individual prerequisites for creativity
- Development of individual skills for creativity
- Knowledge about teams
- Development of team-oriented skills for creativity
- Knowledge and know-how about transfer to idea generation teams
The primary objective of this course is that the student deepens an applied understanding of how to model the most common robotic systems and devices. The contents of the following ETH Bachelor lectures or equivalent are assumed to be known: Mechanics and Dynamics, Control, Basics in Fluid Dynamics.

The student receives a solid background in kinematics, dynamics, and rotations of multi-body systems. On the basis of state of the art applications, he/she will learn all necessary tools to work in the field of design or control of robotic systems.

- Further training with specialized lectures and large participation from the industry.
- Further training with specialized lectures and large participation from the industry.
- Methods of knowledge transfer
- Cooperation & communication in innovation teams
- Idea generation and development in teams
- Roles in innovation processes
- Idea generation and development in teams
- Roles in innovation processes
- Knowledge about individual prerequisites for creativity:
- Personality, motivation, intelligence
- Development of individual skills for creativity:
- Focus on creativity as problem analysis & solving
- Individual skills in theoretical models
- Individual competencies: exercises and reflection
- Knowledge about teams:
- Definitions and models
- Development of team-oriented skills for creativity:
- Idea generation and development in teams
- Cooperation & communication in innovation teams
- Knowledge and know-how about transfer to idea generation teams:
- Self-reflection & development planning
- Methods of knowledge transfer

**Content**

- Basic knowledge about creativity and skills:
  - Introduction into creativity & innovation: definitions and models
- Knowledge about individual prerequisites for creativity:
  - Personality, motivation, intelligence
- Development of individual skills for creativity:
  - Focus on creativity as problem analysis & solving
  - Individual skills in theoretical models
  - Individual competencies: exercises and reflection
- Knowledge about teams:
  - Definitions and models
  - Roles in innovation processes
- Development of team-oriented skills for creativity:
  - Idea generation and development in teams
  - Cooperation & communication in innovation teams
- Knowledge and know-how about transfer to idea generation teams:
  - Self-reflection & development planning
  - Methods of knowledge transfer

**Prerequisites / notice**

- Further training with specialized lectures and large participation from the industry.

**Literature**

- Further training with specialized lectures and large participation from the industry.
- Methods of knowledge transfer

**Abstract**

Future training on selected current topics of the manufacturing technology. Per afternoon a selected topic is presented in several lectures, by the majority by experts from the industry. The students prepare a summary of the lectures given and prepare themselves on the basis of these lectures and own information search.

- Further training with specialized lectures and large participation from the industry.
- Methods of knowledge transfer

**Objective**

- Contious further training to current topics of the manufacturing technique. Exchange of experience and knowledge with the industry and other universities.
- Further training with specialized lectures and large participation from the industry.
- Methods of knowledge transfer

**Content**

- Selected actual topics on manufacturing methods and tools, machine tools, NC-control and drives, components and measuring methods and devices. Topics are changing every year.
- Further training with specialized lectures and large participation from the industry.
- Methods of knowledge transfer

**Lecture notes**

- Slides, script and other documents will be distributed via moodle.ethz.ch (access only for students registered to this course)
- Further training with specialized lectures and large participation from the industry.
- Methods of knowledge transfer

**151-0727-00L**

**Colloquium on Manufacturing Technology**

- 4 credits
- W
- 3K
- K. Wegener, F. Kuster

**Abstract**

Future training on selected current topics of the manufacturing technology. Per afternoon a selected topic is presented in several lectures, by the majority by experts from the industry. The students prepare a summary of the lectures given and prepare themselves on the basis of these lectures and own information search.

**Objective**

- Contious further training to current topics of the manufacturing technique. Exchange of experience and knowledge with the industry and other universities.

**Content**

- Selected actual topics on manufacturing methods and tools, machine tools, NC-control and drives, components and measuring methods and devices. Topics are changing every year.

**Prerequisites / notice**

- Further training with specialized lectures and large participation from the industry.

**Language:** Help for English speaking students on request.

**151-0851-00L**

**Robot Dynamics**

- 4 credits
- W
- 2V+1U
- M. Hutter, R. Siegwart, T. Stastny

**Abstract**

We will provide an overview on how to kinematically and dynamically model typical robotic systems such as robot arms, legged robots, rotary wing systems, or fixed wing.

**Objective**

- The primary objective of this course is that the student deepens an applied understanding of how to model the most common robotic systems. The student receives a solid background in kinematics, dynamics, and rotations of multi-body systems. On the basis of state of the art applications, he/she will learn all necessary tools to work in the field of design or control of robotic systems.

**Content**

- The course consists of three parts: First, we will refresh and deepen the student's knowledge in kinematics, dynamics, and rotations of multi-body systems. In this context, the learning material will build upon the courses for mechanics and dynamics available at ETH, with the particular focus on their application to robotic systems. The goal is to foster the conceptual understanding of similarities and differences among the various types of robots. In the second part, we will apply the learned material to classical robotic arms as well as legged systems and discuss kinematic constraints and interaction forces. In the third part, focus is put on modeling fixed wing aircraft, along with related design and control concepts. In this context, we also touch aerodynamics and flight mechanics to an extent typically required in robotics. The last part finally covers different helicopter types, with a focus on quadrotors and the coaxial configuration which we see today in many UAV applications. Case studies on all main topics provide the link to real applications and to the state of the art in robotics.

**Prerequisites / notice**

- Further training with specialized lectures and large participation from the industry.

**Literature**

- Further training with specialized lectures and large participation from the industry.

**151-0917-00L**

**Mass Transfer**

- 4 credits
- W
- 2V+2U
- R. Büchel, S. E. Pratsinis

**Abstract**

This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore the application of these principles to important engineering problems is demonstrated.

**Objective**

- This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore the application of these principles to important engineering problems is demonstrated.

**Content**

- Fick’s laws; application and significance of mass transfer; comparison of Fick’s laws with Newton's and Fourier's laws; derivation of Fick's 2nd law; diffusion in dilute and concentrated solutions; rotating disk; dispersion; diffusion coefficients, viscosity and heat conduction (Pr and Sc numbers); Brownian motion; Stokes-Einstein equation; mass transfer coefficients (Nu and Sh numbers); mass transfer across interfaces; Reynolds- and Chilton-Colburn analogies for mass-, heat-, and momentum transfer in turbulent flows; film-, penetration-, and surface renewal theories; simultaneous mass, heat and momentum transfer (boundary layers); homogenous and heterogenous reversible and irreversible reactions; diffusion-controlled reactions; mass transfer and first order heterogenous reaction. Applications.

**Literature**


**Prerequisites / notice**

- Two tests are offered for practicing the course material. Participation is mandatory.

**151-1116-00L**

**Introduction to Aircraft and Car Aerodynamics**

- 4 credits
- W
- 3G
- J. Wildi

**Abstract**

- Aircraft aerodynamics: Atmosphere; aerodynamic forces (lift, drag); thrust.

**Objective**

- An introduction to the basic principles and interrelationships of aircraft and automotive aerodynamics.
- To understand the basic relations of the origin of aerodynamic forces (e lift, drag). To quantify the aerodynamic forces for basic configurations of aircraft and car components.
- Illustration of the intrinsic problems and results using examples.
- Using experimental and theoretical methods to illustrate possibilities and limits.
Airplane aerodynamics: atmosphere, aerodynamic forces (ascending force; profile, wings, Resistance, residual resistance, induced resistance); thrust (overview of the propulsion system, aerodynamics of the propellers), introduction to static longitudinal stability.


**Lecture notes**

1.) Grundlagen der Flugtechnik (Basics of flight science, script in german language)
2.) Einführung in die Fahrzeug aerodynamik (Introduction in car aerodynamics, script in german language)

**Literature**

English literature covering the content of the course:


**227-0225-00L Linear System Theory**

**W 6 credits 5G M. Kamgarpour**

**Abstract**

The class is intended to provide a comprehensive overview of the theory of linear dynamical systems, their use in control, filtering, and estimation and their applications to areas ranging from avionics to systems biology.

**Objective**

By the end of the class students should be comfortable with the fundamental results in linear system theory and the mathematical tools used to derive them.

**Content**

- Rings, fields and linear spaces, normed linear spaces and inner product spaces.
- Ordinary differential equations, existence and uniqueness of solutions.
- Continuous and discrete time, time varying linear systems. Time domain solutions. Time invariant systems treated as a special case.
- Controllability and observability, canonical forms, Kalman decomposition. Time invariant systems treated as a special case.
- Stability and stabilization, observers, state and output feedback, separation principle.
- Realization theory.

**Lecture notes**


**Prerequisites / notice**

Prerequisites: Control Systems I (227-0103-00) or equivalent and sufficient mathematical maturity.

**227-0447-00L Image Analysis and Computer Vision**

**W 6 credits 3V+1U L. Van Gool, O. Göksel, E. Konukoglu**

**Abstract**


**Objective**

Overview of the most important concepts of image formation, perception and analysis, and Computer Vision. Gaining own experience through practical computer and programming exercises.

**Content**

The first part of the course starts off from an overview of existing and emerging applications that need computer vision. It shows that the realm of image processing is no longer restricted to the factory floor, but is entering several fields of our daily life. First it is investigated how the parameters of the electromagnetic waves are related to our perception. Also the interaction of light with matter is considered. The most important hardware components of technical vision systems, such as cameras, optical devices and illumination sources are discussed. The course then turns to the steps that are necessary to arrive at the discrete images that serve as input to algorithms. The next part describes necessary preprocessing steps of image analysis, that enhance image quality and/or detect specific features. Linear and non-linear filters are introduced for that purpose. The course will continue by analyzing procedures allowing to extract additional types of basic information from multiple images, with motion and depth as two important examples. The estimation of image velocities (optical flow) will get due attention and methods for object tracking will be presented. Several techniques are discussed to extract three-dimensional information about objects and scenes. Finally, approaches for the recognition of specific objects as well as object classes will be discussed and analyzed.

**Lecture notes**

Course material Script, computer demonstrations, exercises and problem solutions

**Prerequisites / notice**

Prerequisites: Basic concepts of mathematical analysis and linear algebra. The computer exercises are based on Linux and C. The course language is English.

**227-0517-00L Electrical Drive Systems II**

**W 6 credits 4G P. Steimer, G. Scheuer, C. A. Stulz**

**Abstract**

In the course "Drive System II" the power semiconductors are repeated. The creation of converters based on the combination of switches/cells and based topologies is explained. Another main focus is on the 3-level inverter with its switching and transfer functions. Further topics are the control of the synchronous machine, of line-side converters and issues with converter-fed machines.

**Objective**

The students establish a deeper understanding in regards of the design of the main components of an electrical drive system. They establish knowledge on the most important interaction with the grid and the machine and their related high dynamic control.

**Content**

Converter topologies (switch or cell based), multi-pulse diode rectifiers, system aspects of transformer and electrical machines, 3-level inverter with its switching and transfer functions, grid side harmonics, modeling and control of synchronous machines (including permanent magnet machines), control of line-side converters, reflection effects with power cables, winding insulation and bearing stress. Field trip to ABB Semiconductors.

**Lecture notes**

Skit is sold at the beginning of the lectures or can be downloaded from Ilias

**Literature**

Skit of lecture; References in skript to related technical publications and books

**Prerequisites / notice**

Prerequisites: Electrical Drive Systems I (recommended), Basics in electrical engineering, power electronics, automation and mechatronics

**227-0689-00L System Identification**

**W 4 credits 2V+1U R. Smith**

**Abstract**

Theory and techniques for the identification of dynamic models from experimentally obtained system input-output data.

**Objective**

To provide a series of practical techniques for the development of dynamical models from experimental data, with the emphasis being on the development of models suitable for feedback control design purposes. To provide sufficient theory to enable the practitioner to understand the trade-offs between model accuracy, data quality and data quantity.

**Content**

Introduction to modeling: Black-box and grey-box models; Parametric and non-parametric models; ARX, ARMAX (etc.) models.

Predictive, open-loop, black-box identification methods. Time and frequency domain methods. Subspace identification methods.

Optimal experimental design, Cramer-Rao bounds, input signal design.

Parametric identification methods. On-line and batch approaches.

Closed-loop identification strategies. Trade-off between controller performance and information available for identification.


**Prerequisites / notice**


Control systems (227-0216-00L) or equivalent.
Introduction, problem definition, overview

Topics covered:

3V+1U+1A

This course introduces core modeling techniques and algorithms from statistics, optimization, planning, and control and study applications in areas such as sensor networks, robotics, and the Internet.

The course provides an introduction to the field of human-computer interaction, emphasizing the central role of the user in system design. Through detailed case studies, students will be introduced to different methods used to analyse the user experience and shown how these can inform the design of new interfaces, systems and technologies.

The goal of the course is that students should understand the principles of user-centred design and be able to apply these in practice. The course will introduce students to various methods of analysing the user experience, showing how these can be used at different stages of system development from requirements analysis through to usability testing. Students will get experience of designing and carrying out user studies as well as analysing results. The course will also cover the basic principles of interaction design. Practical exercises related to touch and gesture-based interaction will be used to reinforce the concepts introduced in the lecture. To get students to further think beyond traditional system design, we will discuss issues related to ambient information and awareness.

How can we build systems that perform well in uncertain environments and unforeseen situations? How can we develop systems that exhibit "intelligent" behavior, without prescribing explicit rules? How can we build systems that learn from experience in order to improve their performance? We will study core modeling techniques and algorithms from statistics, optimization, planning, and control and study applications in areas such as sensor networks, robotics, and the Internet. The course is designed for upper-level undergraduate and graduate students.

Content

Topics covered:
- Search (BFS, DFS, A*), constraint satisfaction and optimization
- Tutorial in logic (propositional, first-order)
- Probability
  - Bayesian Networks (models, exact and approximate inference, learning)
  - Temporal models (Hidden Markov Models, Dynamic Bayesian Networks)
- Probabilistic planning (MDPs, POMDPs)
- Reinforcement learning
- Combining logic and probability

Prerequisites / notice

Solid basic knowledge in statistics, algorithms and programming

The objective of this course are:
- To introduce the fundamental problems of computer vision.
- To introduce the main concepts and techniques used to solve those.
- To enable participants to implement solutions for reasonably complex problems.
- To enable participants to make sense of the computer vision literature.

Content

Camera models and calibration, invariant features, Multiple-view geometry, Model fitting, Stereo Matching, Segmentation, 2D Shape matching, Shape from Silhouettes, Optical flow, Structure from motion, Tracking, Object recognition, Object category recognition

Prerequisites / notice

It is recommended that students have taken the Visual Computing lecture or a similar course introducing basic image processing concepts before taking this course.

The goal of this course is to provide students with a good understanding of computer vision and image analysis techniques. The main concepts and techniques will be studied in depth and practical algorithms and approaches will be discussed and explored through the exercises.

The objectives of this course are:
- To introduce the main concepts and techniques used to solve those.
- To enable participants to implement solutions for reasonably complex problems.
- To enable participants to make sense of the computer vision literature.

Content

Camera models and calibration, invariant features, Multiple-view geometry, Model fitting, Stereo Matching, Segmentation, 2D Shape matching, Shape from Silhouettes, Optical flow, Structure from motion, Tracking, Object recognition, Object category recognition

Prerequisites / notice

It is recommended that students have taken the Visual Computing lecture or a similar course introducing basic image processing concepts before taking this course.

Rehabilitation Engineering II: Rehabilitation of Sensory and Vegetative Functions

The goal of this course is to present classical and new rehabilitation engineering principles applied to compensate or enhance motor, sensory, and cognitive deficits. Focus is on the restoration and treatment of the human sensory and vegetative system.

Objective

Provide knowledge on the anatomy and physiology of the human sensory system, related dysfunctions and pathologies, and how rehabilitation engineering can provide sensory restoration and substitution.

Content

This lecture is independent from Rehabilitation Engineering I. Thus, both lectures can be visited in arbitrary order.

Introduction, problem definition, overview

Rehabilitation of visual function
- Anatomy and physiology of the visual sense
- Technical aids (glasses, sensor substitution)
- Retina and cortex implants
Rehabilitation of hearing function
- Anatomy and physiology of the auditory sense
- Hearing aids
- Cochlea Implants
Rehabilitation and use of kinesthetic and tactile function
- Anatomy and physiology of the kinesthetic and tactile sense
- Tactile/haptic displays for motion therapy (incl. electrical stimulation)
- Role of displays in motor learning
Rehabilitation of vestibular function
- Anatomy and physiology of the vestibular sense
- Rehabilitation strategies and devices (e.g. BrainPort)
Rehabilitation of vegetative Functions
- Cardiac Pacemaker
- Phrenic stimulation, artificial breathing aids
- Bladder stimulation, artificial sphincter
Brain stimulation and recording
- Deep brain stimulation for patients with Parkinson, epilepsy, depression
- Brain-Computer Interfaces
Virtual Reality in Medicine

Introductory Books:
- R. Riener

Virtual Reality has the potential to provide descriptive and practical information for medical training and therapy while relieving the patient. The lecture will derive the technical principles of multi-modal simulation and interface technologies in Virtual Reality. Neural prostheses - replacing motor function after disease or disability. Eds.: R. Stein, H. Peckham, D. Popovic. New York and Oxford: Oxford University Press.


Selected Journal Articles and Web Links:

VideoTact, ForeThought Development, LLC. http://my.execpc.com/?dwysocki/videotac.html

Prerequisites / notice
Target Group:
Students of higher semesters and PhD students of
- D-MAVT, D-ITET, D-INFK, D-HEST
- Biomedical Engineering, Robotics, Systems and Control
- Medical Faculty, University of Zurich
- Students of other departments, faculties, courses are also welcome
This lecture is independent from Rehabilitation Engineering I. Thus, both lectures can be visited in arbitrary order.

376-1279-00L Virtual Reality in Medicine n  W 3 credits  2V  R. Riener

Does not take place this semester.

Abstract
Virtual Reality has the potential to support medical training and therapy. This lecture will derive the technical principles of multi-modal (audiovisual, haptic, tactile etc.) input devices, displays and rendering techniques. Examples are presented in the fields of surgical training, intra-operative augmentation, and rehabilitation. The lecture is accompanied by practical courses and excursions.

Objective
Provide theoretical and practical knowledge of new principles and applications of multi-modal simulation and interface technologies in medical education, therapy, and rehabilitation.

Content
Virtual Reality has the potential to provide descriptive and practical information for medical training and therapy while relieving the patient. The lecture will derive the technical principles of multi-modal simulation and interface technologies in medical education, therapy, and rehabilitation. The lecture is accompanied by practical courses and excursions.

Target Group:
Students of higher semesters and PhD students of
- D-MAVT, D-ITET, D-INFK, D-HEST
- Biomedical Engineering, Robotics, Systems and Control
- Medical Faculty, University of Zurich

Students of other departments, faculties, courses are also welcome!

Literature

Data: 06.03.2019 12:57  Autumn Semester 2016  Page 1062 of 1571
This course focuses on the emerging, interdisciplinary field of physical human-robot interaction, bringing together themes from robotics, real-time control, human factors, haptics, virtual environments, interaction design and other fields to enable the development of human-oriented robotic systems.

The objective of this course is to give an introduction to the fundamentals of physical human-robot interaction, through lectures on the underlying theoretical/mechatronics aspects and application fields, in combination with a hands-on lab tutorial. The course will guide students through the design and evaluation process of such systems.

By the end of this course, you should understand the critical elements in human-robot interactions - both in terms of engineering and human factors - and use these to evaluate and de-sign safe and efficient assistive and rehabilitative robotic systems. Specifically, you should be able to:

1) identify critical human factors in physical human-robot interaction and use these to derive design requirements;
2) compare and select mechatronic components that optimally fulfill the defined design requirements;
3) derive a model of the device dynamics to guide and optimize the selection and integration of selected components into a functional system;
4) design control hardware and software and implement and test human-interactive control strategies on the physical setup;
5) characterize and optimize such systems using both engineering and psychophysical evaluation metrics;
6) investigate and optimize one aspect of the physical setup and convey and defend the gained insights in a technical presentation.

This course provides an introduction to fundamental aspects of physical human-robot interaction. After an overview of human haptic, visual and auditory sensing, neurophysiology and psychophysics, principles of human-robot interaction systems (kinematics, mechanical transmissions, robot sensors and actuators used in these systems) will be introduced. Throughout the course, students will gain knowledge of interaction control strategies including impedance/admittance and force control, haptic rendering basics and issues in device design for humans such as transparency and stability analysis, safety hardware and procedures. The course is organized into lectures that aim to bring students up to speed with the basics of these systems, readings on classical and current topics in physical human-robot interaction, laboratory sessions and lab visits. Students will attend periodic laboratory sessions where they will implement the theoretical aspects learned during the lectures. Here the salient features of haptic device design will be identified and theoretical aspects will be implemented in a haptic system based on the haptic paddle (http://www.relab.ethz.ch/education/courses/phri/request-ethz-haptic-paddle-hardware-documentation.html), by creating simple dynamic haptic virtual environments and understanding the performance limitations and causes of instabilities (direct/virtual coupling, friction, damping, time delays, sampling rates, quantization, etc.) during rendering of different mechanical properties.

Lecture notes
Will be distributed through the document repository before the lectures. http://www.relab.ethz.ch/education/courses/phri.html

Literature
<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>151-0104-00L</td>
<td>Uncertainty Quantification for Engineering &amp; Life Sciences</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>P. Koumoutsakos</td>
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<td></td>
<td><em>Does not take place this semester.</em></td>
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<td><strong>Abstract</strong></td>
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<td></td>
<td>Quantification of uncertainties in computational models pertaining to applications in engineering and life sciences. Exploitation of massively available data to develop computational models with quantifiable predictive capabilities. Applications of Uncertainty Quantification and Propagation to problems in mechanics, control, systems and cell biology.</td>
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<td></td>
<td>The course will teach fundamental concepts of Uncertainty Quantification and Propagation (UQ+P) for computational models of systems in Engineering and Life Sciences. Emphasis will be placed on practical and computational aspects of UQ+P including the implementation of relevant algorithms in multicore architectures.</td>
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<td><strong>Content</strong></td>
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<td></td>
<td>Topics that will be covered include: Uncertainty quantification under parametric and non-parametric modelling uncertainty, Bayesian inference with model class assessment, Markov Chain Monte Carlo simulation, prior and posterior reliability analysis.</td>
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<td><strong>Lecture notes</strong></td>
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<td>The class will be largely based on the book: Data Analysis: A Bayesian Tutorial by Devinderjit Sivia as well as on class notes and related literature that will be distributed in class.</td>
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<tr>
<td></td>
<td>1. Data Analysis: A Bayesian Tutorial by Devinderjit Sivia</td>
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<td></td>
<td>2. Probability Theory: The Logic of Science by E. T. Jaynes</td>
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<td>3. Class Notes</td>
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<td><strong>Prerequisites / notice</strong></td>
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<tr>
<td></td>
<td>Fundamentals of Probability, Fundamentals of Computational Modeling</td>
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<td>151-0107-20L</td>
<td>High Performance Computing for Science and Engineering (HPCSE) I</td>
<td>W</td>
<td>4</td>
<td>4G</td>
<td>M. Troyer, P. Chatzidoukas</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td></td>
<td>This course gives an introduction into algorithms and numerical methods for parallel computing for multi and many-core architectures and for applications from problems in science and engineering.</td>
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<td>Introduction to HPC for scientists and engineers</td>
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<td>1. Parallel Computing Architectures</td>
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<td>2. MultiCores</td>
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<td>3. ManyCores</td>
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<td></td>
<td>Programming models and languages:</td>
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<td></td>
<td>1. C++ threading (2 weeks)</td>
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<td>2. OpenMP (4 weeks)</td>
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<td>3. MPI (5 weeks)</td>
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<td>Computers and methods:</td>
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<td></td>
<td>1. Hardware and architectures</td>
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<td>2. Libraries</td>
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<td>3. Particles: N-body solvers</td>
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<td>4. Fields: PDEs</td>
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<td>5. Stochastics: Monte Carlo</td>
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<td><strong>Lecture notes</strong></td>
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<td></td>
<td>The powerpoint slides presented in the lectures will be made available in hardcopy and as pdf files. Several readings will also be made available electronically.</td>
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<td><em>Autumn Semester 2016</em></td>
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<tr>
<td>151-0604-00L</td>
<td>Microrobotics</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>B. Nelson</td>
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<td></td>
<td><em>Does not take place this semester.</em></td>
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<td></td>
<td><strong>Abstract</strong></td>
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<td>Microrobotics is an interdisciplinary field that combines aspects of robotics, micro and nanotechnology, biomedical engineering, and materials science. The aim of this course is to expose students to the fundamentals of this emerging field. Throughout the course students are expected to submit assignments. The course concludes with an end-of-semester examination.</td>
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<td><strong>Objective</strong></td>
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<td>The objective of this course is to expose students to the fundamental aspects of the emerging field of microrobotics. This includes a focus on physical laws that predominate at the microscale, technologies for fabricating small devices, bio-inspired design, and applications of the field.</td>
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<td><strong>Content</strong></td>
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<td>Main topics of the course include:</td>
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<td>- Scaling laws at micro/nano scales</td>
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<td>- Electrostatics</td>
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<td>- Electromagnetism</td>
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<td>- Low Reynolds number flows</td>
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<td>- Observation tools</td>
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<td>- Materials and fabrication methods</td>
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<td>- Applications of biomedical microrobots</td>
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<td><strong>Lecture notes</strong></td>
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<td>The lecture will be taught in English.</td>
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<td>151-0605-00L</td>
<td>Nanosystems</td>
<td>W</td>
<td>4</td>
<td>4G</td>
<td>A. Stemmer, J.N. Tisserant</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td>From atoms to molecules to condensed matter: characteristic properties of simple nanosystems and how they evolve when moving towards complex ensembles. Intermolecular forces, their macroscopic manifestations, and ways to control such interactions. Self-assembly and directed assembly of 2D and 3D structures. Special emphasis on the emerging field of molecular electronic devices.</td>
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<td><strong>Objective</strong></td>
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<td>Familiarize students with basic science and engineering principles governing the nano domain.</td>
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</table>
With guidance from a tutor, the individual silicon microsystem process steps that are required for the fabrication of an accelerometer are carried out. This course provides fundamental knowledge of surface plasmon polaritons and discusses their applications in plasmonics. Students learn the individual process steps that are required to make a MEMS (Micro Electro Mechanical System) and carry out the fabrication and testing steps in the clean rooms by themselves. Additionally, they learn the requirements for working in clean rooms. Processing and characterization will be documented and analyzed in a final report. Limited access to the course is provided based on the following priorities:

- Priority 1: master students of the master's program in "Micro and Nanosystems"
- Priority 2: master students of the master's program in "Mechanical Engineering" with a specialization in Microsystems and Nanoscale Engineering
- Priority 3: master students, who attended the bachelor course "151-0621-00L Microsystems Technology" successfully.
- Priority 4: all other students (PhD, bachelor, master) with a background in silicon or microsystems process technology.

If there are more than 15 students registered, we regret to restrict access to this course by the following rules:

- Written documentation and evaluation of the entire production, processing and characterization of the MEMS is documented and evaluated in a final report.
- Testing and characterization of the MEMS device
- Packaging and electrical connection of a MEMS device
- Photolithography, dry etching, wet etching, sacrificial layer etching, critical point drying, various cleaning procedures
- Limited access to the clean rooms. Processing and characterization will be documented and analyzed in a final report. Limited access to the course is provided based on the following priorities:
- Priority 1: master students of the master's program in "Micro and Nanosystems"
- Priority 2: master students of the master's program in "Mechanical Engineering" with a specialization in Microsystems and Nanoscale Engineering
- Priority 3: master students, who attended the bachelor course "151-0621-00L Microsystems Technology" successfully.
- Priority 4: all other students (PhD, bachelor, master) with a background in silicon or microsystems process technology.

If there are more than 15 students registered, we regret to restrict access to this course by the following rules:

- Written documentation and evaluation of the entire production, processing and characterization of the MEMS is documented and evaluated in a final report.
- Testing and characterization of the MEMS device
- Packaging and electrical connection of a MEMS device
- Photolithography, dry etching, wet etching, sacrificial layer etching, critical point drying, various cleaning procedures
- Limited access to the clean rooms. Processing and characterization will be documented and analyzed in a final report.
- Participating students are required to attend all scheduled lectures and meetings of the course.

Students will be notified at the first lecture of the course (introductory lecture) as to whether they are able to participate.

The course is offered in autumn and spring semester.

**Seminar on Micro and Nanosystems**

- Scientific presentations from the field of Micro- and Nanosystems
- In particular, the seminar addresses students, who are interested in scientific work in the field of Micro- and Nanosystem technologies, or who have started already with it. Respectively, current examples in the research will be discussed.

**Introduction to Plasmonics**

- This course provides fundamental knowledge of surface plasmon polaritons and discusses their applications in plasmonics.
Electromagnetic oscillations known as surface plasmon polaritons have many unique properties that are useful across a broad set of applications in biology, chemistry, physics, and optics. The field of plasmonics has arisen to understand the behavior of surface plasmon polaritons and to develop applications in areas such as catalysis, imaging, photovoltaics, and sensing. In particular, metallic nanoparticles and patterned metallic interfaces have been developed to utilize plasmonic resonances. The aim of this course is to provide the basic knowledge to understand and apply the principles of plasmonics. The course will strive to be approachable to students from a diverse set of science and engineering backgrounds.

### Content

- Fundamentals of Plasmonics
  - Basic electromagnetic theory
  - Optical properties of metals
  - Surface plasmon polaritons on surfaces
  - Surface plasmon polariton propagation
  - Localized surface plasmons
- Applications of Plasmonics
  - Waveguides
  - Extraordinary optical transmission
  - Enhanced spectroscopy
  - Sensing
  - Metamaterials

### Literature


### Prerequisites / notice

Two tests are offered for practicing the course material. Participation is mandatory.

151-0931-00L  
**Seminar on Particle Technology**  
**Abstract**  
The goal of the lecture is to convey a basic knowledge in the area of PV materials as well as their construction and production processes and to empower the students to apply the knowledge gained to address current problems in research and practice.

**Objective**  
Students attend and give research presentations for the research they plan to do and at the end of the semester they defend their results and answer questions from research scientists. Familiarize the students with the latest in this field.

151-0917-00L  
**Mass Transfer**  
**W 4 credits 2V+2U**  
R. Büchel, S. E. Pratsinis

### Prerequisites / notice

This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore the application of these principles to important engineering problems is demonstrated.

**Content**  
This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore the application of these principles to important engineering problems is demonstrated.

**Literature**  

227-0377-00L  
**Physics of Failure and Failure Analysis of Electronic Devices and Equipment**  
**W 3 credits 2V**  
U. Sennhauser

### Abstract

Failures have to be avoided by proper design, material selection and manufacturing. Properties, degradation mechanisms, and expected lifetime of materials are introduced and the basics of failure analysis and analysis equipment are presented. Failures will be demonstrated experimentally and the opportunity is offered to perform a failure analysis with advanced equipment in the laboratory.

**Objective**  
Introduction to the degradation and failure mechanisms and causes of electronic components, devices and systems as well as to methods and tools of reliability testing, characterization and failure analysis.

**Content**  
Summary of reliability and failure analysis terminology; physics of failure: materials properties, physical processes and failure mechanisms; failure analysis of ICs, PCBs, opto-electronics, discrete and other components and devices; basics and properties of instruments; application in circuit design and reliability analysis.

**Lecture notes**  
Comprehensive copy of transparencies

227-0455-00L  
**Terahertz: Technology & Applications**  
**W 3 credits 2V**  
K. Sankaran

### Abstract

This course will provide a solid foundation for understanding physical principles of THz applications. We will discuss various building blocks of THz technology - components dealing with generation, manipulation, and detection of THz electromagnetic radiation. We will introduce THz applications in the domain of imaging, communications, and energy harvesting.

**Objective**  
This is an introductory course on Terahertz (THz) technology and applications. Devices operating in THz frequency range (0.1 to 10 THz) have been increasingly studied in the recent years. Progress in nonlinear optical materials, ultrafast optical and electronic techniques has strengthened research in THz application developments. Due to unique interaction of THz waves with materials, applications with new capabilities can be developed. In theory, they can penetrate somewhat like X-rays, but are not considered harmful radiation, because THz energy level is low. They should be able to provide resolution as good or better than magnetic resonance imaging (MRI), possibly with simpler equipment. Imaging, very-high bandwidth communication, and energy harvesting are the most widely explored THz application areas. We will study the basics of THz generation, manipulation, and detection. Our emphasis will be on the physical principles and applications of THz in the domain of imaging, communication and energy harvesting.

**Content**  
**INTRODUCTION**  
Chapter 1: Introduction to THz Physics  
Chapter 2: Components of THz Technology  
THz TECHNOLOGY MODULES  
Chapter 3: THz Generation  
Chapter 4: THz Detection  
Chapter 5: THz Manipulation  
APPLICATIONS  
Chapter 6: THz Imaging  
Chapter 7: THz Communication  
Chapter 8: THz Energy Harvesting
### Bioengineering

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<tr>
<th>Number</th>
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<tr>
<td>151-0104-00L</td>
<td>Uncertainty Quantification for Engineering &amp; Life Sciences</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>P. Koumoutsakos</td>
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</table>

**Abstract**
Quantification of uncertainties in computational models pertaining to applications in engineering and life sciences. Exploitation of massively available data to develop computational models with quantifiable predictive capabilities. Applications of Uncertainty Quantification and Propagation to problems in mechanics, control, systems and cell biology.

**Objective**
The course will teach fundamental concept of Uncertainty Quantification and Propagation (UQ+P) for computational models of systems in Engineering and Life Sciences. Emphasis will be placed on practical and computational aspects of UQ+P including the implementation of relevant algorithms in multicore architectures.

**Content**
Topics that will be covered include: Uncertainty quantification under parametric and non-parametric modeling uncertainty, Bayesian inference with model class assessment, Markov Chain Monte Carlo simulation, prior and posterior reliability analysis.

**Lecture notes**
The class will be largely based on the book: *Data Analysis: A Bayesian Tutorial* by Devinderjit Sivia as well as on class notes and related literature that will be distributed in class.

**Literature**
1. *Data Analysis: A Bayesian Tutorial* by Devinderjit Sivia
2. Probability Theory: *The Logic of Science* by E. T. Jaynes
3. Class Notes

**Prerequisites / notice**
Fundamentals of Probability, Fundamentals of Computational Modeling

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<tr>
<td>151-0107-20L</td>
<td>High Performance Computing for Science and Engineering (HPCSE) I</td>
<td>W</td>
<td>4 credits</td>
<td>4G</td>
<td>M. Troyer, P. Chatzidoukas</td>
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</table>

**Abstract**
This course gives an introduction into algorithms and numerical methods for parallel computing for multi and many-core architectures and for applications from problems in science and engineering.

**Objective**
Introduction to HPC for scientists and engineers
Fundamental of:
1. Parallel Computing Architectures
2. MultiCores
3. ManyCores

**Content**
Programming models and languages:
1. C++ threading (2 weeks)
2. OpenMP (4 weeks)
3. MPI (5 weeks)

Computers and methods:
1. Hardware and architectures
2. Libraries
3. Particles: N-body solvers
4. Fields: PDEs
5. Stochastics: Monte Carlo

**Lecture notes**
http://www.cse-lab.ethz.ch/index.php/teaching/42-teaching/classes/615-hpcse1

**Literature**
Class notes, handouts

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<td>151-0255-00L</td>
<td>Energy Conversion and Transport in Biosystems</td>
<td>W</td>
<td>4 credits</td>
<td>2+1U</td>
<td>D. Poulilakos, A. Ferrari</td>
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**Abstract**
Theory and application of thermodynamics and energy conversion in biological systems with focus on the cellular level.

**Objective**
Theory and application of energy conversion at the cellular level. Understanding of the basic features governing solutes transport in the principal systems of the human cell. Connection of characteristics and patterns from other fields of engineering to biofluidics. Heat and mass transport processes in the cell, generation of forces, work and relation to biomedical technologies.

**Content**
Mass transfer models for the transport of chemical species in the human cell. Organization and function of the cell membrane and of the cell cytoskeleton. The role of molecular motors in cellular force generation and their function in cell migration. Description of the functionality of these systems and of analytical experimental and computational techniques for understanding of their operation. Introduction to cell metabolism, cellular energy transport and cellular thermodynamics.

**Lecture notes**
Material in the form of hand-outs will be distributed.

**Literature**
Class notes, handouts therein.

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<tr>
<th>Number</th>
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<tr>
<td>151-0317-00L</td>
<td>Visualization, Simulation and Interaction - Virtual Reality II</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>A. Kunz</td>
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**Abstract**
This lecture provides deeper knowledge on the possible applications of virtual reality, its basic technology, and future research findings. The goal is to provide a strong knowledge on Virtual Reality for a possible future use in business processes.

**Objective**
Virtual Reality can not only be used for the visualization of 3D objects, but also offers a wide application field for small and medium enterprises (SME). This could be for instance an enabling technology for net-based collaboration, the transmission of images and other data, the interaction of the human user with the digital environment, or the use of augmented reality systems.

The goal of the lecture is to provide a deeper knowledge of today’s VR environments that are used in business processes. The technical background, the algorithms, and the applied methods are explained in more detail. Finally, future tasks of VR will be discussed and an outlook on ongoing international research is given.

**Content**
Introduction into Virtual Reality; basics of augmented reality; interaction with digital data, tangible user interfaces (TUI); basics of simulation; compression procedures of image-, audio-, and video data; new materials for force feedback devices; introduction into data security; cryptography; definition of free-form surfaces; digital factory; new research fields of virtual reality

**Lecture notes**
The handout is available in German and English.

**Prerequisites / notice**
Didactical concept: The course consists of lectures and exercises.
This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore the application of these principles to important engineering problems is demonstrated.

**Objective**
This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore the application of these principles to important engineering problems is demonstrated.

**Content**
Fick's laws; application and significance of mass transfer; comparison of Fick's 2nd law; diffusion in dilute and concentrated solutions; rotating disk; dispersion; diffusion coefficients, viscosity and heat conduction (Pr and Sc numbers); Brownian motion; Stokes-Einstein equation; mass transfer coefficients (Nu and Sh numbers); mass transfer across interfaces; Reynolds- and Chilton-Colburn analogies for mass-, heat-, and momentum transfer in turbulent flows; film-, penetration-, and surface renewal theories; simultaneous mass, heat and momentum transfer (boundary layers); homogeneous and heterogenous reversible and irreversible reactions; diffusion-controlled reactions; mass transfer and first order heterogenous reaction. Applications.

**Literature**

**Prerequisites / notice**
Two tests are offered for practicing the course material. Participation is mandatory.

**Objective**
You will learn how to apply the scientific discipline of ergonomics for system analysis and product development "in order to optimise human well-being and overall system performance" (www.iea.cc). The course offers the framework of models, concepts, methods and tools of applied ergonomics. Teaching is combined with learning-by-doing and research-based learning.

**Content**
- Knowledge of:
  - Principles and rules of applied ergonomic system and product design.
  - Methods and tools of ergonomic analysis and evaluation.
  - Practical experiences and hands-on skills in:
    - Conducting a study in system and task analysis.
    - Analysing human-product interactions.
    - Applying ergonomic knowledge for product and system improvements.
  - Definition and role of applied ergonomics in engineering and design.
  - Framework of ergonomic analysis and design.
  - Design principles and rules.
  - Methods and tools for system and task analysis.
  - Hands-on experience in team work:
    - Experimental study of human-product interaction and usability through eye-tracking.
    - Field study of system and task analysis, including on-site visits of complex work stations (Hospital OR/ICU or Air traffic/Railway Control Rooms).

**Lecture notes**
Handout at the start of the course.

**Literature**

**Prerequisites / notice**
Max. number of participants is 15.
Experiments and field studies in teams of 2-3 students are obligatory.

**Objective**
Introduction and analysis of medical imaging technology including X-ray procedures, computed tomography, nuclear imaging techniques using single photon and positron emission tomography, magnetic resonance imaging and ultrasound imaging techniques.

**Content**
- X-ray imaging
- Computed tomography
- Single photon emission tomography
- Positron emission tomography
- Magnetic resonance imaging
- Ultrasound/Doppler imaging

**Lecture notes**
Lecture notes and handouts

**Literature**
Webb A, Smith N.B. Introduction to Medical Imaging: Physics, Engineering and Clinical Applications; Cambridge University Press 2011
Analysis, Linear Algebra, Physics, Basics of Signal Theory, Basic skills in Matlab programming

**Objective**
Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The focus is on learning the concepts that govern common medical instruments and the most important organs from an engineering point of view. In addition, the most recent achievements and trends of the field of biomedical engineering are also outlined.

**Content**
Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The course provides an overview of the various topics of the different tracks of the biomedical engineering master course and helps orienting the students in selecting their specialized classes and project locations.

**Literature**

**Prerequisites / notice**

**Objective**
Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The focus is on learning the concepts that govern common medical instruments and the most important organs from an engineering point of view. In addition, the most recent achievements and trends of the field of biomedical engineering are also outlined.

**Content**

**Practical and theoretical exercises in small groups in the laboratory.**
<table>
<thead>
<tr>
<th>Lecture notes</th>
<th>Introduction to Biomedical Engineering by Enderle, Banchard, and Bronzino AND</th>
</tr>
</thead>
<tbody>
<tr>
<td><a href="https://www1.ethz.ch/lbb/Education/BME">https://www1.ethz.ch/lbb/Education/BME</a></td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>227-0393-10L</th>
<th>Bioelectronics and Biosensors</th>
<th>W</th>
<th>6 credits</th>
<th>2V+2U</th>
<th>J. Vörös, M. F. Yanik, T. Zambelli</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Abstract</strong></td>
<td>The course introduces the concepts of bioelectricity and biosensing. The sources and use of electrical fields and currents in the context of biological systems and problems are discussed. The fundamental challenges of measuring biological signals are introduced. The most important biosensing techniques and their physical concepts are introduced in a quantitative fashion.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>During this course the students will:</td>
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<tr>
<td>- learn the basic concepts in biosensing and bioelectronics</td>
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<td>- be able to solve typical problems in biosensing and bioelectronics</td>
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<td>- learn about the remaining challenges in this field</td>
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<tr>
<td><strong>Content</strong></td>
<td>L1. Bioelectronics history, its applications and overview of the field</td>
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<tr>
<td>- Volta and Galvani dispute</td>
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<tr>
<td>- BMI, pacemaker, cochlear implant, retinal implant, limb replacement devices</td>
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<tr>
<td>- Fundamentals of biosensing</td>
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<td>- Glucometer and ELISA</td>
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<tr>
<td>L2. Fundamentals of quantum and classical noise in measuring biological signals</td>
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<td>L3. Biomeasurement techniques with photons</td>
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<td>L4. Acoustics sensors</td>
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<tr>
<td>- Differential equation for quartz crystal resonance</td>
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<tr>
<td>- Acoustic sensors and their applications</td>
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<tr>
<td>L5. Engineering principles of optical probes for measuring and manipulating molecular and cellular processes</td>
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<td>L6. Optical biosensors</td>
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<tr>
<td>- Differential equation for optical waveguides</td>
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<td>- Optical sensors and their applications</td>
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<tr>
<td>- Plasmonic sensing</td>
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<td>L7. Basic notions of molecular adsorption and electron transfer</td>
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<tr>
<td>- Quantum mechanics: Schrödinger equation energy levels from H atom to crystals, energy bands</td>
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<tr>
<td>- Electron transfer: Marcus theory, Gerischer theory</td>
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<td>L8. Potentiometric sensors</td>
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<tr>
<td>- Fundamentals of the electrochemical cell at equilibrium (Nernst equation)</td>
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<td>- Principles of operation of ion-selective electrodes</td>
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<td>L9. Amperometric sensors and bioelectric potentials</td>
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<tr>
<td>- Fundamentals of the electrochemical cell with an applied overpotential to generate a faraday current</td>
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<tr>
<td>- Principles of operation of amperometric sensors</td>
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<tr>
<td>- Ion flow through a membrane (Fick equation, Nernst equation, Donnan equilibrium, Goldman equation)</td>
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<td>L10. Channels, amplification, signal gating, and patch clamp Y4</td>
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<td>L11. Action potentials and impulse propagation</td>
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<td>L12. Functional electric stimulation and recording</td>
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<td>- MEA and CMOS based recording</td>
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<tr>
<td>- Applying potential in liquid - simulation of fields and relevance to electric stimulation</td>
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<tr>
<td>L13. Neural networks, memory and learning</td>
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<table>
<thead>
<tr>
<th>Literature</th>
<th>Plonsky and Barr, Bioelectricity: A Quantitative Approach (Third edition)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prerequisites / notice</td>
<td>Supervised exercises solving real-world problems. Some Matlab based exercises in groups.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>227-0447-00L</th>
<th>Image Analysis and Computer Vision</th>
<th>W</th>
<th>6 credits</th>
<th>3V+1U</th>
<th>L. Van Gool, O. Göksel, E. Konukoglu</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Abstract</strong></td>
<td>Light and perception. Digital image formation. Image enhancement and feature extraction. Unitary transformations. Color and texture. Image segmentation and deformable shape matching. Motion extraction and tracking. 3D data extraction. Invariant features. Specific object recognition and object class recognition.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>Overview of the most important concepts of image formation, perception and analysis, and Computer Vision. Gaining own experience through practical computer and programming exercises.</td>
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<tr>
<td><strong>Content</strong></td>
<td>The first part of the course starts off from an overview of existing and emerging applications that need computer vision. It shows that the realm of image processing is no longer restricted to the factory floor, but is entering several fields of our daily life. First it is investigated how the parameters of the electromagnetic waves are related to our perception. Also the interaction of light with matter is considered. The most important hardware components of technical vision systems, such as cameras, optical devices and illumination sources are discussed. The course then turns to the steps that are necessary to arrive at the discrete images that serve as input to algorithms. The next part describes necessary preprocessing steps of image analysis, that enhance image quality and/or detect specific features. Linear and non-linear filters are introduced for that purpose. The course will continue by analyzing procedures allowing to extract additional types of basic information from multiple images, with motion and depth as two important examples. The estimation of image velocities (optical flow) will get due attention and methods for object tracking will be presented. Several techniques are discussed to extract three-dimensional information about objects and scenes. Finally, approaches for the recognition of specific objects as well as object classes will be discussed and analyzed.</td>
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<tr>
<td>Lecture notes</td>
<td>Course material Script, computer demonstrations, exercises and problem solutions</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Prerequisites: Basic concepts of mathematical analysis and linear algebra. The computer exercises are based on Linux and C. The course language is English.</td>
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<tr>
<th>227-0455-00L</th>
<th>Terahertz: Technology &amp; Applications</th>
<th>W</th>
<th>3 credits</th>
<th>2V</th>
<th>K. Sankaran</th>
</tr>
</thead>
</table>

Data: 06.03.2019 12:57 Autumn Semester 2016 Page 1069 of 1571
This course will provide a solid foundation for understanding physical principles of THz applications. We will discuss various building blocks of THz technology - components dealing with generation, manipulation, and detection of THz electromagnetic radiation. We will introduce THz applications in the domain of imaging, communications, and energy harvesting.

This is an introductory course on Terahertz (THz) technology and applications. Devices operating in THz frequency range (0.1 to 10 THz) have been increasingly studied in the recent years. Progress in nonlinear optical materials, ultrafast optical and electronic techniques has strengthened research in THz application developments. Due to unique interaction of THz waves with materials, applications with new capabilities can be developed. In theory, they can penetrate somewhat like X-rays, but are not considered harmful radiation, because THz energy level is low. They should be able to provide resolution as good or better than magnetic resonance imaging (MRI), possibly with simpler equipment. Imaging, very-high bandwidth communication, and energy harvesting are the most widely explored THz application areas.

The course gives an introduction into cellular and molecular biology, specifically for students with a background in engineering. The focus will be on the basic organization of eukaryotic cells, molecular mechanisms and cellular functions. Textbook knowledge will be combined with results from recent research and technological innovations in biology.

After completing this course, engineering students will be able to apply their previous training in the quantitative and physical sciences to modern biology. Students will also learn the principles how biological models are established, and how these models can be tested.

Lectures will include the following topics: DNA, chromosomes, RNA, protein, genetics, gene expression, membrane structure and function, vesicular traffic, cellular communication, energy conversion, cytoskeleton, cell cycle, cellular growth, apoptosis, autophagy, cancer, development and stem cells.

In addition, three journal clubs will be held, where one/two publications will be discussed (part I: 1 Journal club, part II: 2 Journal Clubs). For each journal club, students (alone or in groups of up to three students) have to write a summary and discussion of the publication. These written documents will be graded and count as 25% for the final grade.

The lecture includes a general introduction to the principles of tomographic imaging from image formation to image reconstruction. It provides the physical and engineering basics to understand how imaging beamlines at synchrotron facilities work, looks into the recently developed phase contrast methods, and explores the first applications of X-ray nano-tomographic experiments.

The course finally provides the necessary background to understand the quantitative evaluation of tomographic data, from basic image analysis to complex morphometrical computations and 3D visualization, keeping the focus on biomedical applications.

The main goal of this course is to demonstrate the differences in communication between the fields of medicine and engineering. Since such differences become the most evident during actual collaborative work, the course is based on a current project in physiology research that combines medicine and engineering. For the engineering students, the specific aims of the course are to:

- Acquire a working understanding of the anatomy and physiology of the investigated system;
- Identify the engineering challenges in the project and communicate them to the medical students;
- Develop and implement, together with the medical students, solution strategies for the identified challenges;
- Present the found solutions to a cross-disciplinary audience.

This course will provide a solid foundation for understanding physical principles of THz applications. We will discuss various building blocks of THz technology - components dealing with generation, manipulation, and detection of THz electromagnetic radiation. We will introduce THz applications in the domain of imaging, communications, and energy harvesting.

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- Identify the engineering challenges in the project and communicate them to the medical students;
- Develop and implement, together with the medical students, solution strategies for the identified challenges;
- Present the found solutions to a cross-disciplinary audience.
Content
After a general introduction to interdisciplinary communication and detailed background on the collaborative project, the engineering students will receive tailored lectures on the anatomy and physiology of the relevant system. They will then team up with medical students who have received a basic introduction to engineering methodology to collaborate on said project. In the process, they will be coached both by lecturers from ETH Zurich and the University of Zurich, receiving lectures customized to the project. The course will end with each team presenting their solution to a cross-disciplinary audience.

Lecture notes
Handouts and relevant literature will be provided.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Type</th>
<th>Instructor(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-1177-00L</td>
<td>Human Factors I</td>
<td>W</td>
<td>2</td>
<td>M. Menozzi Jäckli, R. Huang, M. Siegrist</td>
</tr>
</tbody>
</table>

Abstract
Every day humans interact with various systems. Strategies of interaction, individual needs, physical & mental abilities, and system properties are important factors in controlling the quality and performance in interaction processes. In the lecture, factors are investigated by basic scientific approaches. Discussed topics are important for optimizing people's satisfaction & overall performance.

Objective
The goal of the lecture is to empower students in better understanding the applied theories, principles, and methods in various applications. Students are expected to learn about how to enable an efficient and qualitatively high standing interaction between human and the environment, considering costs, benefits, health, and safety as well. Thus, an ergonomic design and evaluation process of products, tasks, and environments may be promoted in different disciplines. The goal is achieved in addressing a broad variety of topics and embedding the discussion in macroscopic factors such as the behavior of consumers and objectives of economy.

Content
- Physiological, physical, and cognitive factors in sensation and perception
- Body spaces and functional anthropometry, Digital Human Models
- Experimental techniques in assessing human performance and well-being
- Human factors and ergonomics in system designs, product development and innovation
- Human information processing and biological cybernetics
- Interaction among consumers, environments, behavior, and tasks

Literature
- Gavriel Salvendy, Handbook of Human Factors and Ergonomics, 4th edition (2012), is available on NEBIS as electronic version and for free to ETH students
- Further textbooks are introduced in the lecture
- Brochures, checklists, key articles etc. are uploaded in ILIAS

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<tr>
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<th>Type</th>
<th>Instructor(s)</th>
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<tr>
<td>376-1219-00L</td>
<td>Rehabilitation Engineering II: Rehabilitation of Sensory and Vegetative Functions</td>
<td>W</td>
<td>3</td>
<td>R. Riener, R. Gassert, L. Marchal Crespo</td>
</tr>
</tbody>
</table>

Abstract
Rehabilitation Engng is the application of science and technology to ameliorate the handicaps of individuals with disabilities to reintegrate them into society. The goal is to present classical and new rehabilitation engineering principles applied to compensate or enhance motor, sensory, and cognitive deficits. Focus is on the restoration and treatment of the human sensory and vegetative system.

Objective
Provide knowledge on the anatomy and physiology of the human sensory system, related dysfunctions and pathologies, and how rehabilitation engineering can provide sensory restoration and substitution.

This lecture is independent from Rehabilitation Engineering I. Thus, both lectures can be visited in arbitrary order.

Content
Introduction, problem definition, overview
Rehabilitation of visual function
- Anatomy and physiology of the visual sense
- Technical aids (glasses, sensor substitution)
- Retina and cortex implants
Rehabilitation of hearing function
- Anatomy and physiology of the auditory sense
- Hearing aids
- Cochlea Implants
Rehabilitation and use of kinesthetic and tactile function
- Anatomy and physiology of the kinesthetic and tactile sense
- Tactile/haptic displays for motion therapy (incl. electrical stimulation)
- Role of displays in motor learning
Rehabilitation of vestibular function
- Anatomy and physiology of the vestibular sense
- Rehabilitation strategies and devices (e.g. BrainPort)
Rehabilitation of vegetative Functions
- Cardiac Pacemaker
- Phrenic stimulation, artificial breathing aids
- Bladder stimulation, artificial sphincter
- Brain stimulation and recording
- Deep brain stimulation for patients with Parkinson, epilepsy, depression
- Brain-Computer Interfaces

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Virtual Reality has the potential to provide descriptive and practical information for medical training and therapy while relieving the patient. It can provide theoretical and practical knowledge of new principles and applications of multi-modal simulation and interface technologies in medical education, therapy, and rehabilitation. The lecture is accompanied by practical courses and excursions.

Prerequisites / notice

Target Group: Students of higher semesters and PhD students of
- D-MAVT, D-ITET, D-INFK, D-HEST
- Biomedical Engineering, Robotics, Systems and Control
- Medical Faculty, University of Zurich

Students of other departments, faculties, courses are also welcome
This lecture is independent from Rehabilitation Engineering I. Thus, both lectures can be visited in arbitrary order.

Literature

This course focuses on the emerging, interdisciplinary field of physical human-robot interaction, bringing together themes from robotics, real-time control, human factors, haptics, virtual environments, interaction design and other fields to enable the development of human-oriented robotic systems.

The objective of this course is to give an introduction to the fundamentals of physical human-robot interaction, through lectures on the underlying theoretical/mechatronics aspects and application fields, in combination with a hands-on lab tutorial. The course will guide students through the design and evaluation process of such systems. By the end of this course, you should understand the critical elements in human-robot interactions - both in terms of engineering and human factors - and use these to evaluate and design safe and efficient assistive and rehabilitative robotic systems. Specifically, you should be able to:

1) Identify critical human factors in physical human-robot interaction and use these to derive design requirements;
2) Compare and select mechatronic components that optimally fulfill the defined design requirements;
3) Derive a model of the device dynamics to guide and optimize the selection and integration of selected components into a functional system;
4) Design control hardware and software and implement and test human-interactive control strategies on the physical setup;
5) Characterize and optimize such systems using both engineering and psychophysical evaluation metrics;
6) Investigate and optimize one aspect of the physical setup and convey and defend the gained insights in a technical presentation.

This course provides an introduction to fundamental aspects of physical human-robot interaction. After an overview of human haptic, visual and auditory sensing, neurophysiology and psychophysics, principles of human-robot interaction systems (kinematics, mechanical transmissions, robot sensors and actuators used in these systems) will be introduced. Throughout the course, students will gain knowledge of interaction control strategies including impedance/admittance and force control, haptic rendering basics and issues in device design for humans such as transparency and stability analysis, safety hardware and procedures. The course is organized into lectures that aim to bring students up to speed with the basics of these systems, readings on classical and current topics in physical human-robot interaction, laboratory sessions and lab visits. Students will attend periodic laboratory sessions where they will implement the theoretical aspects learned during the lectures. Here the salient features of haptic device design will be identified and theoretical limitations and causes of instabilities (direct/virtual coupling, friction, damping, time delays, sampling rates, quantization, etc.) during rendering of different mechanical properties.

Lecture notes
Will be distributed through the document repository before the lectures. http://www.relab.ethz.ch/education/courses/phri.html

Prerequisites / notice
The course language is English. Basic experience in Information Technology and Computer Science will be of advantage. More details will be announced in the lecture.

376-1504-00L Physical Human Robot Interaction (pHRI) W 4 credits 2V+2U R. Gassert, O. Lamberty
Number of participants limited to 26.

Prerequisites / notice
Notice:
The registration is limited to 26 students There are 4 credit points for this lecture. The lecture will be held in English. The students are expected to have basic control knowledge from previous classes. http://www.relab.ethz.ch/education/courses/phri.html

376-1651-00L Clinical and Movement Biomechanics W 4 credits 3G S. Lorenzetti, R. List, N. Singh

Data: 06.03.2019 12:57 Autumn Semester 2016 Page 1073 of 1571
Measurement and modeling of the human movement during daily activities and in a clinical environment.

The students are able to analyse the human movement from a technical point of view, to process the data and perform modeling with a focus towards clinical application.

This course includes study design, measurement techniques, clinical testing, accessing movement data and analysis as well as modeling with regards to human movement.

376-1714-00L  Biocompatible Materials 4 credits W 3G K. Manuria, J. Möller, M. Zenobi-Wong

Abstract
Introduction to molecules used for biomaterials, molecular interactions between different materials and biological systems (molecules, cells, tissues). The concept of biocompatibility is discussed and important techniques from biomaterials research and development are introduced.

Objective
The class consists of three parts:
1. Introduction into molecular characteristics of molecules involved in the materials-to-biology interface. Molecular design of biomaterials.
2. The concept of biocompatibility.
3. Introduction into methodology used in biomaterials research and application.

Content
Introduction into native and polymeric biomaterials used for medical applications. The concepts of biocompatibility, biodegradation and the consequences of degradation products are discussed on the molecular level. Different classes of materials with respect to potential applications in tissue engineering and drug delivery are introduced. Strong focus lies on the molecular interactions between materials having very different bulk and/or surface chemistry with living cells, tissues and organs. In particular the interface between the materials and the eukaryotic cell surface and possible reactions of the cells with an implant material are elucidated. Techniques to design, produce and characterize materials in vitro as well as in vivo analysis of implanted and explanted materials are discussed.

In addition, a link between academic research and industrial entrepreneurship is established by external guest speakers.

Lecture notes
Handouts can be accessed online.

Literature
(available online via ETH library)
Handouts provided during the classes and references therein.

376-1985-00L  Trauma Biomechanics 4 credits W 2V+1U K.U. Schmitt, M. H. Muser

Abstract
Trauma biomechanics in an interdisciplinary research field investigating the biomechanics of injuries and related subjects such as prevention. The lecture provides an introduction to the basic principles of trauma biomechanics.

Objective
Introduction to the basic principles of trauma biomechanics.

Content
This lecture serves as an introduction to the field of trauma biomechanics. Emphasis is placed on the interdisciplinary nature of impact biomechanics, which uses the combination of fundamental engineering principles and advanced medical technologies to develop injury prevention measures. Topics include: accident statistics and accident reconstruction, biomechanical response of the human to impact loading, injury mechanisms and injury criteria, test methods (including crash tests), computer simulations using multi-body and finite element modelling techniques, aspects of passive safety of vehicles (focusing on restraint systems and vehicle compatibility). Real world examples mainly from automobile safety are used to augment lecture material.

Lecture notes
Handouts will be made available.

Literature

402-0341-00L  Medical Physics I 6 credits W 2V+1U P. Manser

Abstract
Introduction to the fundamentals of medical radiation physics. Functional chain due to radiation exposure from the primary physical effect to the radiobiological and medically manifest secondary effects. Dosimetric concepts of radiation protection in medicine. Mode of action of radiation sources used in medicine and its illustration by means of Monte Carlo simulations.

Objective
Understanding the functional chain from primary physical effects of ionizing radiation to clinical radiation effects. Dealing with dose as a quantitative measure of medical exposure. Getting familiar with methods to generate ionizing radiation in medicine and learn how they are applied for medical purposes. Eventually, the lecture aims to show the students that medical physics is a fascinating and evolving discipline where physics can directly be used for the benefits of patients and the society.

Content
The lecture is covering the basic principles of ionizing radiation and its physical and biological effects. The physical interactions of photons as well as charged particles will be reviewed and their consequences for medical applications will be discussed. The concept of Monte Carlo simulation will be introduced in the excercises and will help the student to understand the characteristics of ionizing radiation in simple and complex situations. Fundamentals in dosimetry will be provided in order to understand the physical and biological effects of ionizing radiation. Deterministic as well as stochastic effects will be discussed and fundamental knowledge about radiation protection will be provided. In the second part of the lecture series, we will focus on the generation of the x-ray tube, the clinical linear accelerator, and different radioactive sources in radiology, radiotherapy and nuclear medicine will be addressed. Applications in radiology, nuclear medicine and radiotherapy will be described with a special focus on the physics underlying these applications.

Lecture notes
A script will be provided.

551-0319-00L  Cellular Biochemistry (Part I) 3 credits W 2V U. Kutay, R. I. Enchev, B. Kornmann, M. Peter, I. Zemp, further lecturers

Abstract
Concepts and molecular mechanisms underlying the biochemistry of the cell, providing advanced insights into structure, function and regulation of individual cell components. Particular emphasis will be put on the spatial and temporal integration of different molecules and signaling pathways into global cellular processes such as intracellular transport, cell division & growth, and cell migration.

Objective
The full-year course (551-0319-00 & 551-0320-00) focuses on the molecular mechanisms and concepts underlying the biochemistry of cellular physiology, investigating how these processes are integrated to carry out highly coordinated cellular functions. The molecular characterisation of complex cellular functions requires a combination of approaches such as biochemistry, but also cell biology and genetics. This course is therefore the occasion to discuss these techniques and their integration in modern cellular biochemistry.

The students will be able to describe the structural and functional details of individual cell components, and the spatial and temporal regulation of their interactions. In particular, they will learn to explain the integration of different molecules and signaling pathways into complex and highly dynamic cellular processes such as intracellular transport, cytoskeletal rearrangements, cell motility, cell division and cell growth. In addition, they will be able to illustrate the relevance of particular signaling pathways for cellular pathologies such as cancer.

Content
Structural and functional details of individual cell components, regulation of their interactions, and various aspects of the regulation and compartmentalisation of biochemical processes.

Literature
Recommended supplementary literature (review articles and selected primary literature) will be provided during the course.

Lecture notes
Scripts and additional material will be provided during the semester. Please contact Dr. Alicia Smith for assistance with the learning materials. (alicia.smith@bc.biol.ethz.ch)
### Design, Computation, Product Development & Manufacturing

#### Number 151-0104-00L

**Uncertainty Quantification for Engineering & Life Sciences**

- **Type**: W
- **ECTS**: 4 credits
- **Hours**: 3G
- **Lecturers**: P. Koumoutsakos

**Abstract**

Quantification of uncertainties in computational models pertaining to applications in engineering and life sciences. Exploitation of massively available data to develop computational models with quantifiable predictive capabilities. Applications of Uncertainty Quantification and Propagation to problems in mechanics, control, systems and cell biology.

**Objective**

The course will teach fundamental concept of Uncertainty Quantification and Propagation (UQ+P) for computational models of systems in Engineering and Life Sciences. Emphasis will be placed on practical and computational aspects of UQ+P including the implementation of relevant algorithms in multicore architectures.

**Content**

Topics that will be covered include: Uncertainty quantification under parametric and non-parametric modelling uncertainty, Bayesian inference with model class assessment, Markov Chain Monte Carlo simulation, prior and posterior reliability analysis.

**Lecture notes**

The class will be largely based on the book: Data Analysis: A Bayesian Tutorial by Devinderjit Sivia as well as on class notes and related literature that will be distributed in class.

**Literature**

1. Data Analysis: A Bayesian Tutorial by Devinderjit Sivia
2. Probability Theory: The Logic of Science by E. T. Jaynes
3. Class Notes

**Prerequisites / notice**

Fundamentals of Probability, Fundamentals of Computational Modeling

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#### Number 151-0735-00L

**Dynamic Behavior of Materials and Structures**

- **Type**: W
- **ECTS**: 4 credits
- **Hours**: 2V+2U
- **Lecturers**: D. Mohr

**Abstract**

Lectures and computer labs concerned with the modeling of the deformation response and failure of engineering materials (metals, polymers and composites) subject to extreme loadings during manufacturing, crash, impact and blast events.

**Objective**

Students will learn to apply, understand and develop computational models of a large spectrum of engineering materials to predict their dynamic deformation response and failure in finite element simulations. Students will become familiar with important dynamic testing techniques to identify material model parameters from experiments. The ultimate goal is to provide the students with the knowledge and skills required to engineer modern multi-material solutions for high performance structures in automotive, aerospace and naval engineering.

**Content**

Topics include viscoelasticity, temperature and rate dependent plasticity, dynamic brittle and ductile fracture; impulse transfer, impact and wave propagation in solids; computational aspects of material model implementation into hydrocodes; simulation of dynamic failure of structures;

**Lecture notes**

Slides of the lectures, relevant journal papers and users manuals will be provided.

**Literature**

Various books will be recommended covering the topics discussed in class

**Prerequisites / notice**

Course in continuum mechanics (mandatory), finite element method (recommended)

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#### Number 151-3205-00L

**Experimental Ergonomics**

- **Type**: W
- **ECTS**: 4 credits
- **Hours**: 2V+2A
- **Lecturers**: J. Held

**Abstract**

You will learn how to apply the scientific discipline of ergonomics for system analysis and product development "in order to optimise human well-being and overall system performance" (www.iea.cc). The course offers the framework of models, concepts, methods and tools of applied ergonomics. Teaching is combined with learning-by-doing and research-based learning.

**Objective**

Knowledge of:

- Principles and rules of applied ergonomic system and product design.
- Methods and tools of ergonomic analysis and evaluation.

Practical experiences and hands-on skills in:

- Conducting a study in system and task analysis.
- Analysing human-product interactions.
- Applying ergonomic knowledge for product and system improvements.

**Content**

- Definition and role of applied ergonomics in engineering and design.
- Framework of ergonomic analysis and design.
- Design principles and rules.
- Methods and tools for system and task analysis.

Hands-on experience in team work:

- Experimental study of human-product interaction and usability through eye-tracking.
- Field study of system and task analysis, including on-site visits of complex work stations (Hospital OR/ICU or Air traffic/Railway Control Rooms).

**Lecture notes**

Handout at the start of the course.

**Literature**


**Prerequisites / notice**

Max. number of participants is 15.

Experiments and field studies in teams of 2-3 students are obligatory.

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#### Number 151-3209-00L

**Engineering Design Optimization**

- **Type**: W
- **ECTS**: 4 credits
- **Hours**: 4G
- **Lecturers**: K. Shea, T. Stankovic

**Abstract**

The course covers fundamentals of computational optimization methods in the context of engineering design. It develops skills to formally state and model engineering design tasks as optimization problems and select appropriate methods to solve them.

**Objective**

The lecture and exercises teach the fundamentals of optimization methods in the context of engineering design. After taking the course students will be able to express engineering design problems as formal optimization problems. Students will also be able to select and apply a suitable optimization method given the nature of the optimization model. They will understand the links between optimization and engineering design in order to design more efficient and performance optimized technical products. The exercises are MATLAB based.

**Content**


**Lecture notes**

Available on Moodle
Semester Project

The semester project is designed to train the students in the solution of specific engineering problems. This makes use of the technical and practical skills acquired during the master's program. Students are divided into teams, and the project is supervised by professors.

Objective

During the course, students will learn about different design thinking methods and tools. This will enable them to:
- Generate deep insights through the systematic observation and interaction of key stakeholders.
- Engage in collaborative ideation with a multidisciplinary (student) team.
- Rapidly prototype and iteratively test ideas and concepts using various materials and techniques.

Content

The purpose of this course is to equip the students with methods and tools to tackle a broad range of problems. Following a Design Thinking approach, the students will learn how to observe and interact with key stakeholders in order to develop an in-depth understanding of what is truly important and emotionally meaningful to the people at the center of a problem. Based on these insights, the students ideate on possible solutions and immediately validated them through quick iterations of prototyping and testing using different tools and materials.

For more information and the application visit: http://sparklabs.ch/ethz

Industrial Internship

The main objective of the 12-week internship is to expose master's students to the industrial work environment. During this period, students have the opportunity to be involved in ongoing projects at the host institution.

Objective

The main objective of the 12-week internship is to expose master's students to the industrial work environment.

GESS Science in Perspective

see GESS Science in Perspective: Type A: Enhancement of Reflection Capability

see GESS Science in Perspective: Language Courses ETH/ÜZH

Recommended GESS Science in Perspective (Type B) for D-MAVT.

Master's Thesis

Students who fulfill the following criteria are allowed to begin with their Master's Thesis:

- a. successful completion of the bachelor program;
- b. fulfilling of any additional requirements necessary to gain admission to the master programme;

For more information and the application visit: http://sparklabs.ch/ethz
c. successful completion of the semester project and industrial internship;
d. achievement of 28 ECTS in the category "Core Courses".

The Master's Thesis must be approved in advance by the tutor and is supervised by a professor of ETH Zurich.
To choose a titular professor as a supervisor, please contact the D-MAVT Student Administration.

Abstract
Master's programs are concluded by the master's thesis. The thesis is aimed at enhancing the student's capability to work independently toward the solution of a theoretical or applied problem. The subject of the master's thesis, as well as the project plan and roadmap, are proposed by the tutor and further elaborated with the student.

Objective
The thesis is aimed at enhancing the student's capability to work independently toward the solution of a theoretical or applied problem.

Course Units for Additional Admission Requirements
The courses below are only available for MSc students with additional admission requirements.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>406-0173-AAL</td>
<td>Linear Algebra I and II</td>
<td>E-</td>
<td>6</td>
<td>13R</td>
<td>N. Hungerbühler</td>
</tr>
<tr>
<td></td>
<td>Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement. Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.</td>
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</table>

Abstract
Linear algebra is an indispensable tool of engineering mathematics. The course is an introduction to basic methods and fundamental concepts of linear algebra and its applications to engineering sciences.

Objective
After completion of this course, students are able to recognize linear structures and to apply adequate tools from linear algebra in order to solve corresponding problems from theory and applications. In addition, students have a basic knowledge of the software package Matlab.

Content
- Linear maps, kernel and image, coordinates and matrices, coordinate transformations, norm of a matrix, orthogonal matrices, eigenvalues and eigenvectors, algebraic and geometric multiplicity, eigenbasis, diagonalizable matrices, symmetric matrices, orthonormal basis, condition number, linear differential equations, Jordan decomposition, singular value decomposition, examples in MATLAB, applications.

Reading:
- Gilbert Strang "Introduction to linear algebra", Wellesley-Cambridge Press: Chapters 1-6, 7.1-7.3, 8.1, 8.2, 8.6

Literature

406-0353-AAL | Analysis III                         | E-   | 4    | 9R    | M. Soner
|              | Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement. Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit. |

Abstract
Introduction to partial differential equations. Differential equations which are important in applications are classified and solved. Elliptic, parabolic and hyperbolic differential equations are treated. The following mathematical tools are introduced: Laplace transforms, Fourier series, separation of variables, methods of characteristics.

Objective
Mathematical treatment of problems in science and engineering. To understand the properties of the different types of partial differential equations.

Content
- Laplace Transforms:
  - Laplace Transform, Inverse Laplace Transform, Linearity, s-Shifting
  - Transforms of Derivatives and Integrals, ODEs
  - Unit Step Function, t-Shifting
  - Short Impulses, Dirac's Delta Function, Partial Fractions
  - Convolution, Integral Equations
  - Differentiation and Integration of Transforms
- Fourier Series, Integrals and Transforms:
  - Fourier Series
  - Functions of Any Period p=2L
  - Even and Odd Functions, Half-Range Expansions
  - Forced Oscillations
  - Approximation by Trigonometric Polynomials
  - Fourier Integral
  - Fourier Cosine and Sine Transform
- Partial Differential Equations:
  - Basic Concepts
  - Modeling: Vibrating String, Wave Equation
  - Solution by separation of variables; use of Fourier series
  - D'Alembert Solution of Wave Equation, Characteristics
  - Heat Equation: Solution by Fourier Series
  - Heat Equation: Solutions by Fourier Integrals and Transforms
  - Modeling Membrane: Two Dimensional Wave Equation
  - Laplacian in Polar Coordinates: Circular Membrane, Fourier-Bessel Series
  - Solution of PDEs by Laplace Transform
Literature

For reference/complement of the Analysis I/II courses:
Christian Blatter: Ingenieur-Analysis (Download PDF)

Prerequisites / notice
Up-to-date information about this course can be found at:
http://www.math.ethz.ch/education/bachelor/lectures/hs2013/other/analysis3_itet

<table>
<thead>
<tr>
<th>Mechanical Engineering Master - Key for Type</th>
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</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>W</td>
</tr>
<tr>
<td>Compulsory</td>
<td>Eligible for credits</td>
</tr>
</tbody>
</table>

| E- | Recommended, not eligible for credits |
| Z  | Courses outside the curriculum        |
| Dr | Suitable for doctorate                |

<table>
<thead>
<tr>
<th>Key for Hours</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>V</td>
<td>G</td>
</tr>
<tr>
<td>lecture</td>
<td>lecture with exercise</td>
</tr>
</tbody>
</table>

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<tr>
<th>U</th>
<th>S</th>
<th>K</th>
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<tbody>
<tr>
<td>exercise</td>
<td>seminar</td>
<td>colloquium</td>
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</tbody>
</table>

<table>
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<tr>
<th>P</th>
<th>A</th>
<th>D</th>
<th>R</th>
</tr>
</thead>
<tbody>
<tr>
<td>practical/laboratory course</td>
<td>independent project</td>
<td>diploma thesis</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

ECTS
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Introduction to Test Theory and Test Construction in Educational Contexts (University of Zürich)

- **Title**: Human Learning (EW1)
  - This lecture is only apt for students who intend to enrol in the programs "Teaching Diploma" or "Teaching Certificate". It is about learning in childhood and adolescence.

- **Type**: O
- **ECTS**: 2
- **Hours**: 2G
- **Lecturers**: E. Stern

- **Abstract**: This course looks into scientific theories and also empirical studies on human learning and relates them to the school.

- **Objective**: Anyone wishing to be a successful teacher must first of all understand the learning process. Against this background, theories and findings on the way humans process information and on human behaviour are prepared in such a manner that they can be used for planning and conducting lessons. Students additionally gain an understanding of what is going on in learning and behavioural research so that teachers are put in a position where they can further educate themselves in the field of research into teaching and learning.

- **Content**: Thematische Schwerpunkte:

  - Lernen als Verhaltensänderung und als Informationsverarbeitung:
    - Das menschliche Gedächtnis unter besonderer Berücksichtigung der Verarbeitung symbolischer Information
    - Lernen als Wissenskonstruktion und Kompetenzerwerb unter besonderer Berücksichtigung des Wissenstransfers
    - Lernen durch Instruktion und Erklärungen
    - Die Rolle von Emotion und Motivation beim Lernen
    - Interindividuelle Unterschiede in der Lernfähigkeit und ihre Ursachen
    - Intelligenztheorien
    - Geschlechtsunterschiede beim Lernen

  - Lernformen:

  - Thematische Schwerpunkte:
    - Lernen als Verhaltensänderung und als Informationsverarbeitung:
      - Das menschliche Gedächtnis unter besonderer Berücksichtigung der Verarbeitung symbolischer Information
      - Lernen als Wissenskonstruktion und Kompetenzerwerb unter besonderer Berücksichtigung des Wissenstransfers
      - Lernen durch Instruktion und Erklärungen
      - Die Rolle von Emotion und Motivation beim Lernen
      - Interindividuelle Unterschiede in der Lernfähigkeit und ihre Ursachen
      - Intelligenztheorien
      - Geschlechtsunterschiede beim Lernen

    - Lernformen:

- **Lecture notes**: Folien werden zur Verfügung gestellt.

- **Literature**:

- **Prerequisites / notice**: This lecture is only apt for students who intend to enrol in the programs "Lehrdiplom" or "Didaktisches Zertifikat". It is about learning in childhood and adolescence.
### Subject Didactics and Professional Training

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-1079-00L</td>
<td>Teaching Internship including Examination Lessons in Mechanical and Process Engineering</td>
<td>W</td>
<td>6 credits</td>
<td>13P</td>
<td>S. P. Kaufmann, J. Dual</td>
</tr>
</tbody>
</table>

The teaching internship can just be visited if all other courses of TC are completed. Repetition of the teaching internship is excluded even if the examination lessons are to be repeated.

- Students apply the insights, abilities and skills they have acquired within the context of an educational institution. They observe 10 lessons and teach 20 lessons independently. Two of them are as assessed as Examination Lessons.
- Students use their specialist-subject, educational-science and subject-didactics training to draw up concepts for teaching.
- They are able to assess the significance of tuition topics for their subject from different angles (including interdisciplinary angles) and impart these to their pupils.
- They learn the skills of the teaching trade.
- They practise finding the balance between instruction and openness so that pupils can and, indeed, must make their own cognitive contribution.
- They learn to assess pupils' work.
- Together with the teacher in charge of their teacher training, the students constantly evaluate their own performance.
Subject Didactics I for D-MAVT and D-ITET

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
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</tr>
</thead>
<tbody>
<tr>
<td>151-1061-00L</td>
<td>Didactical methods in mechanical and electrical engineering</td>
<td>O</td>
<td>4</td>
<td>G</td>
<td>S. P. Kaufmann, J. Dual</td>
</tr>
</tbody>
</table>

Abstract

- The students can plan, conduct and critically reflect single lessons.
- They orient themselves towards the academic goals and take into account existing knowledge, the professional environment and the ambitions of the students.
- They can apply the basic teaching principles meaningfully in their subject and suitably structure the learning phases.
- They can reduce and present complex technical content such that it is in a form suitable for the students to learn.
- They have considered examples of the common conceptual errors encountered by students.

Content

- Didactic analysis
- Competences and goals
- Preparation and wrap-up of lessons
- Process and structure of a typical lesson
- Teaching techniques (informative introduction to lessons, Advance Organizer, learning assignments, frontal teaching, questions, assignments, feedback)
- Assignments and short tests
- Media and language competence
- Conceptual change, misconceptions,
- Integration of the subcomponents of a lesson.

Prerequisites / notice

151-1072-00L Mentored Work in Didactics of Mechanical and Process Engineering

<table>
<thead>
<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-1072-00L</td>
<td>In their mentored work, the students combine and extend their knowledge of didactics of engineering to develop a syllabus.</td>
<td>O</td>
<td>2</td>
<td>A</td>
<td>S. P. Kaufmann, J. Dual</td>
</tr>
</tbody>
</table>

Abstract

The students are able to develop a syllabus. Based on didactical literature, they combine different teaching techniques and methods. They reflect different forms of assessments and are able to use them appropriately.

Content


Prerequisites / notice

Voraussetzung: Der Einsatz von geeigneter Literatur ist Teil des Leistungsauftrages.

Further Subject Didactics

- They reflect different forms of assessments and are able to use them appropriately.
- They have considered examples of the common conceptual errors encountered by students.
- They can apply the basic teaching principles meaningfully in their subject and suitably structure the learning phases.
- They can reduce and present complex technical content such that it is in a form suitable for the students to learn.
- They have considered examples of the common conceptual errors encountered by students.

Mechanical and Process Engineering TC - Key for Type

<table>
<thead>
<tr>
<th>Type</th>
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</tr>
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<tbody>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
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<tr>
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<td>P</td>
<td>practical/laboratory course</td>
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<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
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</tbody>
</table>

Key for Hours

- O Compulsory
- W+ Eligible for credits and recommended
- W Eligible for credits

ECTS

European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
### Examination Block A

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>401-0261-GUL</td>
<td>Analysis I</td>
<td>O</td>
<td>8</td>
<td>5V+4U</td>
<td>A. Steiger</td>
</tr>
</tbody>
</table>

**Abstract**
Differential and integral calculus for functions of one and several variables; vector analysis; ordinary differential equations of first and of higher order, systems of ordinary differential equations; power series. The mathematical methods are applied in a large number of examples from mechanics, physics and other areas which are basic to engineering.

**Objective**
Introduction to the mathematical foundations of engineering sciences, as far as concerning differential and integral calculus.

**Literature**
U. Stammbach: Analysis I/II

**Prerequisites / notice**
Die Übungsaufgaben (inkl. Multiple Choice) sind ein wichtiger Bestandteil der Lehrveranstaltung. Es wird erwartet, dass Sie mindestens 75% der wöchentlichen Serien bearbeiten und zur Korrektur einreichen.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>401-0151-00L</td>
<td>Linear Algebra</td>
<td>O</td>
<td>4</td>
<td>3G+2U</td>
<td>V. C. Gradinaru, R. Käppeli</td>
</tr>
</tbody>
</table>

**Abstract**
Contents: Linear systems - the Gaussian algorithm, matrices - LU decomposition, determinants, vector spaces, least squares - QR decomposition, linear maps, eigenvalue problem, normal forms - singular value decomposition; numerical aspects; introduction to MATLAB.

**Objective**
Einführung in die Lineare Algebra für Ingenieure unter Berücksichtigung numerischer Aspekte

**Lecture notes**
K. Nipp / D. Stoffer, Lineare Algebra, vdf Hochschulverlag, S. Auflage 2002

**Literature**
K. Nipp / D. Stoffer, Lineare Algebra, vdf Hochschulverlag, S. Auflage 2002

### Examination Block B

<table>
<thead>
<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
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<tbody>
<tr>
<td>529-3001-02L</td>
<td>Chemistry I</td>
<td>O</td>
<td>4</td>
<td>2V+2U</td>
<td>C. Padeste, P. J. Walde, W. R. Caseri</td>
</tr>
</tbody>
</table>

**Abstract**
General Chemistry I: Stoichiometry, atoms, molecules, chemical bond and molecular structure, gases, solutions, chemical equilibrium, solubility, acids and bases, thermodynamics, electrochemistry, kinetics.

**Objective**
Introduction to general and inorganic chemistry.

**Content**
1) Atoms, molecules, periodic table of the elements
2) Stoichiometry: Mole, chemical equations, elemental analyses
3) Reactions in water, stoichiometry in solutions
4) Thermochemistry: Energy and enthalpy, thermochemical equations, Hess theorem
5) Gases: Gas laws, reactions and stoichiometry in the gas phase, kinetic theory
6) Atomic structure and binding models: ionic, covalent and metallic bonds, Lewis- and resonance formula, electronegativity and polarity, VSEPR model
7) Liquids and solids, phase transitions
8) Solutions; dissolution processes, colligative properties
9) Kinetics: reaction rates, temperature dependence, reaction orders and reaction laws, collision theory, catalysis
11) Acid-base equilibria: acid/base-concepts, pH calculations, buffer systems, titrations
12) Dissolution and equilibria of complex formation
13) Thermodynamics: 3 laws of thermodynamics, free enthalpy and equilibrium
14) Redox reactions and electrochemistry: Faraday's laws, electrode potential and Nernst equation
15) Complexes: equilibria, structure and isomerism

**Lecture notes**
Folienskript wird jeweils vor den vorlesungstunden als PDF versandt.

**Literature**

### Examination Block C

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
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<tr>
<td>327-0103-00L</td>
<td>Introduction to Materials Science</td>
<td>O</td>
<td>3</td>
<td>3G</td>
<td>M. Niederberger, N. Spencer, P. Uggowitzer</td>
</tr>
</tbody>
</table>

**Abstract**
Fundamental knowledge and understanding of the atomistic and macroscopic concepts of material science.

**Objective**
Basic concepts in materials science.

**Content**
Contents:
Atomic structure
Atomic bonds
Crystalline structure, perfection - imperfection
Diffusion
Mechanical and thermal properties
Phase diagrams
Kinetics
Structural materials
Electric, magnetic and optical properties of materials
Materials selection criteria

**Lecture notes**
http://www.multimat.mat.ethz.ch/education/lectures/intro.html

**Literature**
James F. Shackelford
Introduction to Materials Science for Engineers

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>327-0104-00L</td>
<td>Crystallography</td>
<td>O</td>
<td>3</td>
<td>2V+1U</td>
<td>M. Fiebig</td>
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</tbody>
</table>

**Abstract**
Introduction into the fundamental relationships between chemical composition, crystal structure, symmetry and physical properties of solids.
Objective
Introduction into the fundamental relationships between chemical composition, crystal structure, symmetry and physical properties of solids. Emphasis: group-theoretical introduction into symmetry, discussion of the factors governing the formation of crystal structures, structural dependence of physical properties, fundamentals of experimental techniques probing the crystal structure.

Content
Symmetry and order: lattices, point groups, space groups.

Crystal chemistry: geometrical, physical and chemical factors governing the formation of crystal structures; close sphere packings; typical basic crystal structures; lattice energy; magnetic crystals; quasicrystals.

Structure/property relationships: Example quartz (piezoelectricity); perovskite and derivative structures (ferroelectrics and high-temperature superconductors); magnetic materials.

Materials characterization: diffraction techniques, optical techniques.

Lecture notes
A script of the lecture until 2014 is available. New script: to be decided.

Literature

Prerequisites / notice
Organisation: Two hours of lectures per week accompanied by one hour of exercises.

Additional Basic Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>327-0105-00L</td>
<td>Introduction to Scientific Practice for Material Scientists</td>
<td>O</td>
<td>2</td>
<td>2G</td>
<td>S. Morgenthaler Kobas, M. B. Willeke</td>
</tr>
<tr>
<td>327-0111-00L</td>
<td>Practical Laboratory Course I</td>
<td>O</td>
<td>6</td>
<td>6P</td>
<td>M. B. Willeke, M. R. Dusseiller, S. Morgenthaler Kobas, P. J. Walde</td>
</tr>
</tbody>
</table>

Introduction into the fundamental relationships between chemical composition, crystal structure, symmetry and physical properties of solids. Emphasis: group-theoretical introduction into symmetry, discussion of the factors governing the formation of crystal structures, structural dependence of physical properties, fundamentals of experimental techniques probing the crystal structure. Symmetry and order: lattices, point groups, space groups.

Crystal chemistry: geometrical, physical and chemical factors governing the formation of crystal structures; close sphere packings; typical basic crystal structures; lattice energy; magnetic crystals; quasicrystals.

Structure/property relationships: Example quartz (piezoelectricity); perovskite and derivative structures (ferroelectrics and high-temperature superconductors); magnetic materials.

Materials characterization: diffraction techniques, optical techniques.

Lecture notes
A script of the lecture until 2014 is available. New script: to be decided.

Literature

Prerequisites / notice
Organisation: Two hours of lectures per week accompanied by one hour of exercises.

3. Semester

Basic Courses Part 2

Examination Block 1

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>529-0051-00L</td>
<td>Analytical Chemistry I</td>
<td>O</td>
<td>3</td>
<td>3G</td>
<td>D. Günther, M.O. Ebert, R. Zenobi</td>
</tr>
</tbody>
</table>

Introduction into the most important spectroscoical methods and their applications to gain structural information. Knowledge about the necessary theoretical background of spectroscoical methods and their practical applications. Application oriented basics of organic and inorganic instrumental analysis and of the empirical employment of structure elucidation methods:

- Mass spectrometry; Ionization methods, mass separation, isotope signals, rules of fragmentation, rearrangements.
- NMR spectroscopy: Experimental basics, chemical shift, spin-spin coupling.
- IR spectroscopy: Revisiting topics like harmonic oscillator, normal vibrations, coupled oscillating systems (in accordance to the basics of the related lecture in physical chemistry); sample preparation, acquisition techniques, law of Lambert and Beer, interpretation of IR spectra; Raman spectroscopy.

Script will be for the production price

- M. Hesse, H. Meier, B. Zeeh, Spektroskopische Methoden in der organischen Chemie, 5. überarbeitete Auflage, Thieme, Stuttgart, 1995
Lecture notes

Der Vorlesungsstoff ist sehr nahe am Lehrbuch gehalten, Skripte werden ggf. durch die Dozenten zur Verfügung gestellt.

Knowledge of the basic principles of probability and statistics.

Consolidation of the basics of organic chemistry.

W. R. Caseri

Type
Ziel dieser Vorlesung ist es, die grundlegenden Experimente zu kennen sowie die dazugehörende Theorie zu verstehen und sie in einfachen Problemstellungen zur Anwendung zu bringen.

Objective
Die Vorlesung "Physik II" ist eine Einführung in die Grundlagen der modernen Elektrotechnik, der Quantenmechanik und Atomphysik. Inhalt:
- Einfache analoge und digitale Schaltungen
- Die Postulate der Wellenmechanik.
- Eindimensionale Probleme (Teilchen im Kasten, Der Tunneleffekt, Der QM harmonische Oscillator)
- Bewegung im Zentralfeld
- Der Drehrimpulsoperator (Darstellung von Zuständen und Operatoren, Matrixdarstellung des Drehrimpulsoperators, Das Stern-Gerlach Experiment; der Spin, Die Addition von Drehrimpulsen in der Quantenmechanik)
- Atomphysik (Die Spin-Bahn Kopplung, Der Hamilton-Operator der Spin-Bahn Wechselwirkung, Störungsrechnung für stationäre Zustände mit diskretem Spektrum, Anwendung der Störungstheorie; die Feinstrukturaufspaltung der atomaren Energienebenen, Ein Atom im äusseren Magnetfeld: Zeeman-Effekt, Die Hyperfeinstruktur der s-Zustände)
- Mehr-Teilchen Systeme (Das Energiespektrum des He-Atoms, Angeregte Zustände des Heliumatoms, Das Mendelejew'sche Periodensystem, Spektraltermine)
- Übergang in Folge einer zeitabhängigen, periodischen Störung (Magnetische Resonanz (I. Rabi, Phys. Rev. 51, 652 (1937), Nobel Preis 1944), Verallgemeinerung der Rabi Formel auf Übergänge in Folge einer zeitabhängigen, periodischen Störung)

Lecture notes
Ein Skript wird verteilt.

Prerequisites / notice
Prerequisites: Physics I.

Organic Chemistry in Materials Science

Type
This lecture allows the students to consolidate the basics of organic chemistry through selected exercises.

Objective
This lecture consists predominantly of exercises and serves mainly to prepare the students intensively for aspects in materials science, based on the lecture Chemie II. A large number of questions will be provided, which will partially be discussed in the lecture while the other part is devoted to self-study.

Content
This lecture allows the students to consolidate the basics of organic chemistry through selected exercises.

Prerequisites / notice
Exercises are integrated in the lectures. In addition, attendance in the lecture 529-0289-00 "Instrumental analysis of organic compounds" (4th semester) is recommended.

Prerequisites / notice
Ein Skript wird verteilt.

Literature
Biochemistry I

Prerequisites / notice

Examination Block 2

Number
Title
Type
ECTS
Hours
Lecturers

401-0603-00L
Stochastics (Probability and Statistics)
O
4
2V+1U
M. H. Maathuis

Abstract
This class covers the following concepts: random variables, probability, discrete and continuous distributions, joint and conditional probabilities and distributions, the law of large numbers, the central limit theorem, descriptive statistics, statistical inference, inference for normally distributed data, point estimation, and two-sample tests.

Objective
Knowledge of the basic principles of probability and statistics.

Content
Introduction to probability theory, some basic principles from mathematical statistics and basic methods for applied statistics.

Lecture notes
Lecture notes

Data: 06.03.2019 12:57  Autumn Semester 2016  Page 1084 of 1571
Analysis III

Abstract

Introduction to partial differential equations. Differential equations which are important in applications are classified and solved. Elliptic, parabolic and hyperbolic differential equations are treated. The following mathematical tools are introduced: Laplace transforms, Fourier series, separation of variables, methods of characteristics.

Objective

Mathematical treatment of problems in science and engineering. To understand the properties of the different types of partial differential equations.

The first lecture is on Thursday, September 29 13-15 in HG F 7 and video transmitted into HG F 5.

The exercises Sheet are here:

The coordinator is Claudio Sibilia (see https://www.math.ethz.ch/the-department/people.html?u=sibiliaC)

The first exercise session is on Thursday, September 22 or resp. Friday, September 23. If you would like feedback on your work, please give it to your course assistant or leave it in the box of your course assistant in HG F 27. The due Date is one week later the assignment.

Office hour (Praesenz): Thursday 16-17, NO E 39.

Content

Laplace Transforms:
- Laplace Transform, Inverse Laplace Transform, Linearity, s-Shifting
- Transforms of Derivatives and Integrals, ODEs
- Unit Step Function, t-Shifting
- Short Impulses, Dirac's Delta Function, Partial Fractions
- Convolution, Integral Equations
- Differentiation and Integration of Transforms

Fourier Series, Integrals and Transforms:
- Fourier Series
- Functions of Any Period p=2L
- Even and Odd Functions, Half-Range Expansions
- Forced Oscillations
- Approximation by Trigonometric Polynomials
- Fourier Integral
- Fourier Cosine and Sine Transform

Partial Differential Equations:
- Basic Concepts
- Modeling: Vibrating String, Wave Equation
- Solution by separation of variables; use of Fourier series
- D'Alembert Solution of Wave Equation, Characteristics
- Heat Equation: Solution by Fourier Series
- Heat Equation: Solutions by Fourier Integrals and Transforms
- Modeling Membrane: Two Dimensional Wave Equation
- Laplacian in Polar Coordinates: Circular Membrane, Fourier-Bessel Series
- Solution of PDEs by Laplace Transform

Download the syllabus: https://polybox.ethz.ch/index.php/s/bu5KY8vWNMOnaAa

Lecture notes

Alessandra Iozzi's Lecture notes: https://polybox.ethz.ch/index.php/s/RcsFm70tWCheSqH

Errata: https://polybox.ethz.ch/index.php/s/vKh86gvQRTtwlE0w

Literature


For reference/complement of the Analysis I/II courses:
Christian Blatter: Ingenieur-Analysis (Download PDF)
Lecture notes  For metals see:  
http://www.metphys.mat.ethz.ch/education/lectures/materialwissenschaft-i.html  
For ceramics see:  
http://www.complex.mat.ethz.ch/education/lectures.html  

### Literature

**Metals:**
- D. A. Porter, K. E. Easterling  
  Phase Transformations in Metals and Alloys - Second Edition  
  ISBN : 0-7487-5741-4  
  Nelson Thornes  

**Ceramics:**
- Murz, D.; Fett, T.: Ceramics, Mechanical Properties, Failure Behaviour, Materials Selection,  
  - diverse CEN ISO Standards given in the slides  
- Barsoum MW: Fundamentals of Ceramics:  
- "Brevieral Ceramics" published by the "Verband der Keramischen Industrie e.V.", ISBN 3-924158-77-0. partly its contents may be found in the internet @ http://www.keramverband.de/brevier_eng/brevier.htm or on our homepage  
- Silicon-Based Structural Ceramics (Ceramic Transactions), Stephen C. Danforth (Editor), Brian W. Sheldon, American Ceramic Society, 2003,  
- Phase relationships in the zirconia-yttria system, HGM Scott - Journal of Materials Science, 1975, Springer  
- Thommy Ekström and Mats Nygren, SiAION Ceramics J Am Cer Soc Volume 75 Page 259 - February 1992  
- In the first part of the lecture the bases are obtained for metals. In the second part the basics of cermics will be presented.  
- One part of the lecture will be taught in English, but most of it in German.

#### Additional Basic Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>327-0311-00L</td>
<td>Practical Laboratory Course III</td>
<td>O</td>
<td>3</td>
<td>6P</td>
<td>M. B. Willeke, J. Patscheider, P. J. Walde</td>
</tr>
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</table>

**Abstract**  
To impart basic knowledge and experimental competence using selected examples from chemistry and physics.

**Objective**  
To impart basic knowledge and experimental competence using selected examples from chemistry and physics.

**Content**  
Chemistry III: Synthesis of PMMA via Transesterification; manufacture of poly(methylmethacrylat) via radical polymerization of methylmethacrylat; 3D-printing.

**Lecture notes**
Notes with information for each experiment (aim of the experiment, theory, experimental procedure, data analysis) can be downloaded from the web (https://praktikum.mat.ethz.ch or https://www.mat.ethz.ch/studies/bachelor/laborpraktische-ausbildung.html).

**Prerequisites / notice**

### 5. Semester

#### Basic Courses Part 2

#### Examination Block 5

<table>
<thead>
<tr>
<th>Number</th>
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<tr>
<td>327-0504-00L</td>
<td>Materials Characterisation Methods</td>
<td>O</td>
<td>3</td>
<td>2V+1U</td>
<td>L. Heyderman</td>
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</table>

**Abstract**  
The lecture course is aimed to qualifying the student to choose the optimum characterization method according to the questions posed. The main topics are: Thermal Analysis (TD, TG, TM, DTA, DSC), light microscopy, diffraction methods (XRD, NRD, SAD), electron microscopy (TEM, HRTEM, STEM, HAADF-STEM, SEM, ESEM, EFEM, EDX, EELS).

**Objective**  
The lecture course is aimed to qualifying the student to choose the optimum characterization method according to the questions posed.

**Content**  
Introduction into the fundamentals of materials characterization: Thermal Analysis (TD, TG, TM, DTA, DSC), light microscopy, diffraction methods (XRD, NRD, SAD), electron microscopy (TEM, HRTEM, STEM, HAADF-STEM, SEM, ESEM, EFEM, EDX, EELS). The emphasis is on the discussion of the fundamentals of these characterization methods.

**Literature**  
Characterization of Materials (Volume Editor: E. Lifshin).

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>327-0508-00L</td>
<td>Simulation Techniques in Materials Science</td>
<td>O</td>
<td>4</td>
<td>2V+2U</td>
<td>C. Ederer</td>
</tr>
</tbody>
</table>

**Abstract**  
Introduction to simulation techniques that are relevant for material science. Simulation methods for continua (finite differences, finite elements), mesoscopic methods (cellular automata, mesoscopic Monte Carlo methods), microscopic methods (Molecular Dynamics, Monte-Carlo simulations, Density Functional Theory).
Learn techniques which are used in the computer-based study of the physics of materials; Obtain an overview of which simulation techniques are useful for which type of problems; develop the capability to transform problems in materials science into a form suitable for computer studies, including writing the computer program and analyzing the results.

- Modeling and simulation techniques in materials science.
- Simulation methods for continua (finite differences, basic idea of finite elements).
- Mesoscopic methods (Cellular automata, phase-field models, mesoscopic Monte Carlo methods).
- Microscopic methods (Molecular dynamics, Monte-Carlo simulation for many-particle systems, basic idea of density functional theory).


327-0407-00L Materials Physics I
Only for MATL BSc, Programme Regulations 2016.

Abstract
This course introduces classical and quantum mechanical concepts for the understanding of material properties from a microscopic point of view. The lectures focus on the static and dynamic properties of crystals, the formation of chemical bonds and electronic bands in molecules, insulators, metals, and semiconductors, and on the thermal and electrical properties that emerge from this analysis.

Objective
Providing physical concepts for the understanding of material properties:

Understanding the electronic properties of solids is at the heart of modern society and technology. The aim of this course is to provide fundamental concepts that allow the student to relate the microscopic structure of matter and the quantum mechanical behavior of electrons to the macroscopic properties of materials. Beyond fundamental curiosity, such level of understanding is required in order to develop and appropriately describe new classes of materials for future technology applications. By the end of the course the student should have developed a semi-quantitative understanding of basic concepts in solid state physics and be able to appreciate the pertinence of different models to the description of specific material properties.

Content
PART I: Structure of solid matter, real and reciprocal space
The crystal lattice, Bravais lattices, primitive cells and unit cells, Wigner-Seitz cell, primitive lattice vectors, lattice with a basis, examples of 3D and 2D lattices.
Fourier transforms and reciprocal space, reciprocal lattice vectors, Brilloin zones

PART II: Dynamics of atoms in crystals
Lattice vibrations and phonons in 1D, phonons in 1D chains with monoatomic basis, phonon in 1D chains with a diatomic basis, optical and acoustic modes, phase and group velocities, phonon dispersion and eigenvectors. Phonons in 2D and 3D.
Quantum mechanical description of lattice waves in solids, the harmonic oscillator, the concept of phonon, phonon statistics, Bose-Einstein distribution, phonon density of states, Debye and Einstein models, thermal energy, heat capacity of solids.

PART III: Electron states and energy bands in molecules and solids
Electronic properties of materials, classical concepts: electrical conductivity, Hall effect, thermoelectric effects. Drude model. Transition to quantum models and review of quantum mechanical concepts.
Introduction to molecular orbital theory and linear combination of atomic orbitals (LCAO). The H2+ molecule, homonuclear and heteronuclear molecules, benzene, sigma and pi bonds, sp3 and sp2 hybridization. From molecules to periodic crystal structures.
The free electron gas: Fermi statistics, Fermi energy and Fermi surface, density of states in k-space and as a function of energy. Inadequacy of the free electron model.

PART IV: Electrical and heat conduction
Dynamics of electrons in energy bands, phase and group velocity, crystal momentum, the effective mass concept, scattering phenomena. The equilibrium and non-equilibrium distribution function for electrons. The Boltzmann equation in the presence of external fields in the relaxation time approximation.
Electrical and thermal conductivities revisited. Electron transport due to electric fields (drift) and concentration gradients (diffusion). Einstein's relations. Transport of heat by electrons, Seebeck effect and thermopower, Peltier effect, thermoelectric cooling, thermoelectric energy conversion.

PART V: Semiconductors: concepts and devices
Dynamics of electrons in energy bands, phase and group velocity, crystal momentum, the effective mass concept, scattering phenomena. The equilibrium and non-equilibrium distribution function for electrons. The Boltzmann equation in the presence of external fields in the relaxation time approximation.
Electrical and thermal conductivities revisited. Electron transport due to electric fields (drift) and concentration gradients (diffusion). Einstein's relations. Transport of heat by electrons, Seebeck effect and thermopower, Peltier effect, thermoelectric cooling, thermoelectric energy conversion.

Lecture notes
will be handed out during the lectures

Literature
- H. Ibach, H. Lüth: Solid-State Physics (Springer, 2003), available as e-Book from the ETH library, also in German.
- C. Kittel, Introduction to Solid State Physics (Wiley, 2005), also available in German.

Prerequisites / notice
Physics I and II. Knowledge of basic quantum mechanical concepts. The lecture will be given in English. The script will be available in English.

Exam Block 6

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>327-0501-00L</td>
<td>Metals I</td>
<td>O</td>
<td>3</td>
<td>2V+1U</td>
<td>R. Spolenak</td>
</tr>
</tbody>
</table>

Abstract
Repetition and advancement of dislocation theory. Mechanical properties of metals: hardening mechanisms, high temperature plasticity, alloying effects. Case studies in alloying to illustrate the mechanisms.

Objective
Repetition and advancement of dislocation theory. Mechanical properties of metals: hardening mechanisms, high temperature plasticity, alloying effects. Case studies in alloying to illustrate the mechanisms.
### Content

**Dislocation theory:**
- Properties of dislocations, motion and kinetics of dislocations, dislocation-dislocation and dislocation-boundary interactions, consequences of partial dislocations, sessile dislocations
- Hardening theory:
  - a. solid solution hardening: case studies in copper-nickel and iron-carbon alloys
  - b. particle hardening: case studies on aluminium-copper alloys
- High temperature plasticity:
  - thermally activated glide
  - power-law creep
  - diffusional creep: Coble, Nabarro-Herring
- deformation mechanism maps
- Case studies in turbine blades
- superplastizity
- alloying effects

**Hardening theory:**
- a. solid solution hardening: case studies in copper-nickel and iron-carbon alloys
- b. particle hardening: case studies on aluminium-copper alloys

**High temperature plasticity:**
- thermally activated glide
- power-law creep
- diffusional creep: Coble, Nabarro-Herring
- deformation mechanism maps
- Case studies in turbine blades
- superplastizity
- alloying effects

### Literature

- Gottstein, Physikalische Grundlagen der Materialkunde, Springer Verlag
- Haasen, Physikalische Metallkunde, Springer Verlag
- Rösler/Harders/Bäker, Mechanisches Verhalten der Werkstoffe, Teubner Verlag
- Porter/Easterling, Transformations in Metals and Alloys, Chapman & Hall
- Hull/Bacon, Introduction to Dislocations, Butterworth & Heinemann
- Courtney, Mechanical Behaviour of Materials, McGraw-Hill

---

### 327-0502-00L Polymers I

**Abstract**
Physical foundations of single polymer molecules and interacting chains.

**Objective**
The course offers a modern approach to the understanding of universal static and dynamic properties of polymers.

**Content**
- Polymer Physics:
  1. Introduction to Polymer Physics, Random Walks
  2. Excluded Volume
  3. Structure Factor from Scattering Experiments
  4. Persistence
  5. Solvent and Temperature Effects
  6. Flory theory
  7. Self-consistent field theory
  8. Interacting Chains, Phase Separation and Critical Phenomena
  9. Rheology
  10. Numerical methods in polymer physics, computer experiments

**Lecture notes**
A script is available at http://www.polyphys.mat.ethz.ch/education/courses/polymere-I

**Literature**

**Prerequisites / notice**
Computer experiments will use the simple MATLAB programming language and will be made available, if necessary or useful.

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### 327-0503-00L Ceramics I

**Abstract**
Introduction to ceramic processing.

**Objective**
The aim is the understanding of the basic principles of ceramic processing.

**Content**
- Basic chemical processes for powder production.
- Liquid-phase synthesis methods.
- Sol-Gel processes.
- Classical crystallization theory.
- Gas phase reactions.
- Basics of the colloidal chemistry for suspension preparation and control.
- Characterization techniques for powders and colloids.
- Shaping techniques for bulk components and thin films.
- Sintering processes and microstructural control.

**Lecture notes**
See: http://www.multimat.mat.ethz.ch/education/lectures/ceramics.html

**Literature**
Books and references will be given on the lecture notes.

---

### 327-1221-00L Biological and Bio-Inspired Materials

**Abstract**
The aim of this course is to impart knowledge on the underlying principles governing the design of biological materials and on strategies to fabricate synthetic model systems whose structural organization resembles those of natural materials.

**Objective**
The course first offers a comprehensive introduction to evolutive aspects of materials design in nature and a general overview about the most common biopolymers and biominerals found in biological materials. Next, current approaches to fabricate bio-inspired materials are presented, followed by a detailed evaluation of their structure-property relationships with focus on mechanical, optical, surface and adaptive properties.

**Content**
This course is structured in 3 blocks:
- Biological engineering principles
- Basic building blocks found in biological materials
- Replicating biological design principles in synthetic materials
- Biological and bio-inspired materials: polymer-reinforced and ceramic-toughened composites
- Lightweight biological and bio-inspired materials
- Functional biological and bio-inspired materials: surfaces, self-healing and adaptive materials
- Bio-inspired design and systems
- Bio-inspiration in the building environment
- Future developments in bio-inspired materials

**Lecture notes**
Copies of the slides will be made available for download before each lecture.
The course is mainly based on the books listed below. Additional references will be provided during the lectures.


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**Basic Courses Part 3**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>327-0511-00L</td>
<td>Practical Course V</td>
<td>O</td>
<td>6 credits</td>
<td>8P</td>
<td>M. B. Willeke, J. F. Löffler</td>
</tr>
<tr>
<td>Abstract</td>
<td>Acquisition of independent scientific-technical skills; project management; organization and undertaking of experiments; interpretation, scientifically and technically correct project presentation in oral and written form.</td>
<td></td>
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</tr>
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<td>Objective</td>
<td>Acquisition of independent scientific/technical skills; project management; organization and conducting of experiments; interpretation and scientifically/technically correct presentation of projects in oral and written form.</td>
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</tr>
<tr>
<td>Content</td>
<td>Supervision by DMATL research groups</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Prerequisites / notice</td>
<td>Prerequisite: Successful participation in the &quot;Praktika I - IV&quot; (courses within the material science bachelor study at ETH) or comparable practical lab courses.</td>
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**Compensatory Courses**

*Only possible after consultation with the Director of Studies.*

**Basic Courses Part 2 - Examination Block 5 (ONLY for Progr. Reg. 2012)**

<table>
<thead>
<tr>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>327-0407-00L</td>
<td>Materials Physics I</td>
<td>O</td>
<td>6 credits</td>
<td>3V+2U</td>
<td>P. Gambardella</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course introduces classical and quantum mechanical concepts for the understanding of material properties from a microscopic point of view. The lectures focus on the static and dynamic properties of crystals, the formation of chemical bonds and electronic bands in molecules, insulators, metals, and semiconductors, and on the thermal and electrical properties that emerge from this analysis.</td>
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<tr>
<td>Objective</td>
<td>Providing physical concepts for the understanding of material properties: Understanding the electronic properties of solids is at the heart of modern society and technology. The aim of this course is to provide fundamental concepts that allow the student to relate the microscopic structure of matter and the quantum mechanical behavior of electrons to the macroscopic properties of materials. Beyond fundamental curiosity, such level of understanding is required in order to develop and appropriately describe new classes of materials for future technology applications. By the end of the course the student should have developed a semi-quantitative understanding of basic concepts in solid state physics and be able to appreciate the pertinence of different models to the description of specific material properties.</td>
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PART I: Structure of solid matter, real and reciprocal space

The crystal lattice, Bravais lattices, primitive cells and unit cells, Wigner-Seitz cell, primitive lattice vectors, lattice with a basis, examples of 3D and 2D lattices.

Fourier transforms and reciprocal space, reciprocal lattice vectors, Brillouin zones


PART II: Dynamics of atoms in crystals

Lattice vibrations and phonons in 1D, phonons in 1D chains with monoatomic basis, phonon in 1D chains with a diatomic basis, optical and acoustic modes, phase and group velocities, phonon dispersion and eigenvectors. Phonons in 2D and 3D.

Quantum mechanical description of lattice waves in solids, the harmonic oscillator, the concept of phonon, phonon statistics, Bose-Einstein distribution, phonon density of states, Debye and Einstein models, thermal energy, heat capacity of solids.

PART III: Electron states and energy bands in molecules and solids

Electronic properties of materials, classical concepts: electrical conductivity, Hall effect, thermoelectric effects. Drude model. Transition to quantum models and review of quantum mechanical concepts.

Introduction to molecular orbital theory and linear combination of atomic orbitals (LCAO). The H₂⁺ molecule, homonuclear and heteronuclear molecules, benzene, sigma and pi bonds, sp³ and sp² hybridization. From molecules to periodic crystal structures.

The free electron gas: Fermi statistics, Fermi energy and Fermi surface, density of states in k-space and as a function of energy. Inadequacy of the free electron model.


PART IV: Electrical and heat conduction

Dynamics of electrons in energy bands, phase and group velocity, crystal momentum, the effective mass concept, scattering phenomena. The equilibrium and non-equilibrium distribution function for electrons. The Boltzmann equation in the presence of external fields in the relaxation time approximation.

Electrical and thermal conductivities revisited. Electron transport due to electric fields (drift) and concentration gradients (diffusion). Einstein's relations. Transport of heat by electrons, Seebeck effect and thermopower, Peltier effect, thermoelectric cooling, thermoelectric energy conversion.

PART V: Semiconductors: concepts and devices

<table>
<thead>
<tr>
<th>Key for Hours</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

ECTS | European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
### Core Courses

<table>
<thead>
<tr>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>327-0505-00L</td>
<td>Surfaces, Interfaces and their Applications I</td>
<td>W</td>
<td>3 credits</td>
<td>2V+1U</td>
<td>N. Spencer, M. P. Heuberger, L. Isa</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>After being introduced to the physical/chemical principles and importance of surfaces and interfaces, the student is introduced to the most important techniques that can be used to characterize surfaces. Later, liquid interfaces are treated, followed by an introduction to the fields of tribology (friction, lubrication, and wear) and corrosion.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>To gain an understanding of the physical and chemical principles, as well as the tools and applications of surface science, and to be able to choose appropriate surface-analytical approaches for solving problems.</td>
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<tr>
<td><strong>Content</strong></td>
<td>Introduction to Surface Science</td>
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</table>

<table>
<thead>
<tr>
<th>Lecture notes</th>
<th>Script Download:</th>
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<tbody>
<tr>
<td><strong>Prerequisites / notice</strong></td>
<td>Chemistry: General undergraduate chemistry including basic chemical kinetics and thermodynamics</td>
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<td></td>
<td>Physics: General undergraduate physics including basic theory of diffraction and basic knowledge of crystal structures</td>
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<table>
<thead>
<tr>
<th>327-1201-00L</th>
<th>Transport Phenomena I</th>
<th>W Dr</th>
<th>4 credits</th>
<th>4G</th>
<th>H. C. Öttinger</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Abstract</strong></td>
<td>Phenomenological approach to &quot;Transport Phenomena&quot; based on balance equations supplemented by thermodynamic considerations to formulate the undetermined fluxes in the local species mass, momentum, and energy balance equations; fundamentals, applications, and simulations</td>
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<tr>
<td><strong>Objective</strong></td>
<td>The teaching goals of this course are on five different levels:</td>
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<tr>
<td></td>
<td>(1) Deep understanding of fundamentals: local balance equations, constitutive equations for fluxes, entropy balance, interfaces, idea of dimensionless numbers, ...</td>
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<td>(2) Ability to use the fundamental concepts in applications</td>
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<td>(3) Insight into the role of boundary conditions</td>
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<td>(4) Knowledge of a number of applications</td>
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<td>(5) Flavor of numerical techniques: finite elements, finite differences, lattice Boltzmann, Brownian dynamics, ...</td>
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<tr>
<td><strong>Content</strong></td>
<td>Approach to Transport Phenomena</td>
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<td></td>
<td>Diffusion Equation</td>
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<td></td>
<td>Brownian Dynamics</td>
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<td></td>
<td>Refreshing Topics in Equilibrium Thermodynamics</td>
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<td></td>
<td>Balance Equations</td>
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<td></td>
<td>Forces and Fluxes</td>
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<td></td>
<td>Measuring Transport Coefficients</td>
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<td>Pressure-Driven Flows</td>
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<td></td>
<td>Driven Separations</td>
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<td></td>
<td>Complex Fluids</td>
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<tr>
<td><strong>Lecture notes</strong></td>
<td>A detailed manuscript is provided; this manuscript will be developed into a book entitled &quot;A Modern Course in Transport Phenomena&quot; by David C. Venerus and Hans Christian Öttinger</td>
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</tr>
<tr>
<td><strong>Prerequisites / notice</strong></td>
<td>Complex numbers, Vector analysis (integrability; Gauss' divergence theorem). Laplace and Fourier transforms. Ordinary differential equations (basic ideas). Linear algebra (matrices; functions of matrices; eigenvectors and eigenvalues; eigenfunctions). Probability theory (Gaussian distributions; Poisson distributions; averages; moments; variances; random variables). Numerical mathematics (integration). Equilibrium thermodynamics (Gibbs' fundamental equation; thermodynamic potentials; Legendre transforms). Maxwell equations. Programming and simulation techniques (Matlab, Monte Carlo simulations).</td>
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<table>
<thead>
<tr>
<th>327-1202-00L</th>
<th>Solid State Physics and Chemistry of Materials I</th>
<th>W Dr</th>
<th>4 credits</th>
<th>4G</th>
<th>N. Spaldin</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Abstract</strong></td>
<td>In this course we study how the properties of solids are determined from the chemistry and arrangement of the constituent atoms, with a focus on materials that are not well described by conventional band theories because their behavior is governed by strong quantum-mechanical interactions.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>Electronic properties and band theory description of conventional solids</td>
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<tr>
<td></td>
<td>Electron-lattice coupling and its consequences in functional materials</td>
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<tr>
<td></td>
<td>Electron-spin/orbit coupling and its consequences in functional materials</td>
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<tr>
<td></td>
<td>Structure/property relationships in strongly-correlated materials</td>
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</tr>
<tr>
<td><strong>Content</strong></td>
<td>In this course we study how the properties of solids are determined from the chemistry and arrangement of the constituent atoms, with a focus on materials that are not well described by conventional band theories because their behavior is governed by strong quantum-mechanical interactions. We begin with a review of the successes of band theory in describing many properties of metals, semiconductors and insulators, and we practise building up band structures from atoms and describing the resulting properties. Then we explore classes of systems in which the coupling between the electrons and the lattice is so strong that it drives structural distortions such as Peierls instabilities, Jahn-Teller distortions, and ferroelectric transitions. Next, we move on to strong couplings between electronic charge and spin-and/or orbital-angular momentum, yielding materials with novel magnetic properties. We end with examples of the complete breakdown of single-particle band theory in so-called strongly correlated materials, which comprise for example heavy-fermion materials, frustrated magnets, materials with unusual metal-insulator transitions and the high-temperature superconductors.</td>
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</tbody>
</table>

Data: 06.03.2019 12:57 | Autumn Semester 2016 | Page 1092 of 1571
An electronic script for the course is provided at https://eskript.ethz.ch/catalog/matlab.

**Materials at Work I**

**Introduction**

This course attempts to prepare the student for a job as a materials engineer in industry. The gap between fundamental materials science and the application of materials is bridged by the introduction of realistic examples. The gap between fundamental materials science and the application of materials is bridged by the introduction of realistic examples. The course is divided into two parts: I) synthesis of 0-, 1-, 2-, and 3-dimensional building blocks with a length scale from nm to µm, and II) the study of the materials at the invariably wide range of length scales, from nm to m and from mg to tons.

**Objective**

The aim is a) to teach the students how to design and create objects as building blocks with a particular shape and a defined recognition pattern, b) to understand the chemistry that allows for the creation of such hard and soft objects within a certain size range, and c) to master the concepts to assemble these objects into hierarchically structured materials.

**Content**

The course is divided into two parts: I) synthesis of 0-, 1-, 2-, and 3-dimensional building blocks with a length scale from nm to µm, and II) the study of the materials at the invariably wide range of length scales, from nm to m and from mg to tons. Part II is focused on self- and directed assembly methods that can be used to create higher order architectures from those building blocks. This course connects the microscopic with the macroscopic world. Examples include photonic crystals, nanocrystal solids, colloidal molecules, mesocrystals or particle-based foams and aerogels.

**Prerequisites / Literature**

Hands-on assignments will be made available during the course and posted on the moodle page accessible through MyStudies.

**Elective Courses**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>327-1203-00L</td>
<td>Complex Materials I: Synthesis &amp; Assembly</td>
<td>W Dr</td>
<td>4</td>
<td>4G</td>
</tr>
<tr>
<td>327-1204-00L</td>
<td>Materials at Work I</td>
<td>W Dr</td>
<td>4</td>
<td>4S</td>
</tr>
<tr>
<td>327-1207-00L</td>
<td>Soft Materials II</td>
<td>W Dr</td>
<td>4</td>
<td>4G</td>
</tr>
</tbody>
</table>

**Prerequisites / Literature**

References to original articles and reviews for further reading will be provided on the lecture notes.

**Objective**

The course objectives are:

- to learn how to design and create objects as building blocks with a particular shape and a defined recognition pattern
- to understand the chemistry that allows for the creation of such hard and soft objects within a certain size range
- to master the concepts to assemble these objects into hierarchically structured materials

**Content**

The course is divided into two parts: I) synthesis of 0-, 1-, 2-, and 3-dimensional building blocks with a length scale from nm to µm, and II) the study of the materials at the invariably wide range of length scales, from nm to m and from mg to tons. Part II is focused on self- and directed assembly methods that can be used to create higher order architectures from those building blocks. This course connects the microscopic with the macroscopic world. Examples include photonic crystals, nanocrystal solids, colloidal molecules, mesocrystals or particle-based foams and aerogels.

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**Objective**

The course objectives are:

- to learn how to design and create objects as building blocks with a particular shape and a defined recognition pattern
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<td>327-1207-00L</td>
<td>Soft Materials II</td>
<td>W Dr</td>
<td>4</td>
<td>4G</td>
</tr>
</tbody>
</table>

**Prerequisites / Literature**

References to original articles and reviews for further reading will be provided on the lecture notes.

**Objective**

The course objectives are:

- to learn how to design and create objects as building blocks with a particular shape and a defined recognition pattern
- to understand the chemistry that allows for the creation of such hard and soft objects within a certain size range
- to master the concepts to assemble these objects into hierarchically structured materials

**Elective Courses**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>327-1203-00L</td>
<td>Complex Materials I: Synthesis &amp; Assembly</td>
<td>W Dr</td>
<td>4</td>
<td>4G</td>
</tr>
<tr>
<td>327-1204-00L</td>
<td>Materials at Work I</td>
<td>W Dr</td>
<td>4</td>
<td>4S</td>
</tr>
<tr>
<td>327-1207-00L</td>
<td>Soft Materials II</td>
<td>W Dr</td>
<td>4</td>
<td>4G</td>
</tr>
</tbody>
</table>

**Prerequisites / Literature**

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**Objective**

The course objectives are:

- to learn how to design and create objects as building blocks with a particular shape and a defined recognition pattern
- to understand the chemistry that allows for the creation of such hard and soft objects within a certain size range
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<tbody>
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<td>4</td>
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</tr>
<tr>
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<td>W Dr</td>
<td>4</td>
<td>4G</td>
</tr>
</tbody>
</table>
Objective

The course will provide a comprehensive introduction to the principles of fracture mechanics and its applications in the design and analysis of advanced composite and adaptive material systems. Emphasis will be placed on the development of advanced knowledge and understanding of their design, manufacturing, structure and properties, characterisation and applications.

Content

Fracture mechanics is a branch of applied mechanics that studies the behaviour of materials in terms of the fracture process. The course will cover the fundamentals of fracture mechanics, including the basics of fractional mechanics, the principles of applied mechanics and materials science. Cracks and crack-like defects are evaluated with a view to understanding and predicting the cracks' growth tendencies.

The topics covered are:

- Introduction to Linear Elastic Fracture Mechanics (LEFM): crack tip fields, strain and displacement fields in linear elastic materials (Modes I, II, and III); the stress-intensity factor, K; the fracture toughness KIC and their determination; fracture criterion
- Estimates of crack plastic zones in ductile materials
- The compliance method; experimental determination of compliance
- Introduction to fracture mechanics of nonlinear materials: the J-integral; the JIC fracture criterion; JIC testing
- Application of fracture mechanics concepts in the analysis of subcritical crack growth (fatigue, stress corrosion cracking, creep and their combinations)
- Lifetime determination and prediction; failure analysis.

Lecture notes

Copy of the overheads

Literature


K. H. Schwalbe, Bruchmechanik, Carl Hanser Verlag

Prerequisites


Required courses:

- ETH-course 327-0610 Composite Materials or similar course

More and more, the interest in functional fibre composites is increasing. In beginning, the main focus will be on the production of functional fibres, e.g., for fibre-based sensor and actuator composites with polymers, metals and ceramics. Optical, piezoelectric, shape memory and other fibres for advanced composite applications will be treated in detail. There will be a discussion on fibre classification, fibre production (ceramic and others), adaptive and smart materials, types of sensors and actuators (e.g., made from electro-active poly-mers), and sensor networks in photonic polymer composites.

The students should know the possibilities and limitations of the use of standard materials as well as get an idea of new innovative applications. More and more, the interest in functional fibre composites is increasing. In beginning, the main focus will be on the production of functional fibres, e.g. for fibre-based sensor and actuator composites with polymers, metals and ceramics. Optical, piezoelectric, shape memory and other fibres for advanced composite applications will be treated in detail. There will be a discussion on fibre classification, fibre production (ceramic and others), adaptive and smart materials, types of sensors and actuators (e.g., made from electro-active poly-mers), and sensor networks in photonic polymer composites.

The course will provide a comprehensive introduction to the principles of fracture mechanics and its applications in the design and analysis of advanced composite and adaptive material systems. Emphasis will be placed on the development of advanced knowledge and understanding of their design, manufacturing, structure and properties, characterisation and applications.

Content

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The topics covered are:

- Introduction to Linear Elastic Fracture Mechanics (LEFM): crack tip fields, strain and displacement fields in linear elastic materials (Modes I, II, and III); the stress-intensity factor, K; the fracture toughness KIC and their determination; fracture criterion
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- Lifetime determination and prediction; failure analysis.

Lecture notes

Copy of the overheads

Literature


K. H. Schwalbe, Bruchmechanik, Carl Hanser Verlag

Prerequisites


Required courses:

- ETH-course 327-0610 Composite Materials or similar course

More and more, the interest in functional fibre composites is increasing. In beginning, the main focus will be on the production of functional fibres, e.g., for fibre-based sensor and actuator composites with polymers, metals and ceramics. Optical, piezoelectric, shape memory and other fibres for advanced composite applications will be treated in detail. There will be a discussion on fibre classification, fibre production (ceramic and others), adaptive and smart materials, types of sensors and actuators (e.g., made from electro-active poly-mers), and sensor networks in photonic polymer composites.
The course is mainly based on the books listed below. Additional references will be provided during the lectures.

Topics are treated in 2 blocks:

(I) From Quantum to Continuum
From atoms to molecules to condensed matter: characteristic properties of simple nanosystems and how they evolve when moving towards complex ensembles.

(II) Interaction Forces on the Micro and Nano Scale
Intermolecular forces, their macroscopic manifestations, and ways to control such interactions.

This course is structured in 3 blocks:
Block (I): Fundamentals of engineering in biological materials
- Biological engineering principles
- Basic building blocks found in biological materials

Block (II): Replicating biological design principles in synthetic materials
- Biological and bio-inspired materials: polymer-reinforced and ceramic-toughened composites
- Lightweight biological and bio-inspired materials
- Functional biological and bio-inspired materials: surfaces, self-healing and adaptive materials

Block (III): Bio-inspired design and systems
- Bio-inspiration in the building environment
- Future developments in bio-inspired materials

Prerequisites / notice
Prerequisite: the lecture Electron Microscopy (327-0703-00L) has to be attended with success, maximum number of participants 15, work in groups of 3 people.

Lecture notes
Copies of the slides will be made available for download before each lecture.

Literature
Copies of the slides will be made available for download before each lecture.

Content
This course is structured in 3 blocks:
Block (I): Fundamentals of engineering in biological materials
- Biological engineering principles
- Basic building blocks found in biological materials

Block (II): Replicating biological design principles in synthetic materials
- Biological and bio-inspired materials: polymer-reinforced and ceramic-toughened composites
- Lightweight biological and bio-inspired materials
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Block (III): Bio-inspired design and systems
- Bio-inspiration in the building environment
- Future developments in bio-inspired materials

Prerequisites / notice
Prerequisite: the lecture Electron Microscopy (327-0703-00L) has to be attended with success, maximum number of participants 15, work in groups of 3 people.

Lecture notes
Copies of the slides will be made available for download before each lecture.

Literature
Copies of the slides will be made available for download before each lecture.
### Literature


### Prerequisites / notice

#### 402-0313-00L Materials Research Using Synchrotron Radiation

**W** 6 credits 2V+2P  L. Heyderman, V. Scagnoli

**Objective**
A comprehensive understanding of the interaction of x-rays with condensed matter and their use in materials analysis; acquiring hands-on experience with the use of synchrotron radiation.

**Content**
Interaction of x-rays with matter:
- Elastic scattering from bound electron, atom and assemblies of atoms; Compton scattering; principles of diffraction from crystals and scattering from disordered systems; thermal diffuse scattering, small-angle scattering from nanometre-sized objects; X-ray absorption spectroscopy; microscopy; comparison with neutron scattering, where appropriate.

The generation of high-brilliance x-ray beams at synchrotron radiation sources:
- Undulators, wigglers and bending magnets; comparison with conventional lab sources; the future x-ray free electron laser.

**Instrumentation:**
- Monochromator; diffractometer; detector.

**Determination of materials properties:**
- Crystal structure; defects and strain fields; structure of surfaces and interfaces; chemical bonding properties.

**New methods:**
- Coherent x-ray scattering and diffractive imaging.

**Lecture notes**
A reader and a guide through the experiments at the Swiss Light Source will be made available on the web.

**Literature**

**Part of the course is in the form of practical work at the Swiss Light Source. During two days (dates to be agreed), the following experiments will be performed:**
1. Elastic and Compton scattering.
2. Liquid scattering and powder diffraction.
3. X-ray absorption spectroscopy.

**Prerequisites / notice**
The lab course has been designed by J. Als-Nielsen in collaboration with staff from the SLS.

#### 402-0809-00L Introduction to Computational Physics

W 8 credits 2V+2U  H. J. Herrmann

**Abstract**
This course offers an introduction to computer simulation methods for physics problems and their implementation on PCs and super computers: classical equations of motion, partial differential equations (wave equation, diffusion equation, Maxwell's equation), Monte Carlo simulations, percolation, phase transitions

**Content**

**Prerequisites / notice**
Lecture and exercise lessons in english, exams in German or in English

#### 529-0947-00L Basic Polymer Synthesis

W 6 credits 3G  A. D. Schlüter

**Abstract**
Chain-growth polymerizations (anionic, cationic, Ziegler/Natta, ROMP, radical, NMP, ATRP), mechanistic details including how to render a polymerization "living", recent developments, and important examples.

**Objective**
The students should gain an overview of important polymerization procedures, learn how to deal with chemical structures and reactivities, and be able to suggest reasonable synthetic pathways to a given polymer structure. Aspects like achievable molar masses in dependence of the method used and structure perfection play a role throughout.

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Data: 06.03.2019 12:57  Autumn Semester 2016  Page 1096 of 1571
Biomineralization

L. B. Uebersax
K. H. Ernst
1 credit

There is no specific literature recommendation. Numerous references will be provided for an easy access to the original literature.

Physics of Food Colloids
R. Mezzenga

In Physics of Food Colloids the principles of colloid science will be applied to the aggregation of food materials based on proteins, polysaccharides, and emulsifiers. Mixtures of such raw material determine the appearance and performance of our daily food. In a number of examples, colloidal laws are linked to food science and the manufacturing and processing of food.

Lecture notes

A script will not be provided. For all projections shown, however, paper copies will be distributed.

Literature

There is no specific literature recommendation. Numerous references will be provided for an easy access to the original literature.

Prerequisites

The course will be taught in English. Complicated expressions will be explained in German. Questions can be asked in both languages.

PhD students who need recognized credit points are required to pass the written exam.

Objective

The aggregation of food material determines the appearance and performance of complex food systems as well as nutritional aspects. The underlying colloidal laws reflect the structure of the individual raw material (length scale, time scale, and interacting forces). Once these concepts are appreciated the aggregation of most food systems falls into recognizable patterns that can be used to modify and structure exiting food or to design new products. The application and use of these concepts are discussed in light of common food production.

Content

Lectures include interfacial tension (4h), protein aggregation in bulk and interfaces (4h), Pickering emulsions (2h), gels (4h), aggregation of complex mixtures (4h), and the use of light scattering in investigation complex food structures (6h). Most chapters include some hand-ons examples of the gain knowledge to common food products.

Lecture notes

Notes will be handed out during the lectures.

Literature

Provided in the lecture notes.

327-2314-00L

Physicals of Food Colloids

W 3 credits 2V
P. A. Fischer, R. Mezzenga

Abstract

In Physics of Food Colloids the principles of colloid science will be applied to the aggregation of food materials based on proteins, polysaccharides, and emulsifiers. Mixtures of such raw material determine the appearance and performance of our daily food. In a number of examples, colloidal laws are linked to food science and the manufacturing and processing of food.

Objective

The aggregation of food material determines the appearance and performance of complex food system as well as nutritional aspects. The underlying colloidal laws reflect the structure of the individual raw material (length scale, time scale, and interacting forces). Once these concepts are appreciated the aggregation of most food systems falls into recognizable patterns that can be used to modify and structure exiting food or to design new products. The application and use of these concepts are discussed in light of common food production.

Content

Lectures include interfacial tension (4h), protein aggregation in bulk and interfaces (4h), Pickering emulsions (2h), gels (4h), aggregation of complex mixtures (4h), and the use of light scattering in investigation complex food structures (6h). Most chapters include some hand-ons examples of the gain knowledge to common food products.

Lecture notes

Notes will be handed out during the lectures.

Literature

Provided in the lecture notes.

327-0811-00L

Industrial Research and Development at the Interface of Biomaterials and Drug Delivery

W Dr 1 credit 1V
L. B. Uebersax, J. Goldhahn, F. Schlottig, R. Streicher

Abstract

This course will provide an up-to-date, comprehensive review of the industrial perspective at the interface of biomaterials and drugs. This covers regulatory, clinical, pre-clinical and manufacturing concepts. The presentations are provided in an effort to maximize the interaction of student and lecturer.

Objective

- The student will be able to categorize a drug-biomaterial as a "drug" or a "material" from a regulatory perspective and can summarize general regulatory pathways for material/drug development.
- The student will be able to summarize the current concepts and challenges for the industry at the material-drug interface.
- The student will actively develop innovative, industrial concepts at the drug-biomaterial interface.

Content

This course will provide an up-to-date comprehensive review of the industrial perspective at the interface of biomaterials and drugs. General concepts related to regulatory affairs or such as cost-conscious planning of manufacturing processes will be covered by interactive case-studies and in close interaction between students and lecturers. The course covers the future at the biomaterial - implant interface - as it is seen by the industry today - and will be reviewed by experienced and long-standing faculty from industry with the aim to provide a balanced, insightful perspective. From that, clinical development concepts, regulatory pathways and real-life case studies will be discussed with the students. Finally the students - working in small groups of 4-5 - will outline a development pathway for an industrial project and present it to the course and in presence of all faculty to receive maximum feedback to their approaches.

The student will become familiar with the major elements required for a successful development and which challenges have to be taken into account to translate an idea into a successful product.

327-1101-00L

Biomineralization

W 2 credits 2G
K. H. Ernst

Abstract

The course addresses undergraduate and graduate students interested in getting introduced into the basic concepts of biomineralization. The course aims to introduce the basic concepts of biomineralization and the underlying principles, such as supersaturation, nucleation and growth of minerals, the interaction of biomolecules with mineral surfaces, and cell biology of inorganic materials creation. An important part of this class is the independent study and the presentation of original literature from the field.
Content

Biominerallization is a multidisciplinary field. Topics dealing with biology, molecular and cell biology, solid state physics, mineralogy, crystallography, organic and physical chemistry, biochemistry, dentistry, oceanography, geology, etc. are addressed. The course covers definition and general concepts of biominerallization (BM)/ types of biominerals and their function / crystal nucleation and growth / biological induction of BM / control of crystal morphology, habit, shape and orientation by organisms / strategies of compartmentalization / the interface between biomolecules (peptides, polysaccharides) and the mineral phase / modern experimental methods for studying BM phenomena / inter-, intra, extra- and epipellar BM / organic templates and matrices for BM / structure of bone, teeth (vertebrates and invertebrates) and mollusk shells / calcification / silification in diatoms, radiolarians and plants / calcium and iron storage / impact of BM on lithosphere and atmosphere/ evolution / taxonomy of organisms.

1. Introduction and overview
2. Biominerals and their functions
3. Chemical control of biominerallization
4. Control of morphology: Organic templates and additives
5. Modern methods of investigation of BM
6. BM in matrices: bone and nacre
7. Vertebrate teeth
8. Invertebrate teeth
9. BM within vesicles: calcite of coccoliths
10. Silica
11. Iron storage and mineralization

Lecture notes
Script with more than 600 pages with many illustrations will be distributed free of charge.

Literature
3) P. M. Dove, J. J. DeYoreo, S. Weiner (Eds.) Biominerallization, Reviews in Mineralogy & Geochemistry Vol. 54, 2003

Prerequisites / notice
Each attendee is required to present a publication from the field. The selection of key papers is provided by the lecturer. No special requirements are needed for attending. Basic knowledge in chemistry and cell biology is expected.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>W</th>
<th>1 credit</th>
<th>3P</th>
<th>Instructor</th>
</tr>
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<tbody>
<tr>
<td>327-2125-00L</td>
<td>Microscopy Training SEM I - Introduction to SEM</td>
<td>W</td>
<td>1 credit</td>
<td>3P</td>
<td>S. Rodighiero, A. G. Bittermann, K. Kunze, J. Reuteler</td>
</tr>
</tbody>
</table>

Objective
- Set-up, align and operate a SEM successfully and safely.
- Accomplish imaging tasks successfully and optimize microscope performances.
- Master the operation of a low-vacuum and field-emission SEM and EDX instrument.
- Perform sample preparation with corresponding techniques and equipment for imaging and analysis.
- Acquire techniques in obtaining secondary electron and backscatter electron micrographs.
- Perform EDX qualitative and semi-quantitative analysis.

Content
During the course, students learn through lectures, demonstrations, and hands-on sessions how to setup and operate SEM instruments, including low-vacuum and low-voltage applications. This course gives basic skills for students new to SEM. At the end of the course, students with no prior experience are able to align a SEM, to obtain secondary electron (SE) and backscatter electron (BSE) micrographs and to perform energy dispersive X-ray spectroscopy (EDX) qualitative and semi-quantitative analysis. The procedures to better utilize SEM to solve practical problems and to optimize SEM analysis for a wide range of materials will be emphasized.

- Discussion of students' sample/interest
- Introduction and discussion on Electron Microscopy and instrumentation
- Lectures on electron sources, electron lenses and probe formation
- Lectures on beam/specimen interaction, image formation, image contrast and imaging modes.
- Lectures on sample preparation techniques for EM
- Brief description and demonstration of the SEM microscope
- Practice on beam/specimen interaction, image formation, image contrast (and image processing)
- Student participation on sample preparation techniques.
- Scanning Electron Microscopy lab exercises: setup and operate the instrument under various imaging modalities
- Lecture and demonstrations on X-ray micro-analysis (theory and detection), qualitative and semi-quantitative EDX and point analysis, linescans and spectral mapping
- Practice on real-world samples and report results
- Detailed course manual

Prerequisites / notice
No mandatory prerequisites. Please consider the prior attendance to EM Basic lectures (551-1618-00V; 227-0390-00L; 327-0703-00L) as suggested prerequisite.

<table>
<thead>
<tr>
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<th>3P</th>
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<tbody>
<tr>
<td>327-2126-00L</td>
<td>Microscopy Training TEM I - Introduction to TEM</td>
<td>W</td>
<td>1 credit</td>
<td>3P</td>
<td>Does not take place this semester.</td>
</tr>
</tbody>
</table>

Abstract
The introductory course on Transmission Electron Microscopy (TEM) provides theoretical and hands-on learning for new operators, utilizing lectures, demonstrations, and hands-on sessions.

Objective
- Overview of TEM theory, instrumentation, operation and applications.
- Alignment and operation of a TEM, as well as acquisition and interpretation of images, diffraction patterns, accomplishing basic tasks successfully.
- Knowledge of electron imaging modes (including Scanning Transmission Electron Microscopy), magnification calibration, and image acquisition using CCD cameras.
- To set up the TEM to acquire diffraction patterns, perform camera length calibration, as well as measure and interpret diffraction patterns.
- Overview of techniques for specimen preparation.
Using two Transmission Electron Microscopes the students learn how to align a TEM, select parameters for acquisition of images in bright field (BF) and dark field (DF), perform scanning transmission electron microscopy (STEM) imaging, phase contrast imaging, and acquire electron diffraction patterns. The participants will also learn basic and advanced use of digital cameras and digital imaging methods.

- Introduction and discussion on Electron Microscopy and instrumentation.
- Lectures on electron sources, electron lenses and probe formation.
- Lectures on beam/specimen interaction, image formation, image contrast and imaging modes.
- Lectures on sample preparation techniques for EM.
- Brief description and demonstration of the TEM microscope.
- Practice on beam/specimen interaction, image formation, Image contrast (and image processing).
- Demonstration of Transmission Electron Microscopes and imaging modes (Phase contrast, BF, DF, STEM).
- Student participation on sample preparation techniques.
- Transmission Electron Microscopy lab exercises: setup and operate the instrument under various imaging modalities.
- TEM alignment, calibration, correction to improve image contrast and quality.
- Electron diffraction.
- Practice on real-world samples and report results.

**Literature**

- Detailed course manual

**Prerequisites / notice**

No mandatory prerequisites. Please consider the prior attendance to EM Basic lectures (551-1618-00V; 227-0390-00L; 327-0703-00L) as suggested prerequisite.

<table>
<thead>
<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>327-2127-00L</td>
<td>Sustainable Materials Management: Concepts, Methods and Principles</td>
<td>W</td>
<td>1 credit</td>
<td>1V P. Wäger</td>
</tr>
<tr>
<td>227-0455-00L</td>
<td>Terahertz: Technology &amp; Applications</td>
<td>W</td>
<td>3 credits</td>
<td>2V K. Sankaran</td>
</tr>
</tbody>
</table>

**Course Content**: The aim of this course is to introduce important concepts, methods and principles for sustainable materials management and to critically reflect their possibilities and limitations. A particular focus will be laid on recycling issues.

**Objective**: Students develop a basic understanding of important concepts, methods and principles for sustainable materials management and become acquainted with their possibilities and limitations.

**Content**: The course consists of six lectures introducing concepts, methods and principles for a sustainable materials management (including, amongst others, material flow analysis, life cycle assessment, raw materials criticality evaluation), with a particular focus on recycling issues and exemplifications for materials relevant for Information and Communication Technologies (ICT) and emerging energy technologies.

**Prerequisites / notice**

- Yun-Shik Lee, Principles of Terahertz Science and Technology, Springer 2009
- Whenever we deviate from the main material discussed in these books, softcopy of lectures notes will be provided.

**Projects**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>327-1210-00L</td>
<td>Project I</td>
<td>O</td>
<td>12 credits</td>
<td>23A</td>
<td>Professors</td>
</tr>
<tr>
<td>Abstract</td>
<td>Independent scientific practice of 8 weeks which is completed with a written report. Projects, with themes from the chosen scientific fields of interest, are intended to familiarise candidates with scientific procedures and operational methodologies through supervised participation in current research work.</td>
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<tr>
<td>Objective</td>
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<tr>
<td>327-1211-00L</td>
<td>Project II</td>
<td>O</td>
<td>12 credits</td>
<td>23A</td>
<td>Professors</td>
</tr>
<tr>
<td>Abstract</td>
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<tr>
<td>Objective</td>
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</table>

**Master’s Thesis**

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>327-9000-00L</td>
<td>Master’s Thesis</td>
<td>O</td>
<td>30 credits</td>
<td>64D</td>
<td>Professors</td>
</tr>
<tr>
<td>Notice</td>
<td>Only students who fulfill the following criteria are allowed to begin with their master thesis: a. successful completion of the bachelor programme;</td>
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</tbody>
</table>
Independent scientific work of current topics in the field of materials science. Duration 6 months. The work is documented in a written form.

Master thesis is a six month fulltime project and will encourage the students to work independently and in a structured and scientific way. It is guided by a professor of the Department of Materials.

### GESS Science in Perspective

**see GESS Science in Perspective: Type A: Enhancement of Reflection Capability**

**see GESS Science in Perspective: Language Courses** ETH/ÜZH

**Recommended GESS Science in Perspective (Type B) for D-MATL.**

### Course Units for Additional Admission Requirements

The courses below are only available for MSc students with additional admission requirements.

<table>
<thead>
<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>327-0401-AAL</td>
<td>Materials Science II</td>
<td>E-</td>
<td>3</td>
<td>6R</td>
<td>A. D. Schlüter, J. Kübler</td>
</tr>
<tr>
<td></td>
<td>Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.</td>
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<tr>
<td></td>
<td>Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.</td>
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</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
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<td></td>
<td>National, international, independent</td>
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<td></td>
<td>Physical properties and fracture mechanics of brittle materials. Introduction to polymers.</td>
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<td></td>
<td>The composition and microstructures of the most important ceramic materials are introduced. Microstructures and heterogenous phase equilibria and the properties of the four most important structural ceramics and glass are given. An introduction to fracture mechanics of brittle materials will allow to predict the survival probabilities and life time of components under static and dynamic load.</td>
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<td>To achieve a basic understanding for what polymers are like, how one can make them accessible and characterize them and, finally, which properties result from their chemical structure.</td>
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<td>The basics of the chemical bonds of ceramics and glass will be presented. Heterogenous phase equilibria and the properties of the four most important structural ceramics are given. An introduction to fracture mechanics of brittle materials will allow to predict the survival probabilities and life time of components under static and dynamic load.</td>
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<td>This introductory course discusses definitions, introduces types of polyreactions, and compares chain and step-growth polymerizations. It also treats the constitution of homo- and copolymers and networks as well as the configuration and conformation of polymers. Topics of interest are contour length, coil formation, the mobility in polymers, glass temperature, rubber elasticity, molecular weight distribution, energetics of polyreactions, and examples for polyreactions (polyadditions, polycondensations, polymerizations). Selected polymerization mechanisms and procedures are discussed. Some methods of molecular weight determination are introduced.</td>
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<td>Lecture notes</td>
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<tr>
<td></td>
<td>For ceramics see:</td>
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<td>National, international, independent</td>
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<td></td>
<td>- <a href="http://www.complex.mat.ethz.ch/education/lectures.html">http://www.complex.mat.ethz.ch/education/lectures.html</a></td>
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<tr>
<td></td>
<td>Literature</td>
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<td>National, international, independent</td>
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<td></td>
<td>- Modern Ceramic Engineering; David Richerson, Ed. 2, Dekker, 1992.</td>
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<td></td>
<td>Prerequisites / notice</td>
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<td>Both literatures will be made available in the course upon request.</td>
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<td>In the first part of the lecture the bases are obtained for structural ceramics.</td>
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<td>The second part of this lecture gives an introduction to polymers, their composition and properties.</td>
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<tr>
<td>327-0407-AAL</td>
<td>Basic Principles of Materials Physics B</td>
<td>E-</td>
<td>6</td>
<td>13R</td>
<td>P. Gambardella</td>
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<td>Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.</td>
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<td>Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.</td>
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<tr>
<td></td>
<td>Abstract</td>
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<td>National, international, independent</td>
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<td>This course introduces classical and quantum mechanical concepts for the understanding of material properties from a microscopic point of view. The lectures focus on the static and dynamic properties of crystals, the formation of chemical bonds and electronic bands in molecules, insulators, metals, and semiconductors, and on the thermal and electrical properties that emerge from this analysis.</td>
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<td>Objective</td>
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<td>National, international, independent</td>
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<td>Providing physical concepts for the understanding of materials properties.</td>
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<td>Understanding the electronic properties of solids is at the heart of modern society and technology. The aim of this course is to provide fundamental concepts that allow the student to relate the microscopic structure of matter and the quantum mechanical behavior of electrons to the macroscopic properties of materials. Beyond fundamental curiosity, such level of understanding is required in order to develop and appropriately describe new classes of materials for future technology applications. By the end of the course the student should have developed a semi-quantitative understanding of basic concepts in solid state physics and be able to appreciate the pertinence of different models to the description of specific material properties.</td>
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</table>
1. Thermal vacancies and diffusion
2. Nucleation and growth; diffusion-controlled and diffusion-less phase transitions
3. Spinodal decomposition and anharmonic effects
4. Dislocation energy/stacking faults; recovery; recrystallization; solidification
Abstract
Understanding of the electrical, dielectric and optical properties of functional ceramics for materials engineers, physicists and electrical engineers. An introduction is given to modern ceramics materials with multiple functions.

Objective
Ceramics II covers the basic principles of functional ceramics such as linear and non-linear dielectrics, semiconductors, ionic and mixed ionic-electronic conductors as well as materials aspects of high temperature superconductors. Examples of applications cover the range from piezo-, pyro and opto-electronic materials over sensors and solid oxide fuel cells to squids and fault current limiters with superconducting compounds.

At the end of the course, the students should be able to select the chemistry, design the microstructure and devise processing routes to fabricate functional ceramics for electronic, electromechanical, optical and magnetic applications.

Content
- Applications of functional ceramics
- Dieletrics fundamentals & insulators
- Capacitors & resonators
- Ferroelectricity & piezoelectricity
- Pyroelectricity and electro-optic ceramics
- Conductors
- Impedance spectroscopy
- Magnetic ceramics
- Superconductors

Lecture notes
See:
https://www.complex.mat.ethz.ch/education/courses/ceramics2

Literature
Electroceramics; J.A.Moulson
Free download of the book in ETH domain is possible following the link:
http://www3.interscience.wiley.com/cgi-bin/booktoc/104557643

Principles of Electronic Ceramics; L.L.Hench, J.K.West
Abstract
Repetition and advancement of dislocation theory. Mechanical properties of metals: hardening mechanisms, high temperature plasticity, alloying effects. Case studies in alloying to illustrate the mechanisms.

Objective
Repetition and advancement of dislocation theory. Mechanical properties of metals: hardening mechanisms, high temperature plasticity, alloying effects. Case studies in alloying to illustrate the mechanisms.

Content
Dislocation theory:
- Properties of dislocations, motion and kinetics of dislocations, dislocation-dislocation and dislocation-boundary interactions, consequences of partial dislocations, sessile dislocations
- Hardening theory:
  - a. solid solution hardening: case studies in copper-nickel and iron-carbon alloys
  - b. particle hardening: case studies on aluminium-copper alloys
- High temperature plasticity:
  - thermally activated glide
  - power-law creep
  - diffusional creep: Coble, Nabarro-Herring
  - deformation mechanism maps
  - Case studies in turbine blades
  - superplasticity
  - alloying effects

Lecture notes
https://www.met.mat.ethz.ch/education/lect_scripts

Literature
Gottstein, Physikalische Grundlagen der Materialkunde, Springer Verlag
Haasen, Physikalische Metallkunde, Springer Verlag
Rösler/Harders/Bäker, Mechanisches Verhalten der Werkstoffe, Teubner Verlag
Porter/Easterling, Transformations in Metals and Alloys, Chapman & Hall
Hull/Bacon, Introduction to Dislocations, Butterworth & Heinemann
Courtney, Mechanical Behaviour of Materials, McGraw-Hill

327-0612-AAL Metals II E- 3 credits 6R R. Spolenak
Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract
Introduction to materials selection. Basic knowledge of major metallic materials: aluminium, magnesium, titanium, copper, iron and steel. Selected topics in high temperature materials: nickel and iron-base superalloys, intermetallics and refractory metals.

Objective
Introduction to materials selection. Basic knowledge of major metallic materials: aluminium, magnesium, titanium, copper, iron and steel. Selected topics in high temperature materials: nickel and iron-base superalloys, intermetallics and refractory metals.

Content
This course is divided into five parts:

A. Materials selection
- Principles of materials properties maps
- Introduction to the 'Materials selector' software package
- Case studies

B. Light metals and alloys
- Aluminium, magnesium, titanium
- Properties and hardening mechanisms
- Case studies in technological applications

C. Copper and its alloys

D. Iron and steel
- The seven pros for steel
- Fine grained steels, heat resistant steels
- Steel and corrosion phenomena
- Selection and application

E. High temperature alloys
- Superalloys: iron, nickel, cobalt
- Intermetallics: properties and application

Lecture notes
http://www.met.mat.ethz.ch/education/lect_scripts

Literature
Gottstein, Physikalische Grundlagen der Materialkunde, Springer Verlag
Ashby/Jones, Engineering Materials 1 & 2, Pergamon Press
Ashby, Materials Selection in Mechanical Design, Pergamon Press
Porter/Easterling, Transformations in Metals and Alloys, Chapman & Hall
Bürgel, Handbuch Hochtemperatur-Werkstofftechnik, Vieweg Verlag

Prerequisites / notice
Prerequisites: Metals I

327-0610-AAL Advanced Composites E- 3 credits 6R F. J. Clemens, A. Winistörfer
Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract
Introduction of basic concepts for composites with polymer- metal- and ceramic matrix composites; production and properties of composites reinforced with particles, whiskers, short and long fibres; selection criteria, case histories of applications, recycling, future perspectives, and basic concepts for adaptive and functional composites

Objective
Gain an insight into the diversity of opportunities to change the properties of composites, learn about the most important applications and processing techniques
Content
1. Introduction
1.1 What are advanced composites?
1.2 What are materials by combination?
1.3 Are composites an idea of today?
1.4 Delphi foresight
1.5 Why composites?
1.6 References for chapter 1

2. Basic modules
2.1 Particles
2.2 Short fibres including whiskers
2.3 Long fibres
2.4 Matrix materials
2.4.1 Polymers
2.4.2 Metals
2.4.3 Ceramics and glasses
2.5 References for chapter 2

3. PMC: Polymer Matrix Composites
3.1 Historical background
3.2 Types of PMC-laminates
3.3 Production, processing and machining operation
3.4 Mechanics of reinforcement, microstructure, interfaces
3.5 Failure criteria
3.6 Fatigue behaviour of a multiply composite
3.7 Adaptive materials systems
3.8 References for chapter 3

4. MMC: Metal matrix composites
4.1 Introduction: Definitions, selection criteria und "design"
4.2 Types von MMCs - examples und typical properties
4.3 Mechanical and physical properties of MMCs - basics of design, influencing variables and damage mechanisms
4.4 Production processes
4.5 Micro structure / interfaces
4.6 machining operations for MMC
4.7 Applications
4.8 References for chapter 4

5. CMC: Ceramic Matrix Composites
5.1 Introduction and historical background
5.2 Modes of reinforcement
5.3 Production processes
5.4 Mechanisms of reinforcement
5.5 Micro structure / interfaces
5.6 Properties
5.7 Applications
5.8 Materials testing and quality assurance
5.9 References for chapter 5

Lecture notes
The script will be delivered at the begin of the semester

Literature
The script is including a comprehensive list of references

Prerequisites /
written end of semester examination
notice
Before each class, students will get a handout. Students will get the power point presentation of each class by e-mail.

Materials Science Master - Key for Type

<table>
<thead>
<tr>
<th>Key for Type</th>
<th>Description</th>
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<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
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<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
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<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
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<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
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Key for Hours

<table>
<thead>
<tr>
<th>Key for Hours</th>
<th>Description</th>
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<tbody>
<tr>
<td>V</td>
<td>lecture</td>
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<td>G</td>
<td>lecture with exercise</td>
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<td>U</td>
<td>exercise</td>
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<td>S</td>
<td>seminar</td>
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<td>K</td>
<td>colloquium</td>
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<td>P</td>
<td>practical/laboratory course</td>
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<td>A</td>
<td>independent project</td>
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<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
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</table>

ECTS European Credit Transfer and Accumulation System
Special students and auditors need special permission from the lecturers.
The classical life insurance model is presented together with the important insurance types (insurance on one and two lives, term and endowment insurance). 

M. Akveld, The lecture aims at providing a basis in non-life insurance mathematics which forms a core subject of actuarial sciences. It discusses investment returns are an important source of funding for social and pension insurance, and financial risk is an important threat to stability.

The student is familiar with the basics in non-life insurance mathematics and statistics. This includes the basic mathematical models for insurance liability modeling, pricing concepts, stochastic claims reserving models and ruin and solvency considerations.

The following topics are treated: Investment returns are an important source of funding for social and pension insurance, and financial risk is an important threat to stability. 

Objective 

Understand the basic asset-liability framework: essential principles and properties of social and pension insurance; cash flow matching, duration matching, valuation portfolio and loose coupling; the notion of financial risk; long-term vs. short-term risk; coherent measures of risk.

Understand the conditions for sustainable funding: derivation of required returns; interplay between return levels, contribution levels and other parameters; influence of guaranteed benefits.

Understand the notion of risk-taking capability: capital process as a random walk; measures of long-term risk and relation to capital; short-term solvency vs. long-term stability; effect of embedded options and guarantees; interplay between required return and risk-taking capability.

Be able to study empirical properties of financial assets: The Normal hypothesis and the deviations from it; statistical tools for investigating relevant risk and return properties of financial assets; time aggregation properties; be able to conduct analysis of real data for the most important asset classes.

Understand and be able to carry out portfolio construction: the concept of diversification; limitations to diversification / correlation breakdown / what happened in 2008; the Kuhn-Tucker Theorem and optimization (mean-variance, mean-downside); incorporation of constraints; sensitivity and shortcomings of optimized portfolios.

Understand and interpret the asset-liability interplay: the optimized portfolio in the asset-liability framework; short-term risk vs. long-term risk; the influence of constraints; feasible and non-feasible solutions; practical considerations.

Know about active portfolio management: practical issues when implementing an investment strategy; the notion of active management; efficient markets hypothesis and limitations to it; empirical evidence; the fundamental law of active management; Bayesian concepts and the Black-Litterman framework.

Have an overall view: see the big picture of what asset returns can and cannot contribute to social security; be aware of the most relevant outcomes; know the role of the actuary in the financial risk management process.

Further pieces of information are available at Prof. P. Embrechts's secretariat, HG F42.

This course will be held in English and counts towards the diploma of "Aktuar SAV". For the latter, see details under www.actuaries.ch.

Prerequisites: knowledge of probability theory, statistics and applied stochastic processes.

The exams ONLY take place during the official ETH examination period.

Prerequisites: knowledge of probability theory, statistics and applied stochastic processes.

Understand the basic asset-liability framework: essential principles and properties of social and pension insurance; cash flow matching, duration matching, valuation portfolio and loose coupling; the notion of financial risk; long-term vs. short-term risk; coherent measures of risk.

Understand the conditions for sustainable funding: derivation of required returns; interplay between return levels, contribution levels and other parameters; influence of guaranteed benefits.

Understand the notion of risk-taking capability: capital process as a random walk; measures of long-term risk and relation to capital; short-term solvency vs. long-term stability; effect of embedded options and guarantees; interplay between required return and risk-taking capability.

Be able to study empirical properties of financial assets: The Normal hypothesis and the deviations from it; statistical tools for investigating relevant risk and return properties of financial assets; time aggregation properties; be able to conduct analysis of real data for the most important asset classes.

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Understand the conditions for sustainable funding: derivation of required returns; interplay between return levels, contribution levels and other parameters; influence of guaranteed benefits.

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Be able to study empirical properties of financial assets: The Normal hypothesis and the deviations from it; statistical tools for investigating relevant risk and return properties of financial assets; time aggregation properties; be able to conduct analysis of real data for the most important asset classes.

Understand and be able to carry out portfolio construction: the concept of diversification; limitations to diversification / correlation breakdown / what happened in 2008; the Kuhn-Tucker Theorem and optimization (mean-variance, mean-downside); incorporation of constraints; sensitivity and shortcomings of optimized portfolios.

Understand and interpret the asset-liability interplay: the optimized portfolio in the asset-liability framework; short-term risk vs. long-term risk; the influence of constraints; feasible and non-feasible solutions; practical considerations.

Know about active portfolio management: practical issues when implementing an investment strategy; the notion of active management; efficient markets hypothesis and limitations to it; empirical evidence; the fundamental law of active management; Bayesian concepts and the Black-Litterman framework.

Have an overall view: see the big picture of what asset returns can and cannot contribute to social security; be aware of the most relevant outcomes; know the role of the actuary in the financial risk management process.
This course gives a first introduction to the main modelling ideas and mathematical tools from mathematical finance. It aims at a double

1. Required return for a sustainable funding of the institution,
2. Risk-taking capability of the institution,
3. Returns available from financial assets in the market,
4. Risks incurred by investing in these assets.

This task must be accomplished under a number of constraints. Financial risk management in social insurance also means reconciling the long time horizon of the promised insurance benefits with the short time horizon of financial markets and financial risk.

It is not the goal of this lecture to provide the students with any cookbook recipes that can readily be applied without further reflection. The goal is rather to enable the students to develop their own understanding of the problems and possible solutions associated with the management of financial risks in social and pension insurance.

To this end, a rigorous intellectual framework will be developed and a powerful set of mathematical tools from the fields of actuarial mathematics and quantitative risk management will be applied. When analyzing the properties of financial assets, an empirical viewpoint will be taken using statistical tools and considering real-world data.

Lecture notes
Since this is the first instance of this course, there is not yet a full script. However, to complement the blackboard notes, extensive handouts will be provided. Moreover, practical examples and data sets in Excel and Octave / Matlab will be made available to play around with and deepen the understanding of the subject matter.

Prerequisites / notice
Solid base knowledge of probability and statistics is indispensable. Specialized concepts from financial and insurance mathematics as well as quantitative risk management will be introduced in the lecture as needed, but some prior knowledge in some of these areas would be an advantage.

This course counts towards the diploma of "Aktuar SAV".

The exams ONLY take place during the official ETH examination period.

<table>
<thead>
<tr>
<th>401-3913-01L</th>
<th>Mathematical Foundations for Finance</th>
<th>W</th>
<th>4 credits</th>
<th>3V+2U</th>
<th>E. W. Farkas, M. Schweizer</th>
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<tbody>
<tr>
<td>Abstract</td>
<td>First introduction to main modelling ideas and mathematical tools from mathematical finance</td>
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<tr>
<td>Objective</td>
<td>This course gives a first introduction to the main modelling ideas and mathematical tools from mathematical finance. It aims at a double audience: mathematicians who want to learn the modelling ideas and concepts for finance, and non-mathematicians who need an introduction to the main tools from stochastics used in mathematical finance. The main emphasis will be on ideas, but important results will be given with (sometimes partial) proofs.</td>
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<td>- financial market models in finite discrete time</td>
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<td>- absence of arbitrage and martingale measures</td>
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<td>- valuation and hedging in complete markets</td>
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<td>- basics about Brownian motion</td>
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<td>- stochastic integration</td>
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<td>- stochastic calculus: Itô's formula, Girsanov transformation, Itô's representation theorem</td>
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<td></td>
<td>- Black-Scholes formula</td>
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<tr>
<td>Lecture notes</td>
<td>Lecture notes will be sold at the beginning of the course.</td>
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<tr>
<td>Literature</td>
<td>Additional (background) references are given there.</td>
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<thead>
<tr>
<th>363-0565-00L</th>
<th>Principles of Macroeconomics</th>
<th>W</th>
<th>3 credits</th>
<th>2V</th>
<th>J.E. Sturm</th>
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<tbody>
<tr>
<td>Abstract</td>
<td>This course examines the behaviour of macroeconomic variables, such as gross domestic product, unemployment and inflation rates. It tries to answer questions like: How can we explain fluctuations of national economic activity? What can economic policy do against unemployment and inflation? What significance do international economic relations have for Switzerland?</td>
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<tr>
<td>Objective</td>
<td>This lecture will introduce the fundamentals of macroeconomic theory and explain their relevance to everyday economic problems.</td>
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<tr>
<td>Content</td>
<td>This course helps you understand the world in which you live. There are many questions about the macroeconomy that might spark your curiosity. Why are living standards so meagre in many African countries? Why do some countries have high rates of inflation while others have stable prices? Why have some European countries adopted a common currency? These are just a few of the questions that this course will help you answer. Furthermore, this course will give you a better understanding of the potential and limits of economic policy. As a voter, you help choose the policies that guide the allocation of society's resources. When deciding which policies to support, you may find yourself asking various questions about economics. What are the burdens associated with alternative forms of taxation? What are the effects of free trade with other countries? What is the best way to protect the environment? How does the government budget deficit affect the economy? These and similar questions are always on the minds of policy makers.</td>
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<tr>
<td>Lecture notes</td>
<td>The course webpage (to be found at <a href="https://moodle-app2.let.ethz.ch/course/view.php?id=2467">https://moodle-app2.let.ethz.ch/course/view.php?id=2467</a>) contains announcements, course information and lecture slides.</td>
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</tbody>
</table>

We advise you to also buy access to Aplia. This internet platform will support you in learning for this course. To save money, you should buy the book together with Aplia. This is sold as a bundle (ISBN: 9781473715998).

Besides this textbook, the slides and lecture notes will cover the content of the lecture and the exam questions.
Mathematics (General Courses) - Key for Type

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
<td>E</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
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</table>

Key for Hours

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
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<tr>
<td>K</td>
<td>colloquium</td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
First Year

First Year Compulsory Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-1151-00L</td>
<td>Linear Algebra I</td>
<td>O</td>
<td>7 credits</td>
<td>4V+2U</td>
<td>M. Akveld</td>
</tr>
</tbody>
</table>
| Objective    | - Mastering basic concepts of Linear Algebra
  - Introduction to mathematical methods
| Content      | - Basics
  - Vectorspaces and linear maps
  - Systems of linear equations and matrices
  - Determinants
  - Endomorphisms and eigenvalues |

<table>
<thead>
<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-1701-00L</td>
<td>Physics I</td>
<td>O</td>
<td>7 credits</td>
<td>4V+2U</td>
<td>A. Wallraff</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course gives a first introduction to Physics. The emphasis is on classical mechanics, together with an introduction to thermodynamics.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Objective</td>
<td>Acquire knowledge of the basic principles regarding the physics of classical mechanics and thermodynamics. Skills in solving physics problems.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Literature   | Andrew Koenig and Barbara E. Mor: Accelerated C++, Addison-Wesley, 2000.

First Year Examination Block 1

1. Analysis I
   - Introduction to the differential and integral calculus in one real variable: fundamentals of mathematical thinking, numbers, sequences, basic point set topology, continuity, differentiable functions, ordinary differential equations, Riemann integration.
   - The ability to work with the basics of calculus in a mathematically rigorous way.

2. Computer Science
   - Introduction to programming based on the language C++. We cover fundamental types, control statements, functions, arrays, and classes. The concepts will be motivated and illustrated through algorithms and applications.
   - The goal of this lecture is an algorithmically oriented introduction to programming.

3. Physics I
   - This course gives a first introduction to Physics. The emphasis is on classical mechanics, together with an introduction to thermodynamics.
   - Acquire knowledge of the basic principles regarding the physics of classical mechanics and thermodynamics. Skills in solving physics problems.
Bachelor Studies (Programme Regulations 2010)

First Year

Course Units of the first year can be found in section Bachelor Studies (Programme Regulations 2016) - First Year.

Compulsory Courses

 Examination Block I

In Examination Block I either the course unit 402-2883-00L Physics III or the course unit 402-2203-01L Classical Mechanics must be chosen and registered for an examination. (Students may also enrol for the other of the two course units; within the ETH Bachelor's programme in mathematics, this other course unit cannot be registered in myStudies for an examination nor can it be recognised for the Bachelor's degree.)

<table>
<thead>
<tr>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-2303-00L</td>
<td>Complex Analysis</td>
<td>O</td>
<td>6 credits</td>
<td>3V+2U</td>
<td>R. Pandharipande</td>
</tr>
<tr>
<td>Abstract</td>
<td>Complex functions of one variable, Cauchy-Riemann equations, Cauchy theorem and integral formula, singularities, residue theorem, index of closed curves, analytic continuation, special functions, conformal mappings, Riemann mapping theorem.</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Objective</td>
<td>Working Knowledge with functions of one complex variables; in particular applications of the residue theorem</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Literature</td>
<td>Th. Gamelin: Complex Analysis. Springer 2001</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


D. Salamon: "Funktionentheorie". Birkhauser, 2011. (In German)


B. Palka: "An introduction to complex function theory."


R. Remmert: Theory of Complex Functions. Springer Verlag

| 401-2333-00L | Methods of Mathematical Physics I | O    | 6 credits | 3V+2U  | C. A. Keller        |
| Prerequisites / notice | Die Einschreibung in die Übungsgruppen erfolgt online. Melden Sie sich im Laufe der ersten Semesterwoche unter echo.ethz.ch mit Ihrem ETH Account an. Der Übungsbetrieb beginnt in der zweiten Semesterwoche. |

| 402-2883-00L | Physics III                  | W    | 7 credits | 4V+2U  | J. Home            |
| Abstract     | Introductory course on quantum and atomic physics including optics and statistical physics. |
| Objective    | A basic introduction to quantum and atomic physics, including basics of optics and equilibrium statistical physics. The course will focus on the relation of these topics to experimental methods and observations. |
| Lecture notes | Lecture notes will be provided electronically during the course. |


Statistical mechanics: "Statistical Physics", F. Mandl 0-471-91532-7

402-2203-01L Classical Mechanics W 7 credits 4V+2U G. M. Graf
Abstract
A conceptual introduction to theoretical physics: Newtonian mechanics, central force problem, oscillations, Lagrangian mechanics, symmetries and conservation laws, spinning top, relativistic space-time structure, particles in an electromagnetic field, Hamiltonian mechanics, canonical transformations, integrable systems, Hamilton-Jacobi equation.

252-0851-00L Algorithms and Complexity O 4 credits 2V+1U A. Steger
Abstract
Introduction: RAM machine, data structures; Algorithms: sorting, median, matrix multiplication, shortest paths, minimal spanning trees; Paradigms: divide & conquer, dynamic programming, greedy algorithms; Data Structures: search trees, dictionaries, priority queues; Complexity Theory; P and NP, NP-completeness, Cook’s theorem, reductions.
Objective
After this course students know some basic algorithms as well as underlying paradigms. They will be familiar with basic notions of complexity theory and can use them to classify problems.
Content
Lecture notes
Ja. Wird zu Beginn des Semesters verteilt.

>>> Examination Block II

Number Title Type ECTS Hours Lecturers
401-2003-00L Algebra I O 7 credits 4V+2U L. Halbeisen
Abstract
Introduction and development of some basic algebraic structures - groups, rings, fields.
Objective
Introduction to basic notions and results of group, ring and field theory.
Content
Group Theory: basic notions and examples of groups; Subgroups, Quotient groups and Homomorphisms, Sylow Theorems, Group actions and applications
Ring Theory: basic notions and examples of rings; Ring Homomorphisms, ideals and quotient rings, applications
Field Theory: basic notions and examples of fields; finite fields, applications
At the end we prove Mordell’s Theorem for special elliptic curves.

J.F. Humphreys: A Course in Group Theory (Oxford University Press)
G. Smith and O. Tabachnikova: Topics in Group Theory (Springer-Verlag)
M. Artin: Algebra (Birkhaeuser Verlag)
B.L. van der Waerden: Algebra I & II (Springer Verlag)

>>> Core Courses

>>> Core Courses: Pure Mathematics

Number Title Type ECTS Hours Lecturers
401-3531-00L Differential Geometry I W 10 credits 4V+1U U. Lang
Abstract
This course counts as a core course in the Bachelor's degree programme in Mathematics. Holders of an ETH Zurich Bachelor's degree in Mathematics who didn’t use credits from neither 401-3531-00L Differential Geometry I nor 401-3532-00L Differential Geometry II for their Bachelor's degree still can have recognised this course for the Master's degree. Furthermore, at most one of the three course units 401-3461-00L Functional Analysis I 401-3531-00L Differential Geometry I 401-3601-00L Probability Theory can be recognised for the Master's degree in Mathematics or Applied Mathematics.
Objective
Introduction to elementary differential geometry and differential topology.
Content
- Differential geometry in $\mathbb{R}^n$: theory of curves, submanifolds and immersions, inner geometry of hypersurfaces, Gauss map and curvature, Theorema Egregium, special classes of surfaces, Theorem of Gauss-Bonnet, Hyperbolic space. Differential manifolds, tangent bundle, immersions and embeddings, Sard's Theorem, mapping degree and intersection number, vector bundles, vector fields and flows, differential forms, Stokes' Theorem.
- The hyperbolic space.
- Differential topology: differential manifolds, tangent bundle, immersions and embeddings in $\mathbb{R}^n$, Sard's Theorem, transversality, mapping degree and intersection number, vector bundles, vector fields and flows, differential forms, Stokes' Theorem.

M. Artin: Algebra (Birkhaeuser Verlag)
G. Smith and O. Tabachnikova: Topics in Group Theory (Springer-Verlag)
B.L. van der Waerden: Algebra I & II (Springer Verlag)

401-3461-00L Functional Analysis I W 10 credits 4V+1U M. Struwe
Abstract
This course counts as a core course in the Bachelor's degree programme in Mathematics. Holders of an ETH Zurich Bachelor's degree in Mathematics who didn’t use credits from neither 401-3461-00L Functional Analysis I nor 401-3462-00L Functional Analysis II for their Bachelor's degree still can have recognised this course for...
the Master's degree.
Furthermore, at most one of the three course units
401-3461-00L Functional Analysis I
401-3531-00L Differential Geometry I
401-3601-00L Probability Theory
can be recognised for the Master's degree in Mathematics
or Applied Mathematics.

Abstract

Baire category; Banach and Hilbert spaces, bounded linear operators; three fundamental principles: Uniform boundedness, open
mapping/closed graph theorem, Hahn-Banach; convexity; dual spaces; weak and weak* topologies; Banach-Alaoglu; reflexive spaces;
compact operators and Fredholm theory; closed range theorem; spectral theory of self-adjoint operators in Hilbert spaces.

Lecture notes

Lecture Notes on "Funktionalanalyse I" by Michael Struwe

401-3371-00L Dynamical Systems I

W  10 credits 4V+1U  W. Merry

Abstract

This course is a broad introduction to dynamical systems. Topic covered include topological dynamics, ergodic theory and low-dimensional
dynamics.

Objective

Mastery of the basic methods and principal themes of some aspects of dynamical systems.

Content

Topics covered include:

1. Topological dynamics
   (transitivity, attractors, chaos, structural stability)

2. Ergodic theory
   (Poincare recurrence theorem, Birkhoff ergodic theorem, existence of invariant measures)

3. Low-dimensional dynamics
   (Poincare rotation number, dynamical systems on [0,1])

Literature

The most relevant textbook for this course is

Introduction to Dynamical Systems, Brin and Stuck, CUP, 2002.

I will also produce full lecture notes.

Prerequisites / notice

The material of the basic courses of the first two years of the program at ETH is assumed. In particular, you should be familiar with metric
spaces and elementary measure theory.

401-3001-61L Algebraic Topology I

W  8 credits  4G  P. S. Jossen

Abstract

This is an introductory course in algebraic topology. The course will cover the following main topics: introduction to homotopy theory,
homology and cohomology of spaces.

Literature


Book can be downloaded for free at:
http://www.math.cornell.edu/%7ehatcher/AT/ATpage.html

See also:
http://www.math.cornell.edu/%7ehatcher/#anchor1772800

3) E. Spanier, "Algebraic topology", Springer-Verlag

General topology, linear algebra.

Prerequisites / notice

Some knowledge of differential geometry and differential topology is useful but not absolutely necessary.

401-3132-00L Commutative Algebra

W  10 credits  4V+1U  R. Pink

Abstract

This course provides an introduction to commutative algebra as a foundation for and first steps towards algebraic geometry. The material in
this course will be assumed in the lecture course "Algebraic Geometry" in the spring semester 2017.

Objective

We shall cover approximately the material from
--- most of the textbook by Atiyah-MacDonald, or
--- the first half of the textbook by Bosch.
Topics include:
* Basics about rings, ideals and modules
* Localization
* Primary decomposition
* Integral dependence and valuations
* Noetherian rings
* Completions
* Basic dimension theory

Literature

Primary Reference:
2. "Algebraic Geometry and Commutative Algebra" by S. Bosch (Springer 2013)

Prerequisites / notice

Prerequisites: Algebra I (or a similar introduction to the basic concepts of ring theory).

Core Courses: Pure Mathematics (Mathematics Master)
Differential Equations

Course audience at ETH: 3rd year ETH BSc Mathematics and MSc Mathematics and MSc Applied Mathematics students.

Other ETH-students are advised to attend the course "Numerical Methods for Partial Differential Equations" (401-0674-00L) in the CSE curriculum during the spring semester.

Abstract
This course gives a comprehensive introduction into the numerical treatment of linear and non-linear elliptic boundary value problems, related eigenvalue problems and linear, parabolic evolution problems. Emphasis is on theory and the foundations of numerical methods. Practical exercises include MATLAB implementations of finite element methods.

Objective
Participants of the course should become familiar with
- concepts underlying the discretization of elliptic and parabolic boundary value problems
- analytical techniques for investigating the convergence of numerical methods for the approximate solution of boundary value problems
- methods for the efficient solution of discrete boundary value problems
- implementational aspects of the finite element method

Content
A selection of the following topics will be covered:
- Elliptic boundary value problems
- Galerkin discretization of linear variational problems
- The primal finite element method
- Mixed finite element methods
- Discontinuous Galerkin Methods
- Boundary element methods
- Spectral methods
- Adaptive finite element schemes
- Singularly perturbed problems
- Sparse grids
- Galerkin discretization of elliptic eigenproblems
- Non-linear elliptic boundary value problems
- Discretization of parabolic initial boundary value problems

Lecture notes
Course slides will be made available to the audience.

Prerequisites / notice
Practical exercises based on MATLAB

401-3601-00L Probability Theory

W 10 credits 4V+1U A.S. Sznitman

This course counts as a core course in the Bachelor's degree programme in Mathematics. Holders of an ETH Zurich Bachelor's degree in Mathematics who didn’t use credits from none of the three course units 401-3601-00L Probability Theory, 401-3642-00L Brownian Motion and Stochastic Calculus resp. 401-3602-00L Applied Stochastic Processes for their Bachelor's degree still can have recognised this course for the Master's degree. Furthermore, at most one of the three course units 401-3461-00L Functional Analysis I 401-3531-00L Differential Geometry I 401-3601-00L Probability Theory can be recognised for the Master's degree in Mathematics or Applied Mathematics.

Abstract
Basics of probability theory and the theory of stochastic processes in discrete time

Objective
This course presents the basics of probability theory and the theory of stochastic processes in discrete time. The following topics are planned:
- Basics in measure theory, random series, law of large numbers, weak convergence, characteristic functions, central limit theorem, conditional expectation, martingales, convergence theorems for martingales, Galton Watson chain, transition probability, Theorem of Ionescu Tulcea, Markov chains.

Content
This course presents the basics of probability theory and the theory of stochastic processes in discrete time. The following topics are planned:
- Basics in measure theory, random series, law of large numbers, weak convergence, characteristic functions, central limit theorem, conditional expectation, martingales, convergence theorems for martingales, Galton Watson chain, transition probability, Theorem of Ionescu Tulcea, Markov chains.

Lecture notes
available, will be sold in the course

Literature
H. Bauer, Probability Theory, de Gruyter 1996
J. Jacod and P. Protter, Probability essentials, Springer 2004
A. Klenke, Wahrscheinlichkeitstheorie, Springer 2006
D. Williams, Probability with martingales, Cambridge University Press 1991

401-3621-00L Fundamentals of Mathematical Statistics

W 10 credits 4V+1U F. Balabdaoui

Abstract
The course covers the basics of inferential statistics.

252-0057-00L Theoretical Computer Science

W 8 credits 4V+2U+1A J. Hromkovic

Abstract
Concepts to cope with: a) what can be accomplished in a fully automated fashion (algorithmically solvable) b) How to measure the inherent difficulty of tasks (problems) c) What is randomness and how can it be useful? d) What is nondeterminism and what role does it play in CS? e) How to represent infinite objects by finite automata and grammars?

Objective
Learning the basic concepts of computer science along their historical development
This lecture gives an introduction to theoretical computer science, presenting the basic concepts and methods of computer science in its historical context. We present computer science as an interdisciplinary science which, on the one hand, investigates the border between the possible and the impossible and the quantitative laws of information processing, and, on the other hand, designs, analyzes, verifies, and implements computer systems.

The main topics of the lecture are:

- alphabets, words, languages, measuring the information content of words, representation of algorithmic tasks
- finite automata, regular and context-free grammars
- Turing machines and computability
- complexity theory and NP-completeness
- design of algorithms for hard problems

Further reading:


More exercises and examples in:


During the semester, two non-obligatory test exams will be offered.

Core Courses: Applied Mathematics and Further Appl.-Oriented Fields (Mathematics Master)

Electives

Selection: Algebra, Topology, Discrete Mathematics, Logic

The circle method, invented by Hardy and Ramanujan and developed by Hardy and Littlewood and Kloosterman, is one of the most versatile methods currently available to determine the asymptotic behavior of the number of integral solutions to polynomial equations, when the number of solutions is sufficiently large.

The lecture will present an introduction to this method. In particular, it will present the solution of Waring's Problem concerning the representability of integers as sums of a bounded numbers of (fixed) powers of integers.

- alphabets, words, languages, measuring the information content of words, representation of algorithmic tasks
- finite automata, regular and context-free grammars
- Turing machines and computability
- complexity theory and NP-completeness
- design of algorithms for hard problems

The lecture is covered in detail by the textbook "Theoretical Computer Science".

Introduction to Algorithms by T. H. Cormen, C. E. Leiserson, R. L. Rivest; The circle method, invented by Hardy and Ramanujan and developed by Hardy and Littlewood and Kloosterman, is one of the most versatile methods currently available to determine the asymptotic behavior of the number of integral solutions to polynomial equations, when the number of solutions is sufficiently large.

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The lecture will present an introduction to this method. In particular, it will present the solution of Waring's Problem concerning the representability of integers as sums of a bounded numbers of (fixed) powers of integers.

The lecture is covered in detail by the textbook "Theoretical Computer Science".
**Lecturers**

**Finite geometries I, II:** Students will be able to construct and analyse models of finite geometries. They are familiar with closing theorems of finite geometries I, II. Finite geometries combine aspects of geometry, discrete mathematics and the algebra of finite fields. In particular, we plan to study reflection and Coxeter groups, classical invariant theory, and the theory of real semi simple Lie algebras and their representations.

**Combinatorics II**

Despite the title, the course will begin by a recollection of basic concepts of group and representation theory, in particular that of finite groups and Lie groups. Hence the course should be accessible also for students who only had a brief exposure to representation theory, as for example in the MMP course.

**Group and Representation Theory: Beyond an Introduction**

The goal of the course is to study several classical and important (and beautiful!) topics in group and representation theory, that are otherwise often overlooked in a standard curriculum.

In particular, we plan to study reflection and Coxeter groups, classical invariant theory, and the theory of real semi simple Lie algebras and their representations.

**Combinatorics II**

Does not take place this semester.

The course Combinatorics I and II is an introduction into the field of enumerative combinatorics.

Upon completion of the course, students are able to classify combinatorial problems and to apply adequate techniques to solve them.

Contents of the lectures Combinatorics I and II: congruence transformation of the plane, symmetry groups of geometric figures, Euler's function, Cayley graphs, formal power series, permutation groups, cycles, Bunsdie's lemma, cycle index, Polya's theorems, applications to graph theory and isomers.

### Selection: Geometry

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-3057-00L</td>
<td>Finite Geometries II</td>
<td>W</td>
<td>4 credits</td>
<td>2G</td>
<td>N. Hungerbühler</td>
</tr>
<tr>
<td>401-3309-66L</td>
<td>Riemann Surfaces (Part 2)</td>
<td>W</td>
<td>4 credits</td>
<td>2V</td>
<td>A. Buryak</td>
</tr>
</tbody>
</table>

**Abstract**

Finite geometries I, II: Finite geometries combine aspects of geometry, discrete mathematics and the algebra of finite fields. In particular, we will construct models of axioms of incidence and investigate closing theorems. Applications include test design in statistics, block design, and the construction of orthogonal Latin squares.

**Objective**

Finite geometries I, II: Students will be able to construct and analyse models of finite geometries. They are familiar with closing theorems of the axioms of incidence and are able to design statistical tests by using the theory of finite geometries. They are able to construct orthogonal Latin squares and know the basic elements of the theory of block design.

**Content**

Finite geometries I, II: finite fields, rings of polynomials, finite affine planes, axioms of incidence, Euler's thirty-six officers problem, design of statistical tests, orthogonal Latin squares, transformation of finite planes, closing theorems of Desargues and Pappus-Pascal, hierarchy of closing theorems, finite coordinate planes, division rings, finite projective planes, duality principle, finite Möbius planes, error correcting codes, block design

**Literature**

- Albrecht Beutelspacher: Einführung in die endliche Geometrie I,II. Bibliographisches Institut 1983
- Margaret Lynn Batten: Combinatorics of Finite Geometries. Cambridge University Press
- Dembowski: Finite Geometries
- O. Forster, Lectures on Riemann Surfaces.

**Prerequisites / notice**

This is a continuation of 401-3308-16L Riemann Surfaces that was taught in the spring semester (FS 2016), see https://docs.google.com/viewer?a=v&pid=sites&srcid=ZGVmYXVsdGRvbWFpbnhboGF4YW5kcml0cmVhZ2NvbWlvWWRjdGF4OjQuODM1ZDG1ZJNJEINWI for the lecture notes. The students are also assumed to be familiar with what would generally be covered in one semester courses on general topology and on algebra.

### Selection: Analysis

**Number | Title | Type | ECTS | Hours | Lecturers**

**401-3303-00L**

Special Topics in One Complex Variable

Hybergeometric Functions, Boundary values of holomorphic functions, Nevanlinna Theory and other special topics.

R. Remmert: Funktionentheorie II. Springer Verlag
C. Caratheodory: Funktionentheorie. Birkhaeuser
E. Hilf: Analytic Function Theory. AMS Chelsea Publishing
A. Gogolin: Komplexe Integration. Springer

**Prerequisites / notice**

Advanced methods of one complex variables

**401-3604-66L**

Special Topics in Probability: Recent Developments in Percolation Theory

The goal of this course is to present recent developments in Percolation Theory

**Abstract**

The goal of this course is to present recent developments in Percolation Theory

**Objective**

The goal of this course is to present recent developments in Percolation Theory

**Selection: Numerical Analysis**

No course offer

**Selection: Probability Theory, Statistics**

No course offer

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Content

Independent percolation is obtained by deleting randomly (and independently) the edges of a lattice, each with a given probability \( p \) between 0 and 1. One is then interested in the connectivity properties of the random subgraph so-obtained. It is arguably the simplest model from statistical mechanics that displays a phase transition, a drastic change of behavior as the parameter \( p \) varies.

We will first present classical tools and properties of percolation theory: in particular correlation inequalities, exponential decay of connection probabilities, and uniqueness of the infinite connected component. We will then discuss recent developments: for example percolation on Cayley graphs, and continuum limits in two dimensions.

Literature

B. Bollobas, O. Riordan: Percolation, CUP 2006

Prerequisites / notice

Prerequisites:
401-2604-00L Probability and Statistics (mandatory)
401-3601-00L Probability Theory (recommended)

401-3627-00L High-Dimensional Statistics

Abstract

"High-Dimensional Statistics" deals with modern methods and theory for statistical inference when the number of unknown parameters is of much larger order than sample size. Statistical estimation and algorithms for complex models and aspects of multiple testing will be discussed.

Objective

Knowledge of methods and basic theory for high-dimensional statistical inference

Content

Lasso and Group Lasso for high-dimensional linear and generalized linear models; Additive models and many smooth univariate functions; Non-convex loss functions and 11-regularization; Stability selection, multiple testing and construction of p-values; Undirected graphical modeling

Literature


Prerequisites / notice

Knowledge of basic concepts in probability theory, and intermediate knowledge of statistics (e.g. a course in linear models or computational statistics).

401-4623-00L Time Series Analysis

Abstract

Statistical analysis and modeling of observations in temporal order, which exhibit dependence. Stationarity, trend estimation, seasonal decomposition, autocorrelations, spectral and wavelet analysis, ARIMA-, GARCH- and state space models. Implementations in the software R.

Objective

Understanding of the basic models and techniques used in time series analysis and their implementation in the statistical software R.

Content

This course deals with modeling and analysis of variables which change randomly in time. Their essential feature is the dependence between successive observations.

Literature

Not available

Lecture notes

A list of references will be distributed during the course.

Prerequisites / notice

Basic knowledge in probability and statistics

401-0625-01L Applied Analysis of Variance and Experimental Design

Abstract


Objective

Participants will be able to plan and analyze efficient experiments in the fields of natural sciences. They will gain practical experience by using the software R.

Content


Literature


Prerequisites / notice

The exercises, but also the classes will be based on procedures from the freely available, open-source statistical software R, for which an introduction will be held.

401-3611-00L Advanced Topics in Computational Statistics

Abstract

This lecture covers selected advanced topics in computational statistics, including various classification methods, the EM algorithm, clustering, handling missing data, and graphical modelling.

Objective

Students learn the theoretical foundations of the selected methods, as well as practical skills to apply these methods and to interpret their outcomes.

Content

The course is roughly divided in three parts: (1) Supervised learning via (variations of) nearest neighbor methods, (2) the EM algorithm and clustering, (3) handling missing data and graphical models.

Prerequisites / notice

Lecture notes

We assume a solid background in mathematics, an introductory lecture in probability and statistics, and at least one more advanced course in statistics.

401-0649-00L Applied Statistical Regression

Abstract

This course offers a practically oriented introduction into regression modeling methods. The basic concepts and some mathematical background are included, with the emphasis lying in learning “good practice” that can be applied in every student’s own projects and daily work life. A special focus will be laid in the use of the statistical software package R for regression analysis.

Objective

The students acquire advanced practical skills in linear regression analysis and are also familiar with its extensions to generalized linear modeling.

Content

The course starts with the basics of linear modeling, and then proceeds to parameter estimation, tests, confidence intervals, residual analysis, model choice, and prediction. More rarely touched but practically relevant topics that will be covered include variable transformations, multicollinearity problems and model interpretation, as well as general modeling strategies.

The last third of the course is dedicated to an introduction to generalized linear models: this includes the generalized additive model, logistic regression for binary response variables, binomial regression for grouped data and poisson regression for count data.

Prerequisites / notice

A script will be available.
The exercises, but also the classes will be based on procedures from the freely available, open-source statistical software package R, for which an introduction will be held.

In the Mathematics Bachelor and Master programmes, the two course units 401-0649-00L "Applied Statistical Regression" and 401-3622-00L "Regression" are mutually exclusive. Registration for the examination of one of these two course units is only allowed if you have not registered for the examination of the other course unit.

### Selection: Financial and Insurance Mathematics

In the Bachelor's programme in Mathematics 401-3913-01L Mathematical Foundations for Finance is eligible as an elective course, but only if 401-3888-00L Introduction to Mathematical Finance isn't recognised for credits (neither in the Bachelor's nor in the Master's programme). For the category assignment take contact with the Study Administration Office (www.math.ethz.ch/studiensekretariat) after having received the credits.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>401-3925-00L</td>
<td>Non-Life Insurance: Mathematics and Statistics</td>
<td>W</td>
<td>6</td>
<td>4G</td>
<td>M. V. Wüthrich</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td>The lecture aims at providing a basis in non-life insurance mathematics which forms a core subject of actuarial sciences. It discusses collective risk modeling, individual claim size modeling, approximations for compound distributions, ruin theory, premium calculation principles, tariffication with generalized linear models, credibility theory, claims reserving and solvency.</td>
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<td><strong>Objective</strong></td>
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<td></td>
<td>The student is familiar with the basics in non-life insurance mathematics and statistics. This includes the basic mathematical models for insurance liability modeling, pricing concepts, stochastic claims reserving models and ruin and solvency considerations.</td>
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<td></td>
<td><strong>Content</strong></td>
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<tr>
<td></td>
<td>The following topics are treated:</td>
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<td>Collective Risk Modeling</td>
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<td>Individual Claim Size Modeling</td>
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<td>Approximations for Compound Distributions</td>
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<td>Ruin Theory in Discrete Time</td>
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<td>Premium Calculation Principles</td>
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<td>Tariffication and Generalized Linear Models</td>
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<td>Bayesian Models and Credibility Theory</td>
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<td>Claims Reserving</td>
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<td></td>
<td>Solvency Considerations</td>
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<td></td>
<td><strong>Lecture notes</strong></td>
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<td></td>
<td>M. V. Wüthrich, Non-Life Insurance: Mathematics &amp; Statistics</td>
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<td><a href="http://ssrn.com/abstract=2319328">http://ssrn.com/abstract=2319328</a></td>
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<tr>
<td>401-3922-00L</td>
<td>Life Insurance Mathematics</td>
<td>W</td>
<td>4</td>
<td>2V</td>
<td>M. Koller</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td>The classical life insurance model is presented together with the important insurance types (insurance on one and two lives, term and endowment insurance and disability). Besides that the most important terms such as mathematical reserves are introduced and calculated. The profit and loss account and the balance sheet of a life insurance company is explained and illustrated.</td>
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<td>401-3929-00L</td>
<td>Financial Risk Management in Social and Pension Insurance</td>
<td>W</td>
<td>4</td>
<td>2V</td>
<td>P. Blum</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td></td>
<td>Investment returns are an important source of funding for social and pension insurance, and financial risk is an important threat to stability. We study short-term and long-term financial risk and its interplay with other risk factors, and we develop methods for the measurement and management of financial risk and return in an asset/liability context with the goal of assuring sustainable funding.</td>
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<td><strong>Objective</strong></td>
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<td></td>
<td>Understand the basic asset-liability framework: essential principles and properties of social and pension insurance; cash flow matching, duration matching, valuation portfolio and loose coupling; the notion of financial risk; long-term vs. short-term risk; coherent measures of risk.</td>
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<td>Understand the conditions for sustainable funding; derivation of required returns; interplay between return levels, contribution levels and other parameters; influence of guaranteed benefits.</td>
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<td>Understand the notion of risk-taking capability: capital process as a random walk; measures of long-term risk and relation to capital; short-term solvency vs. long-term stability; effect of embedded options and guarantees; interplay between required return and risk-taking capability.</td>
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<td>Be able to study empirical properties of financial assets: the Normal hypothesis and the deviations from it; statistical tools for investigating relevant risk and return properties of financial assets; time aggregation properties; be able to conduct analysis of real data for the most important asset classes.</td>
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<td>Understand and be able to carry out portfolio construction: the concept of diversification; limitations to diversification / correlation breakdown / what happened in 2008; the Kuhn-Tucker Theorem and optimization (mean-variance, mean-downside); incorporation of constraints; sensitivity and shortcomings of optimized portfolios.</td>
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<td>Understand and interpret the asset-liability interplay: the optimized portfolio in the asset-liability framework; short-term risk vs. long-term risk; the influence of constraints; feasible and non-feasible solutions; practical considerations.</td>
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<td>Know about active portfolio management: practical issues when implementing an investment strategy; the notion of active management; efficient markets hypothesis and limitations to it; empirical evidence; the fundamental law of active management; Bayesian concepts and the Black-Litterman framework.</td>
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<td>Have an overall view; see the big picture of what asset returns can and cannot contribute to social security; be aware of the most relevant outcomes; know the role of the actuary in the financial risk management process.</td>
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### Content

For pension insurance and other forms of social insurance, investment returns are an important source of funding. In order to earn these returns, substantial financial risks must be taken, and these risks represent an important threat to financial stability, in the long term and in the short term.

Risk and return of financial assets cannot be separated from one another and, hence, asset management and risk management cannot be separated either. Managing financial risk in social and pension insurance is, therefore, the task of reconciling the contradictory dimensions of

1. Required return for a sustainable funding of the institution,
2. Risk-taking capability of the institution,
3. Returns available from financial assets in the market,
4. Risks incurred by investing in these assets.

This task must be accomplished under a number of constraints. Financial risk management in social insurance also means reconciling the long time horizon of the promised insurance benefits with the short time horizon of financial markets and financial risk.

It is not the goal of this lecture to provide the students with any cookbook recipes that can readily be applied without further reflection. The goal is rather to enable the students to develop their own understanding of the problems and possible solutions associated with the management of financial risks in social and pension insurance.

To this end, a rigorous intellectual framework will be developed and a powerful set of mathematical tools from the fields of actuarial mathematics and quantitative risk management will be applied. When analyzing the properties of financial assets, an empirical viewpoint will be taken using statistical tools and considering real-world data.

### Lecture notes

Since this is the first instance of this course, there is not yet a full script. However, to complement the blackboard notes, extensive handouts will be provided. Moreover, practical examples and data sets in Excel and Octave / Matlab will be made available to play around with and deepen the understanding of the subject matter.

### Prerequisites / notice

Solid base knowledge of probability and statistics is indispensable. Specialized concepts from financial and insurance mathematics as well as quantitative risk management will be introduced in the lecture as needed, but some prior knowledge in some of these areas would be an advantage.

This course counts towards the diploma of "Aktuar SAV".

The exams ONLY take place during the official ETH examination period.

#### Selection: Mathematical Physics, Theoretical Physics

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<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>402-0830-00L</td>
<td>General Relativity</td>
<td>W</td>
<td>10</td>
<td>4V+2U</td>
<td>P. Jetzer</td>
</tr>
<tr>
<td>Abstract</td>
<td>Manifold, Riemannian metric, connection, curvature; Special Relativity; Lorentzian metric; Equivalence principle; Tidal force and spacetime curvature; Energy-momentum tensor, field equations, Newtonian limit; Post-Newtonian approximation; Schwarzschild solution; Mercury’s perihelion precession, light deflection.</td>
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<td>Objective</td>
<td>Basic understanding of general relativity, its mathematical foundations, and some of the interesting phenomena it predicts.</td>
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<tr>
<td>Literature</td>
<td>Suggested textbooks:</td>
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<td></td>
<td>C. Misner, K. Thorne and J. Wheeler: Gravitation</td>
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<td></td>
<td>S. Carroll - Spacetime and Geometry: An Introduction to General Relativity</td>
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<td></td>
<td>R. Wald - General Relativity</td>
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<td>S. Weinberg - Gravitation and Cosmology</td>
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<td></td>
<td>N. Straumann - General Relativity with applications to Astrophysics</td>
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<tr>
<td>402-0822-13L</td>
<td>Introduction to Integrability</td>
<td>W</td>
<td>6</td>
<td>2V+1U</td>
<td>N. Beisert</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course gives an introduction to the theory of integrable systems, related symmetry algebras and efficient calculational methods.</td>
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<tr>
<td>Objective</td>
<td>Integrable systems are a special class of physical models that can be solved exactly due to an exceptionally large number of symmetries. Examples of integrable models appear in many different areas of physics, including classical mechanics, condensed matter, 2d quantum field theories and lately in string- and gauge theories. They offer a unique opportunity to gain a deeper understanding of generic phenomena in a simplified, exactly solvable setting. In this course we introduce the various notions of integrability in classical mechanics, quantum mechanics and quantum field theory. We discuss efficient methods for solving such models as well as the underlying enhanced symmetries.</td>
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<tr>
<td>Content</td>
<td>* Classical Integrability</td>
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<td>* Integrable Field Theory</td>
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<td>* Integrable Spin Chains</td>
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<td>* Quantum Integrability</td>
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<td>* Integrable Statistical Mechanics</td>
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<td></td>
<td>* Quantum Algebra</td>
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<td>* Bethe Ansatz and Related Methods</td>
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<td>* Ads/CFT Integrability</td>
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#### Selection: Mathematical Optimization, Discrete Mathematics

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<th>Number</th>
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<tbody>
<tr>
<td>401-3054-14L</td>
<td>Probabilistic Methods in Combinatorics</td>
<td>W</td>
<td>6</td>
<td>2V+1U</td>
<td>B. Sudakov</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course provides a gentle introduction to the Probabilistic Method, with an emphasis on methodology. We will try to illustrate the main ideas by showing the application of probabilistic reasoning to various combinatorial problems.</td>
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<td>Content</td>
<td>The topics covered in the class will include (but are not limited to): linearity of expectation, the second moment method, the local lemma, correlation inequalities, martingales, large deviation inequalities, Janson and Talagrand inequalities and pseudo-randomness.</td>
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### Auswahl: Theoretical Computer Science

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<th>Number</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>252-1407-00L</td>
<td>Algorithmic Game Theory</td>
<td>W</td>
<td>7 credits</td>
<td>3V+2U+1A</td>
<td>P. Widmayer, P. Penna</td>
</tr>
<tr>
<td>Abstract</td>
<td>Game theory provides a formal model to study the behavior and interaction of self-interested users and programs in large-scale distributed computer systems without central control. The course discusses algorithmic aspects of game theory. Learning the basic concepts of game theory and mechanism design, acquiring the computational paradigm of self-interested agents, and using these concepts in the computational and algorithmic setting. The Internet is a typical example of a large-scale distributed computer system without central control, with users that are typically only interested in their own good. For instance, they are interested in getting high bandwidth for themselves, but don't care about others, and the same is true for computational load or download rates. Game theory provides a particularly well-suited model for the behavior and interaction of such selfish users and programs. Classic game theory dates back to the 1930s and typically does not consider algorithmic aspects at all. Only a few years back, algorithms and game theory have been considered together, in an attempt to reconcile selfish behavior of independent agents with the common good. This course discusses algorithmic aspects of game-theoretic models, with a focus on recent algorithmic and mathematical developments. Rather than giving an overview of such developments, the course aims to study selected important topics in depth.</td>
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<tr>
<td>Objective</td>
<td>Outline: - Introduction to classic game-theoretic concepts. - Existence of stable solutions (equilibria), algorithms for computing equilibria, computational complexity. - Speed of convergence of natural game playing dynamics such as best-response dynamics or regret minimization. - Techniques for bounding the quality-loss due to selfish behavior versus optimal outcomes under central control (a.k.a. the 'Price of Anarchy'). - Design and analysis of mechanisms that induce truthful behavior or near-optimal outcomes at equilibrium. - Selected current research topics, such as Google's Sponsored Search Auction, the U.S. FCC Spectrum Auction, Kidney Exchange. No lecture notes.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Several copies of both books are available in the Computer Science library. Audience: Although this is a Computer Science course, we encourage the participation from all students who are interested in this topic. Requirements: You should enjoy precise mathematical reasoning. You need to have passed a course on algorithms and complexity. No knowledge of game theory is required.</td>
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<tr>
<td>252-0417-00L</td>
<td>Randomized Algorithms and Probabilistic Methods</td>
<td>W</td>
<td>7 credits</td>
<td>3V+2U+1A</td>
<td>A. Steger, E. Welzl</td>
</tr>
<tr>
<td>Abstract</td>
<td>Las Vegas &amp; Monte Carlo algorithms: inequalities of Markov, Chebyshev, Chernoff; negative correlation; Markov chains: convergence, rapidly mixing; generating functions; Examples include: min cut, median, balls and bins, routing in hypercubes, 3SAT, card shuffling, random walks</td>
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<td>Objective</td>
<td>After this course students will know fundamental techniques from probabilistic combinatorics for designing randomized algorithms and will be able to apply them to solve typical problems in these areas. Randomized Algorithms are algorithms that &quot;flip coins&quot; to take certain decisions. This concept extends the classical model of deterministic algorithms and has become very popular and useful within the last twenty years. In many cases, randomized algorithms are faster, simpler or just more elegant than deterministic ones. In the course, we will discuss basic principles and techniques and derive from them a number of randomized methods for problems in different areas.</td>
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<td>Content</td>
<td>Lecture notes: Yes.</td>
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<tr>
<td>252-1425-00L</td>
<td>Geometry: Combinatorics and Algorithms</td>
<td>W</td>
<td>6 credits</td>
<td>2V+2U+1A</td>
<td>B. Gärtner, E. Welzl, M. Hoffmann, A. Pilz</td>
</tr>
<tr>
<td>Abstract</td>
<td>Geometric structures are useful in many areas, and there is a need to understand their structural properties, and to work with them algorithmically. The lecture addresses theoretical foundations concerning geometric structures. Central objects of interest are triangulations. We study combinatorial (Does a certain object exist?) and algorithmic questions (Can we find a certain object efficiently?)</td>
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<tr>
<td>Objective</td>
<td>The goal is to make students familiar with fundamental concepts, techniques and results in combinatorial and computational geometry, so as to enable them to model, analyze, and solve theoretical and practical problems in the area and in various application fields. In particular, we want to prepare students for conducting independent research, for instance, within the scope of a thesis project. Planar and geometric graphs, embeddings and their representation (Whitney's Theorem, canonical orderings, DCEL), polygon triangulations and the art gallery theorem, convexity in R^d, planar convex hull algorithms (Jarvis Wrap, Graham Scan, Chan's Algorithm), point set triangulations, Delaunay triangulations (Lawson flips, lifting map, randomized incremental construction), Voronoi diagrams, the Crossing Lemma and incidence bounds, line arrangements (duality, Zone Theorem, ham-sandwich cuts), 3-SUM hardness, counting planar triangulations.</td>
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</tr>
<tr>
<td>Content</td>
<td>Lecture notes: yes.</td>
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</tr>
<tr>
<td>Prerequisites / notice</td>
<td>Prerequisites: The course assumes basic knowledge of discrete mathematics and algorithms, as supplied in the first semesters of Bachelor Studies at ETH.</td>
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<tr>
<td>263-4655-00L</td>
<td>Lattice Cryptography</td>
<td>W</td>
<td>4 credits</td>
<td>2V+U+1A</td>
<td>V. Lyubashevsky</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course will introduce lattice-based cryptography, which is one of the main candidates for quantum-resistant cryptography. The objective of the course is to bring the students up to a level where they should be able to read academic papers on state-of-the-art designs of lattice-based primitives.</td>
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Data: 06.03.2019 12:57
Autumn Semester 2016
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In this course, we will study lattice-based cryptography. We will cover the basic algorithms associated with integer lattices such as Gram-Schmidt orthogonalization, algorithms for finding short and near lattice vectors, as well as the critical algorithm for sampling lattice points according to a discrete Gaussian distribution. We will then proceed to build up a toolbox of lattice-based cryptographic primitives beginning from collision-resistant hash functions, then moving on to digital signatures, encryption, identity-based encryption, and fully-homomorphic encryption. Particular emphasis will be placed on concrete parameters and practical instantiations. For this purpose, we will also study cryptographic constructions based on the hardness of ideal lattices, which are ideals of polynomial rings.

Prerequisites / notice
There are no formal mathematical pre-requisites, but students should have "mathematical maturity", which entails dealing with abstract concepts and being comfortable with doing mathematical proofs. Some previous exposure to linear algebra, abstract algebra, and cryptography would be useful.

Selection: Further Realms

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
</table>
| 401-3502-66L | Reading Course g THE ENROLMENT IS DONE BY THE STUDY ADMINISTRATION.  
Please send an email to Studiensekretariat D-MATH <studiensekretariat@math.ethz.ch> including the following pieces of information:  
1) which Reading Course (60, 90, 120 hours of work, corresponding to 2, 3, 4 ECTS credits) you wish to register;  
2) in which semester;  
3) for which degree programme;  
4) your name and first name;  
5) your student number;  
6) the name and first name of the supervisor of the Reading Course. | W    | 2 credits | 4A    | Professors |
| 401-3503-66L | Reading Course h THE ENROLMENT IS DONE BY THE STUDY ADMINISTRATION.  
Please send an email to Studiensekretariat D-MATH <studiensekretariat@math.ethz.ch> including the following pieces of information:  
1) which Reading Course (60, 90, 120 hours of work, corresponding to 2, 3, 4 ECTS credits) you wish to register;  
2) in which semester;  
3) for which degree programme;  
4) your name and first name;  
5) your student number;  
6) the name and first name of the supervisor of the Reading Course. | W    | 3 credits | 6A    | Professors |
| 401-3504-66L | Reading Course i THE ENROLMENT IS DONE BY THE STUDY ADMINISTRATION.  
Please send an email to Studiensekretariat D-MATH <studiensekretariat@math.ethz.ch> including the following pieces of information:  
1) which Reading Course (60, 90, 120 hours of work, corresponding to 2, 3, 4 ECTS credits) you wish to register;  
2) in which semester;  
3) for which degree programme;  
4) your name and first name;  
5) your student number;  
6) the name and first name of the supervisor of the Reading Course. | W    | 4 credits | 9A    | Professors |

Abstract
For this Reading Course proactive students make an individual agreement with a lecturer to acquire knowledge through independent literature study.

Core Courses and Electives (Mathematics Master)

Core Courses (Mathematics Master)

Electives (Mathematics Master)

Seminars

Early enrolments for seminars in myStudies are encouraged, so that we will recognize need for additional seminars in a timely manner. Some seminars have waiting lists. Nevertheless, register for at most two mathematics seminars. In this case, you express a stronger preference for the seminar for which you register earlier.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
</table>
| 401-3200-64L | Proofs from THE BOOK  
Number of participants limited to 26. | W    | 4 credits | 2S    | M. Burger |
The seminar covers measure theoretic tools used for the analysis and approximation of nonlinear hyperbolic partial differential equations.

Monte Carlo and Quasi-Monte Carlo Methods: Introduction and current research topics in the theory and implementation of Monte Carlo and quasi-Monte Carlo methods and applications.

- To learn some measure theoretic tools for the analysis and approximation of nonlinear PDEs.
- To read and understand a research paper and present it in an understandable way to other students.

401-3570-66L  Algebraic Number Theory
Number of participants limited to 12.

Abstract
Much of the progress in algebraic number theory aimed at solving concrete Diophantine equations. At the heart of the problem lies the fact that the ring of integers of a number field does not have unique factorization. The "class group" measures how much this property fails. The seminar will present basic results around this invariant, including finiteness and the relation to zeta functions.

401-3180-66L  Homological Algebra
Number of participants limited to 12.

Abstract
Basic concepts of homological algebra, homology and cohomology of groups.

401-3540-66L  Monte Carlo and Quasi-Monte Carlo Methods: Mathematical and Numerical Analysis
Number of participants limited to 6.

Abstract
Introduction and current research topics in the theory and implementation of Monte Carlo and quasi-Monte Carlo methods and applications.

401-3550-66L  Numerical Analysis Seminar: Measure Theoretic Tools for Analyzing and Approximating Nonlinear PDEs
Number of participants limited to 6.

Abstract
The seminar covers measure theoretic tools used for the analysis and approximation of nonlinear hyperbolic partial differential equations. In particular, we will discuss Young measures, compensated compactness, weak-strong uniqueness and algorithms for the approximation of measure-valued solutions. The participants will present individual topics based on the study of research papers.

Objective
- To learn some measure theoretic tools for the analysis and approximation of nonlinear PDEs.
- To read and understand a research paper and present it in an understandable way to other students.

Content
Partial differential equations can be used to model an abundance of natural and physical phenomena, as well as industrial processes. Many of the more sophisticated and more realistic models involve nonlinear PDEs, among others, PDEs in fluid dynamics, astrophysics, elasticity or weather modeling. The solutions to these often exhibit complex structures, such as shocks, oscillations, singularities that are difficult to deal with mathematically and numerically. In our seminar we aim to get a better understanding of the difficulties that arise when dealing with nonlinear PDEs. In particular, we will discuss problems related to the PDEs of fluid dynamics. Solutions to these equations may exhibit shocks and oscillations, and have less regularity than what the definition of a classical solution requires. Therefore, the solution concept has to be relaxed. One way of doing this, is to look for solutions in the space of measure-valued solutions. The participants will present individual topics based on the study of research papers.

Specifically, we will discuss weak convergence in general, the notion of Young measures as a means to represent weak limits of nonlinear functions. Our goal in this seminar is to try to understand this concept better by studying research papers related to this issue. Specifically, we will discuss weak convergence in general, the notion of Young measures as a means to represent weak limits of nonlinear functions, and its application to compensated compactness, existence of solutions to scalar hyperbolic conservation laws, Euler equations, turbulence and statistical solutions of Navier-Stokes equations. We will also discuss algorithms to approximate solutions in the space of measures.

We are open to extend the list of topics by others that are of special interests to the attending students.

Prerequisites / Literature
Basic knowledge of algebraic structures (groups, rings, fields) and Galois theory, at the level of Algebra I and II. More advanced topics will be explained when needed.

401-3180-66L  Homological Algebra
Number of participants limited to 12.

Abstract
Basic concepts of homological algebra, homology and cohomology of groups.

Literature
Our basic reference will be chapters I and VII of Neukirch's book "Algebraic number theory" (Grundlehren Math. Wiss. 322. Springer-Verlag, Berlin, 1999). Additional references will be given at the beginning of the seminar.

Prerequisites / notice
Basic knowledge of algebraic structures (groups, rings, fields) and Galois theory, at the level of Algebra I and II. More advanced topics will be explained when needed.

401-3540-66L  Monte Carlo and Quasi-Monte Carlo Methods: Mathematical and Numerical Analysis
Number of participants limited to 6.

Abstract
Introduction and current research topics in the theory and implementation of Monte Carlo and quasi-Monte Carlo methods and applications.

Prerequisites / notice
Completed courses in Numerical Analysis of Elliptic/ Parabolic PDEs, or Numerical Analysis of Hyperbolic PDEs, or Numerical Analysis of Stochastic ODEs, and FAI, Probability Theory I.

401-3550-66L  Numerical Analysis Seminar: Measure Theoretic Tools for Analyzing and Approximating Nonlinear PDEs
Number of participants limited to 6.

Abstract
The seminar covers measure theoretic tools used for the analysis and approximation of nonlinear hyperbolic partial differential equations. In particular, we will discuss Young measures, compensated compactness, weak-strong uniqueness and algorithms for the approximation of measure-valued solutions. The participants will present individual topics based on the study of research papers.

Objective
- To learn some measure theoretic tools for the analysis and approximation of nonlinear PDEs.
- To read and understand a research paper and present it in an understandable way to other students.

Content
Partial differential equations can be used to model an abundance of natural and physical phenomena, as well as industrial processes. Many of the more sophisticated and more realistic models involve nonlinear PDEs, among others, PDEs in fluid dynamics, astrophysics, elasticity or weather modeling. The solutions to these often exhibit complex structures, such as shocks, oscillations, singularities that are difficult to deal with mathematically and numerically. In our seminar we aim to get a better understanding of the difficulties that arise when dealing with nonlinear PDEs. In particular, we will discuss problems related to the PDEs of fluid dynamics. Solutions to these equations may exhibit shocks and oscillations, and have less regularity than what the definition of a classical solution requires. Therefore, the solution concept has to be relaxed. One way of doing this, is to look for solutions in the space of measure-valued solutions. The participants will present individual topics based on the study of research papers.

Specifically, we will discuss weak convergence in general, the notion of Young measures as a means to represent weak limits of nonlinear functions, and its application to compensated compactness, existence of solutions to scalar hyperbolic conservation laws, Euler equations, turbulence and statistical solutions of Navier-Stokes equations. We will also discuss algorithms to approximate solutions in the space of measures.

We are open to extend the list of topics by others that are of special interests to the attending students.
Number of participants limited to 15.

Abstract
The analysis of differential games with a large number of players finds applications in various research fields, from physics to economics and finance. The aim of Mean Field Games theory is to provide a suitable approximation of such problems with a higher tractability.

Objective
This course aims to give a broad understanding of the basic ideas of Mean Field Games, the main mathematical tools and the possible applications.

Content
We first present and analyze toy models of Mean Field Games in order to familiarize with the subject and to understand what kind of problems can be solved with this theory.

We explore two different approaches to Mean Field Games. From an analytic point of view it consists of a coupled system of PDEs. From a probabilistic point of view it amounts to a particular type of stochastic differential equations.

Literature
1) Notes on Mean Field Games. P. Cardaliaguet
2) Mean Field Games. J.M. Lasry, P.L. Lions
3) Probabilistic theory of Mean Field Games and applications. R. Carmona, F. Delarue

Prerequisites / notice
Basic knowledge of stochastic differential equations.

Seminars (Mathematics Master)

Minor Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-1511-00L</td>
<td>Geometry</td>
<td>W</td>
<td>3 credits</td>
<td>2V+1U</td>
<td>T. Ilmanen</td>
</tr>
<tr>
<td>Abstract</td>
<td>We will study the topology and geometry of 2 and 3 dimensional spaces (manifolds) from an informal point of view.</td>
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</table>
| Objective | - what is it like to live in a non-Euclidean space (for example, in a surface)?
- orientation, genus, curvature
- classification of closed orientable surfaces
- spherical, Euclidean, and hyperbolic geometry
- 3-manifolds a la Thurston |
| Literature | Jeffrey R. Weeks. The Shape of Space. |

402-0351-00L | Astronomy               | W    | 2 credits | 2V | H. M. Schmid, W. Schmutz |
| Abstract | An overview on the important topics in modern astronomy: planets, sun, stars, milky way, galaxies, and cosmology |
| Objective | This lecture gives a general introduction to main topics in modern astronomy. The lecture provide a basis for the more advanced lectures in astrophysics. |
| Content | Planeten, Sonne, Sterne, Milchstrasse, Galaxien und Kosmologie. |
| Lecture notes | Kopien der Präsentationen werde zur Verfügung gestellt. |
| | Der Neue Kosmos. A. Unsöld, B. Baschek, Springer |

Bachelor's Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-2000-00L</td>
<td>Scientific Works in Mathematics</td>
<td>O</td>
<td>0 credits</td>
<td>0</td>
<td>E. Kowalski</td>
</tr>
</tbody>
</table>
| Abstract | Target audience:  
Third year Bachelor students;  
Master students who cannot document to have received an adequate training in working scientifically.  
Mandatory for all Bachelor and Master students with matriculation in the autumn semester 2014 or later.  
| Objective | Learn the basic standards of scientific works in mathematics. |
| Content | - Types of mathematical works
- Publication standards in pure and applied mathematics
- Data handling
- Ethical issues
- Citation guidelines |
| Lecture notes | Moodle of the Mathematics Library: https://moodle-app2.let.ethz.ch/course/view.php?id=519 |
| Prerequisites / notice | This course is completed by the optional course "Recherchieren in der Mathematik" (held in German) by the Mathematics Library. For more details see: http://www.math.ethz.ch/library/services/schulungen |

401-3990-10L | Bachelor's Thesis  
No direct enrolment to this course unit in myStudies.  
Please fill in the online application form.  
Requirements and application form under www.math.ethz.ch/intranet/students/study-administration/theses.html  
(First application will be done by the Study Administration.)  
Abstract | The purpose of the BSc thesis is to deepen knowledge in a certain subject chosen by the student. In their BSc thesis, students should demonstrate their ability to carry out independent work in mathematics and to organize results in a written report. |
| Lecturers | Professors |

GESS Science in Perspective

Science in Perspective
**Language Courses**

see Science in Perspective: Language Courses ETH/UZH

**Additional Courses**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-5000-00L</td>
<td>Zurich Colloquium in Mathematics</td>
<td>E-</td>
<td>0</td>
<td></td>
<td>W. Werner, P. L. Bühlmann, M. Burger, S. Mishra, R. Pandharipande, University lecturers</td>
</tr>
<tr>
<td>401-5990-00L</td>
<td>Zurich Graduate Colloquium (University of Zurich)</td>
<td>E-</td>
<td>0</td>
<td>1K</td>
<td>University lecturers</td>
</tr>
<tr>
<td></td>
<td>No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: MAT075</td>
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<td>Mind the enrolment deadlines at UZH:</td>
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<td><a href="http://www.uzh.ch/studies/application/mobilitaet_en.html">http://www.uzh.ch/studies/application/mobilitaet_en.html</a></td>
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<td></td>
<td>The Graduate Colloquium is an informal seminar aimed at graduate students and postdocs whose purpose is to provide a forum for communicating one's interests and thoughts in mathematics.</td>
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<tr>
<td>401-5960-00L</td>
<td>Colloquium on Mathematics, Computer Science, and Education</td>
<td>E-</td>
<td>0</td>
<td></td>
<td>N. Hungerbühler, M. Akveld, J. Hromkovic, H. Klemen</td>
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<tr>
<td></td>
<td>Subject didactics for mathematics and computer science teachers.</td>
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<tr>
<td></td>
<td>Didactics colloquium</td>
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<tr>
<td></td>
<td>Research colloquium</td>
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<td>Occasionally, talks may be delivered in German.</td>
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<tr>
<td></td>
<td>Research colloquium</td>
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<tr>
<td></td>
<td>The Zurich Theoretical Physics Colloquium is jointly organized by the University of Zurich and ETH Zurich. Its mission is to bring both students and faculty with diverse interests in theoretical physics together. Leading experts explain the basic questions in their field of research and communicate the fascination for their work.</td>
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<tr>
<td>251-0100-00L</td>
<td>Computer Science Colloquium</td>
<td>E-</td>
<td>0</td>
<td></td>
<td>Lecturers</td>
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<td>Invited talks, covering the entire scope of computer science. External Listeners are welcome at no charge. A detailed schedule is published at the beginning of each semester.</td>
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<td>Top international computer scientists take the floor at the distinguished computer science colloquium. Our guest speakers present impacting topics across various areas of the discipline. The colloquium series is held every semester and also includes inaugural and farewell lectures of the department's professors. The colloquium is a noteworthy event for all graduate students. Outside attendance is equally welcome.</td>
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<td>Eingeladene Vorträge aus dem gesamten Bereich der Informatik, zu denen auch Auswärtige kostenlos eingeladen sind. Zu Semesterbeginn erscheint jeweils ein ausführliches Programm.</td>
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<thead>
<tr>
<th>Mathematics Bachelor - Key for Type</th>
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<tr>
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<td>W+</td>
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<td>W</td>
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</tbody>
</table>

Data: 06.03.2019 12:57  Autumn Semester 2016  Page 1122 of 1571
### Key for Hours

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

**ECTS**

- European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
In this seminar, students establish the scientific fundamentals of performance measurement and educational diagnostics and study them on the basis of different current issues.

Objective
At the end of the seminar, participants will be in a position to
- describe the scientific fundamentals of test theory and test structure,
- evaluate examples of scientifically-developed tests in their application context,
- if necessary, critically question the performance assessment that they employ in practice and professionalise it still further.

Content
Die konkreten Inhalte des Seminars ergeben sich aufgrund der Präferenzen der Teilnehmenden und der daraus abgeleiteten Themenübersicht für Vorträge und Seminararbeiten. Im Rahmen der Startveranstaltung wird eine Liste mit möglichen Themen abgegeben und erläutert. Schwerpunkte der Themenvorschläge sind:
- Testentwicklung
- Gütekriterien von Tests
- Aufgabenkonstruktion
- Datenauswertung
- Rasch-Modell
- Internationale Vergleichstests
- Zulassungsstests

Lecture notes
Im Verlaufe des Semesters werden einzelne Unterlagen in den Veranstaltungen abgegeben. Dazu gehören auch die Handouts der verschiedenen, studentischen Vorträge.

Literature
Als Grundlagenliteratur werden folgende Werke empfohlen:
- Weitere Literatur wird in der Lehrveranstaltung genannt.

Prerequisites / notice
Die Leistungsanforderungen richten sich im Umfang nach der Zahl zu erwerbender ECTS-Punkte, wobei 1 ECTS-Punkt einem Zeitaufwand von ca. 30 Arbeitsstunden entspricht. ETHZ-Studierende können im Rahmen dieser Veranstaltung 3 ECTS-Punkte erwerben. Dazu sind folgende Leistungen zu erbringen:
- Präsenz und aktive mündliche Mitarbeit in der Lehrveranstaltung (MA)
- Pflichtlektüre entsprechend der Angaben in der Lehrveranstaltung
- Referat (RE)
- Schreiben einer schriftlichen Arbeit

Weitere Angaben zu den Leistungsanforderungen werden im Rahmen der Startveranstaltung abgegeben und erläutert.
This seminar focuses on teaching units in chemistry, physics and mathematics that have been developed at the MINT Learning Center of Research Methods in Educational Science. Students learn about and learn to use findings from empirical research into mathematical didactics and best practice, as well as theoretical literature from the learning sciences is critically discussed with a focus on research methods.

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**851-0242-05L: Cognitively Activating Instructions in MINT Subjects**

*Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).*

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>851-0242-05L</td>
<td>Cognitively Activating Instructions in MINT Subjects</td>
<td>W</td>
<td>2 credits</td>
<td>2S</td>
<td>R. Schumacher</td>
</tr>
</tbody>
</table>

Abstract: This seminar focuses on teaching units in chemistry, physics, and mathematics that have been developed at the MINT Learning Center of ETH Zurich. In the first meeting, the mission of the MINT Learning Center will be communicated. Furthermore, in groups of two, the students will intensively work on, refine, and optimize a teaching unit following a given goal set in advance.

Objective: Students possess theoretical knowledge and practical competences to be able to cope with the psychosocial demands of teaching.

(1) They know the basic rules of negotiation and conflict management (e.g., mediation) and can apply them in the school context (e.g., in conversations with parents).

(2) They can apply diverse techniques of classroom management (e.g., prevention of disciplinary problems in the classroom) and know relevant authorities for further information (e.g., legal conditions).

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**851-0242-07L: Human Intelligence**

*Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).*

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0242-07L</td>
<td>Human Intelligence</td>
<td>W</td>
<td>1 credit</td>
<td>1S</td>
<td>E. Stern, P. Edelsbrunner, B. Rütsche</td>
</tr>
</tbody>
</table>

Abstract: The focus will be on the book “Intelligenz: Grosse Unterschiede und ihre Folgen” by Stern and Neubauer. Participation at the first meeting is obligatory. It is required that all participants read the complete book. Furthermore, in two meetings of 90 minutes, concept papers developed in small groups (5-10 students) will be discussed.

Objective: Students will intensively work on, refine, and optimize a teaching unit following a given goal set in advance.

- Get to know cognitively activating instructions in MINT subjects
- Get information about recent literature on learning and instruction

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**851-0242-08L: Research Methods in Educational Science**

*Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).*

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0242-08L</td>
<td>Research Methods in Educational Science</td>
<td>W</td>
<td>1 credit</td>
<td>1S</td>
<td>P. Edelsbrunner, B. Rütsche, E. Stern, E. Ziegler</td>
</tr>
</tbody>
</table>

Abstract: Literature from the learning sciences is critically discussed with a focus on research methods. At the first meeting, working groups will be assembled and meetings with those will be set up. In the small groups students will write critical essays about the read literature. At the third meeting, we will discuss the essays and develop research questions in group work.

Objective: Students will intensively work on, refine, and optimize a teaching unit following a given goal set in advance.

- Get to know cognitively activating instructions in MINT subjects
- Get information about recent literature on learning and instruction

---

Subject Didactics and Professional Training

**Autumn Semester 2016**

**Objective**

- Understand research methods used in the empirical educational sciences
- Understand and critically examine information from scientific journals and media
- Understand pedagogically relevant findings from the empirical educational sciences

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**Number of participants limited to 30.**

**Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).**

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**Important:** You can only enrol in the courses of this category if you have not more than 12 CP left for possible additional requirements.

Enrolment in either Mathematics Didactics I or Mathematics Didactics II (spring semester) is compulsory.

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Data: 06.03.2019 12:57  Autumn Semester 2016  Page 1125 of 1571
Objective
- Students use their specialist-subject, educational-science and subject-didactics training to draw up concepts for teaching.
- They are able to assess the significance of tuition topics for their subject from different angles (including interdisciplinary angles) and impart these to their pupils.
- They learn the skills of the teaching trade.
- They practise finding the balance between instruction and openness so that pupils can and, indeed, must make their own cognitive contribution.
- They learn to assess pupils' work.
- Together with the teacher in charge of their teacher training, the students constantly evaluate their own performance.

Content

Die Themen für die beiden Prüfungslektionen am Schluss des Praktikums erfahren die Studierenden in der Regel eine Woche vor dem Prüfungstermin. Sie erstellen eine Vorbereitungsgabe zum Abitur und reichen sie bis am Vortag um 12 Uhr den beiden Prüfungsexperten (Fachdidaktiker/-in, Departementsvertreter/-in) ein. Die gehaltenen Lektionen werden kriteriumsgebunden beurteilt. Die Beurteilung umfasst auch die schriftliche Vorbereitung und eine mündliche Reflexion des Kandidaten/der Kandidatin über die gehaltenen Lektionen im Rahmen eines kurzen Kolloquiums.

Lecture notes
Dokument: schriftliche Vorbereitung für Prüfungslektionen.

Literature
Wird von der Praktikumslehrperson bestimmt.

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<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>401-3057-00L</td>
<td>Finite Geometries II</td>
<td>W</td>
<td>4</td>
<td>2G</td>
<td>N. Hungerbühler</td>
</tr>
<tr>
<td></td>
<td>Finite geometries I, II: Finite geometries combine aspects of geometry, discrete mathematics and the algebra of finite fields. In particular, we will construct models of axioms of incidence and investigate closing theorems. Applications include test design in statistics, block design, and the construction of orthogonal Latin squares.</td>
<td></td>
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<tr>
<td></td>
<td>Objective</td>
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<tr>
<td></td>
<td>Finite geometries I, II: Students will be able to construct and analyse models of finite geometries. They are familiar with closing theorems of the axioms of incidence and are able to design statistical tests by using the theory of finite geometries. They are able to construct orthogonal Latin squares and know the basic elements of the theory of block design.</td>
<td></td>
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<tr>
<td></td>
<td>Content</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Finite geometries I, II: finite fields, rings of polynomials, finite affine planes, axioms of incidence, Euler's thirty-six officers problem, design of statistical tests, orthogonal Latin squares, transformation of finite planes, closing theorems of Desargues and Pappus-Pascal, hierarchy of closing theorems, finite coordinate planes, division rings, finite projective planes, duality principle, finite Möbius planes, error correcting codes, block design</td>
<td></td>
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<tr>
<td></td>
<td>Literature</td>
<td></td>
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<tr>
<td></td>
<td>- Max Jeger, Endliche Geometrien, ETH Skript 1988</td>
<td></td>
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<tr>
<td></td>
<td>- Albrecht Beutelspacher: Einführung in die endliche Geometrie I,II. Bibliographisches Institut 1983</td>
<td></td>
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<td></td>
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<tr>
<td></td>
<td>- Margaret Lynn Batten: Combinatorics of Finite Geometries. Cambridge University Press</td>
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<tr>
<td></td>
<td>- Dembowski: Finite Geometries.</td>
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</tr>
<tr>
<td>401-3059-00L</td>
<td>Combinatorics II</td>
<td>W</td>
<td>4</td>
<td>2G</td>
<td>N. Hungerbühler</td>
</tr>
<tr>
<td></td>
<td>Does not take place this semester.</td>
<td></td>
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<tr>
<td></td>
<td>Abstract</td>
<td></td>
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<tr>
<td></td>
<td>The course Combinatorics I and II is an introduction into the field of enumerative combinatorics.</td>
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<tr>
<td></td>
<td>Objective</td>
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<tr>
<td></td>
<td>Upon completion of the course, students are able to classify combinatorial problems and to apply adequate techniques to solve them.</td>
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<tr>
<td></td>
<td>Content</td>
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</tr>
<tr>
<td></td>
<td>Contents of the lectures Combinatorics I and II: congruence transformation of the plane, symmetry groups of geometric figures, Euler's function, Cayley graphs, formal power series, permutation groups, cycles, Bunside's lemma, cycle index, Polya's theorems, applications to graph theory and isomers.</td>
<td></td>
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<tr>
<td>401-0293-00L</td>
<td>Mathematics III</td>
<td>W</td>
<td>3</td>
<td>2V+1U</td>
<td>A. Caspar, N. Hungerbühler</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Vertiefung der mehdimensional Analysis mit Schwerpunkt in der Anwendung der partiellen Differentialgleichungen, Vertiefung der Linearen Algebra und Einführung in die Systemanalyse und Modellbildung.</td>
<td></td>
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</tr>
</tbody>
</table>
**Objective**

Die Studierenden

+ verstehen Mathematik als Sprache zur Modellbildung und als Werkzeug zur Lösung angewandter Probleme in den Naturwissenschaften.
+ können anspruchsvolle Modelle analysieren, Lösungen qualitativ beschreiben oder allenfalls explizit berechnen: diskret/kontinuierlich in Zeit, Ebene und Raum.
+ können Beispiele und konkrete arithmetische und geometrische Situationen der Anwendungen mit Methoden der höheren Mathematik interpretieren und bearbeiten.

**Content**

### Modellbildung ###

- Einführung und Beispiele
- Mehrdimensionale Modelle
- Pocken-Modell
- SIR-Modell

### Lineare Modelle ###

- Vektorräume
- Diagonalisierbarkeit
- Normalformen
- Exponential einer Matrix
- Lösungsraum eines Linearen DGL-Systems

### Fourier-Reihen ###

- Euklidische Vektorräume
- Orthogonale Projektion
- Anwendungen

### Nichtlineare Modelle ###

- Stationäre Lösungen, Qualitative Aussagen
- Mehrdimensionale Modelle: Räuber-Beute, Lotka-Volterra

### Partielle Differentialgleichungen ###

- Einführung, Repetition, Beispiele
- Fourier-Methoden: Wärmeleitung, Laplace, Wellengleichung, Filter, Computertomographie

### Laplace-Transformation ###

- Definition und Notation
- Rechenregeln
- Anwendungsbeispiel

**Lecture notes**

II (nächstes Semester)

Für Reglement (Prüfungsblock) Bachelor-Studiengang Maschineningenieurwissenschaften 2010; Ausgabe 15.01.2013 (Prüfungsblock)

**Literature**

Siehe Lernmaterial > LiteraturII (nächstes Semester)

Für Reglement (Prüfungsblock) Bachelor-Studiengang Maschineningenieurwissenschaften 2010; Ausgabe 15.01.2013 (Prüfungsblock)

**Prerequisites / notice**

Vorlesungen Mathematik I/II

---

**401-0293-99L Mathematics III (Supplement)**

Simultaneous enrolment in "Mathematics III" (401-0293-00L) is compulsory.

**Abstract**


**Objective**

Die Studierenden kennen die wesentlichen Elemente der mathematischen Modellierung. Sie sind in der Lage, Modelle zu erstellen und mathematisch zu diskutieren. Sie können selbständig Unterrichtssequenzen zur Modellierung entwickeln.

**Content**

- Modellbildung
- Lineare Modelle:
  - Vektorräume, Normalformen, Lösungsraum eines Linearen DGL-Systems
  - Qualitative Aussagen, Nichtlineare Modelle: Stabilität für eine DGL 1. Ordnung, für allgemeine DGL-Systeme
  - Modelle in Raum und Zeit: Partielle DGL, Fourier-Reihe, -Transformation, Laplace-Operator

**Literature**


**Prerequisites / notice**

Grundvorlesungen zur Analysis

---

**401-9985-00L Mentored Work Specialised Courses in the Respective O Subject with an Educational Focus Mathematics A**

Mentored Work Specialised Courses in the Respective Subject with an Educational Focus in Mathematics for TC and Teaching Diploma.

**Abstract**

In the mentored work on their subject specialisation, students link high-school and university aspects of the subject, thus strengthening their teaching competence with regard to curriculum decisions and the future development of the tuition. They compile texts under supervision that are directly comprehensible to the targeted readers - generally specialist-subject teachers at high-school level.
Objective
The aim is for the students
- to familiarise themselves with a new topic by obtaining material and studying the sources, so that they can selectively extend their specialist competence in this way.
- to independently develop a text on the topic, with special focus on its mathematical comprehensibility in respect of the level of knowledge of the targeted readership.
- To try out different options for specialist further training in their profession.

Content
Themenatische Schwerpunkte:

Lernformen:

Lecture notes
Eine Anleitung zur mentorierten Arbeit in FV wird zur Verfügung gestellt.

Literature
Die Literatur ist themenspezifisch. Sie muss je nach Situation selber beschafft werden oder wird zur Verfügung gestellt.

Prerequisites / notice
Die Arbeit sollte vor Beginn des Praktikums abgeschlossen werden.

Colloquia

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-5960-00L</td>
<td>Colloquium on Mathematics, Computer Science, and Education Subject didactics for mathematics and computer science teachers.</td>
<td>E-</td>
<td>0 credits</td>
<td></td>
<td>N. Hungerbühler, M. Akveld, J. Hromkovic, H. Klemenz</td>
</tr>
</tbody>
</table>

Abstract
Didactics colloquium

Mathematics TC - Key for Type

| O  | Compulsory          | E-   | Recommended, not eligible for credits |
| W+ | Eligible for credits and recommended | Z    | Courses outside the curriculum       |
| W  | Eligible for credits      | Dr   | Suitable for doctorate               |

Key for Hours

| V  | lecture               | P    | practical/laboratory course         |
| G  | lecture with exercise  | A    | independent project                 |
| U  | exercise               | D    | diploma thesis                      |
| S  | seminar                | R    | revision course / private study     |
| K  | colloquium             |      |                                          |

ECTS
European Credit Transfer and Accumulation System
Special students and auditors need special permission from the lecturers.
Title: Understanding of research methods used in the empirical human sciences  

Mathematics Didactics I  

ECTS  

This seminar focuses on teaching units in chemistry, physics and mathematics that have been developed at the MINT Learning Center of the ETH Zurich. In the first meeting, the mission of the MINT Learning Center will be communicated. Furthermore, in groups of two, the students will intensively work on, refine and optimize a teaching unit following a goal set in advance.

Objective:  
- Get to know cognitively activating instructions in MINT subjects  
- Get information about recent literature on learning and instruction

Prerequisites / Notice:  
Für eine reibungslose Semesterplanung wird um frühe Anmeldung und persönliches Erscheinen zum ersten Lehrveranstaltungstermin ersucht.

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Student Research Projects: Practical Research on Cognitively Activating Instructions in MINT Subjects  

Lecturers: A. Deiglmayr  

In teams of two, participants in this seminar conduct their own research project. Each team is advised by one of the researchers serving as lecturers in this course. During the first half the semester, relevant methodological knowledge and skills are practiced during plenary meetings and in students’ independent reading (e.g. generating and testing research questions, designing experiments, and analyzing data in the field of Learning and Instruction).

Objective:  
- Understanding research methods used in the empirical educational sciences  
- Understanding findings relevant for education

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Research Methods in Educational Science  

Lecturers: P. Edelsbrunner, B. Rütsche, E. Sterne, E. Ziegler  

At the first meeting, working groups will be assembled and meetings with those will be set up. In the small groups students will write critical essays about the read literature. At the third meeting, we will discuss the essays and develop research questions in group work.

Objective:  
- Understanding research methods used in the empirical educational sciences  
- Understand and critically examine information from scientific journals and media  
- Understand pedagogically relevant findings from the empirical educational sciences

---

Student Research Projects: Practical Research on Learning and Instruction  


The successful completion of both course no. 851-0240-00L “Menschliches Lernen (EW 1)” and course no. 851-0238-01L “Unterstützung und Diagnose von Wissenserwerbsprozessen (EW 3)” is a necessary prerequisite for this course.

Objective:  
- The course is targeted at advanced students who have taken an interest in gathering practical research experience in the field of Learning & Instruction. In teams of two, students conduct their own research projects (planning, conducting, analyzing, interpreting, and presenting research); thus, the course requires a high amount of self-directed working. Students are personally advised, and supported in their research project, by one of the researchers serving as lecturers in this course. During the first half the semester, relevant methodological knowledge and skills are practiced during plenary meetings and in students’ independent reading (e.g. generating and testing research questions, designing experiments, and analyzing data in the field of Learning and Instruction).

Learning goals include:  
- Participants can illustrate and explain basic methods and concepts for research in the fields of Learning and Instruction, e.g. with the help of practical examples.  
- Participants can generate testable research questions for a topic relevant in the fields of Learning and Instruction.  
- Participants can design and conduct a study that is relevant for answering their research question.  
- Participants can summarize and evaluate the main results from a study in the field of learning and Instruction, with regard to the research question being asked.
Teaching Diploma or Mathematics TC at ETH or in Mathematics Teaching Diploma at UZH.

Abstract
Students learn about and learn to use findings from empirical research into mathematical didactics and best practice, as well as theoretical approaches to teaching various topics in mathematics. Methodological suggestions are compared and draft tuition concepts discussed.

Objective
On the basis of their understanding of mathematics, of the knowledge acquired from research into teaching/learning and subject teaching, and also of best practice, students who have completed this course will be in a position to draft motivating learning arrangements, with cognitive appeal, which trigger and maintain learning processes. The aim here is to implement a corresponding teaching plan, so that the mathematics tuition that has given a general-education value, on the one hand, and ensures that pupils acquire the fundamental knowledge necessary for studying at university, on the other hand.

401-9983-00L
Mentored Work Subject Didactics Mathematics A O 2 credits 4A M. Akveld, K. Barro, L. Halbeisen, M. Huber, N. Hungerbühler, A. F. Müller

Abstract
In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.

Objective
- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.
- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

Content
Themen spezifische Schwerpunkte
Die Gegenstände der mentorierten Arbeit in Fachdidaktik stammen in der Regel aus dem gymnasialen Unterricht.

Lernformen

Lecture notes
Eine kurze Anleitung zur mentorierten Arbeit in Fachdidaktik wird zur Verfügung gestellt.

Literature
Die Literatur ist themenspezifisch. Die Studierenden beschaffen sie sich in der Regel selber (siehe Lernziele). In besonderen Fällen wird sie vom Betreuer zur Verfügung gestellt.

Prerequisites / notice
Die Arbeit sollte vor Beginn des Praktikums abgeschlossen werden.

401-9984-00L
Mentored Work Subject Didactics Mathematics B O 2 credits 4A M. Akveld, K. Barro, L. Halbeisen, M. Huber, N. Hungerbühler, A. F. Müller

Abstract
In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.

Objective
- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.
- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

Content
Themen spezifische Schwerpunkte
Die Gegenstände der mentorierten Arbeit in Fachdidaktik stammen in der Regel aus dem gymnasialen Unterricht.

Lernformen

Lecture notes
Eine kurze Anleitung zur mentorierten Arbeit in Fachdidaktik wird zur Verfügung gestellt.

Literature
Die Literatur ist themenspezifisch. Die Studierenden beschaffen sie sich in der Regel selber (siehe Lernziele). In besonderen Fällen wird sie vom Betreuer zur Verfügung gestellt.

Prerequisites / notice
Die Arbeit sollte vor Beginn des Praktikums abgeschlossen werden.

Professional Training in Mathematics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-9970-00L</td>
<td>Introductory Internship Mathematics</td>
<td>O</td>
<td>3</td>
<td>6P</td>
<td>N. Hungerbühler</td>
</tr>
</tbody>
</table>

Abstract
During the introductory teaching practice, the students sit in on five lessons given by the teacher responsible for their teaching practice, and teach five lessons themselves. The students are given observation and reflection assignments by the teacher responsible for their teaching practice.

Objective
Right at the start of their training, students acquire initial experience with the observation of teaching, the establishment of concepts for teaching and the implementation of teaching. This early confrontation with the complexity of everything that teaching involves helps students decide whether they wish to and, indeed, ought to, continue with the training. It forms a basis for the subsequent pedagogical and subject-didactics training.

Content
Die Studierenden können die Bedeutung von Unterrichtsthemen in ihrem Fach unter verschiedenen Blickwinkeln einschätzen. Sie kennen

The teaching practice takes in 50 lessons: 30 are taught by the students, and the students sit in on 20 lessons. The teaching practice lasts

- Students use their specialist-subject, educational-science and subject-didactics training to draw up concepts for teaching.
- They are able to assess the significance of tuition topics in their subject from different angles (including interdisciplinary angles) and
- They acquire the skills of the teaching trade.
- They practise finding the balance between instruction and openness so that pupils can and, indeed, must make their own cognitive
- Together with the teacher in charge of their teacher training, the students constantly evaluate their own performance.

Die Studierenden sammeln Erfahrungen in der Unterrichtsführung, der Auseinandersetzung mit Lernenden, der Klassenbetreuung und der

- to analyze the tuition they have given with regard to its strengths and weaknesses, and outline improvements.
- to develop and conduct teaching that is conducive to learning at high school level, substantiating it in terms of the subject-matter and from
- They acquire the skills of the teaching trade.
- They are able to assess the significance of tuition topics in their subject from different angles (including interdisciplinary angles) and
- Together with the teacher in charge of their teacher training, the students constantly evaluate their own performance.

Die Studierenden können die Bedeutung von Unterrichtsthemen in ihrem Fach unter verschiedenen Blickwinkeln einschätzen. Sie kennen

This is a supplement to the Teaching Internship required to obtain a Master of Advanced Studies in Secondary and Higher Education in the

- Students use their specialist-subject, educational-science and subject-didactics training to draw up concepts for teaching.
- They are able to assess the significance of tuition topics in their subject from different angles (including interdisciplinary angles) and
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- They are able to assess the significance of tuition topics in their subject from different angles (including interdisciplinary angles) and
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- They are able to assess the significance of tuition topics in their subject from different angles (including interdisciplinary angles) and
- Together with the teacher in charge of their teacher training, the students constantly evaluate their own performance.

Data: 06.03.2019 12:57  Autumn Semester 2016  Page 1131 of 1571
Objective
On the basis of a specified topic, the candidate shows that they are in a position
- to develop and conduct teaching that is conducive to learning at high school level, substantiating it in terms of the subject-matter and from
the didactic angle
- to analyze the tuition they have given with regard to its strengths and weaknesses, and outline improvements.

Content
Die Studierenden erfahren das Lektionsthema in der Regel 10 Tage vor dem Prüfungstermin. Von der zuständigen Lehrperson erhalten sie
Informationen über den Wissensstand der zu unterrichtenden Klasse und können sie vor dem Prüfungstermin besuchen.
Sie erstellen eine Vorbereitung gemäss Anleitung und reichen sie bis spätestens 48 Stunden vor der Prüfung den beiden Prüfungsexperten
ein.
Die gehaltene Lektion wird kriteriumsbasiert beurteilt. Die Beurteilung umfasst auch die schriftliche Vorbereitung und eine mündliche
Reflexion des Kandidaten/ der Kandidatin über die gehaltene Lektion im Rahmen eines kurzen Kolloquiums.

Lecture notes
Dokument: Schriftliche Vorbereitung für Prüfungskriterien.

Prerequisites / notice
Nach Abschluss der übrigen Ausbildung.


<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-3059-00L</td>
<td>Combinatorics II</td>
<td></td>
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<tr>
<td></td>
<td>Does not take place this semester.</td>
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</tr>
<tr>
<td>Abstract</td>
<td>The course Combinatorics I and II is an introduction into the field of enumerative combinatorics.</td>
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</tr>
<tr>
<td>Objective</td>
<td>Upon completion of the course, students are able to classify combinatorial problems and to apply adequate techniques to solve them.</td>
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</tr>
<tr>
<td>Content</td>
<td>Contents of the lectures Combinatorics I and II: congruence transformation of the plane, symmetry groups of geometric figures, Euler's function, Cayley graphs, formal power series, permutation groups, cycles, Bunsdie's lemma, cycle index, Polya's theorems, applications to graph theory and isomers.</td>
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</tbody>
</table>

| 401-3057-00L | Finite Geometries II   |      |      |       |                    |
| Abstract    | Finite geometries I, II: Finite geometries combine aspects of geometry, discrete mathematics and the algebra of finite fields. In particular, we will construct models of axioms of incidence and investigate closing theorems. Applications include test design in statistics, block design, and the construction of orthogonal Latin squares. |      |      |       |                    |
| Objective   | Finite geometries I, II: Students will be able to construct and analyse models of finite geometries. They are familiar with closing theorems of the axioms of incidence and are able to design statistical tests by using the theory of finite geometries. They are able to construct orthogonal Latin squares and know the basic elements of the theory of block design. |      |      |       |                    |
| Content     | Finite geometries I, II: finite fields, rings of polynomials, finite affine planes, axioms of incidence, Euler's thirty-six officers problem, design of statistical tests, orthogonal Latin squares, transformation of finite planes, closing theorems of Desargues and Pappus-Pascal, hierarchy of closing theorems, finite coordinate planes, division rings, finite projective planes, duality principle, finite Moebius planes, error correcting codes, block design |      |      |       |                    |
| Literature  | - Max Jeger, Endliche Geometrien, ETH Skript 1988 |      |      |       |                    |
|            | - Albrecht Beutelspacher: Einführung in die endliche Geometrie I,II. Bibliographisches Institut 1983 |      |      |       |                    |
|           | - Margaret Lynn Batten: Combinatorics of Finite Geometries. Cambridge University Press |      |      |       |                    |
|           | - Dembowski: Finite Geometries. |      |      |       |                    |

| 401-0293-00L | Mathematics III      |      |      |       |                    |
| Objective   | Die Studierenden  |      |      |       |                    |
|            | + verstehen Mathematik als Sprache zur Modellbildung und als Werkzeug zur Lösung angewandter Probleme in den Naturwissenschaften. |      |      |       |                    |
|            | + können anspruchsvolle Modelle analysieren, Lösungen qualitativ beschreiben oder allenfalls explizit berechnen: diskret/kontinuierlich in Zeit, Ebene und Raum. |      |      |       |                    |
|            | + können Beispiele und konkrete arithmetische und geometrische Situationen der Anwendungen mit Methoden der höheren Mathematik interpretieren und bearbeiten. |      |      |       |                    |
### Modellbildung ###
- Einführung und Beispiele
- Mehrdimensionale Modelle
- Pocken-Modell
- SIR-Modell

### Lineare Modelle ###
- Vektorräume
- Diagonalisierbarkeit
- Normalformen
- Exponential einer Matrix
- Lösungsraum eines Linearen DGL-Systems

### Fourier-Reihen ###
- Euklidische Vektorräume
- Orthogonale Projektion
- Anwendungen

### Nichtlineare Modelle ###
- Stationäre Lösungen, Qualitative Aussagen
- Mehrdimensionale Modelle: Räuber-Beute, Lotka-Volterra

### Partielle Differentialgleichungen ###
- Einführung, Repetition, Beispiele
- Fourier-Methoden: Wärmeleitung, Laplace, Wellengleichung, Filter, Computertomographie

### Laplace-Transformation ###
- Definition und Notation
- Rechenregeln
- Anwendungsbeispiel

Lecture notes
II (nächstes Semester)
Für Reglement
Bachelor-Studiengang Maschineningenieurwissenschaften 2010; Ausgabe 15.01.2013 (Prüfungsblock)

Literature
Siehe Lernmaterial > Literatur (nächstes Semester)
Für Reglement
Bachelor-Studiengang Maschineningenieurwissenschaften 2010; Ausgabe 15.01.2013 (Prüfungsblock)

Prerequisites / notice
Vorlesungen Mathematik I/II

401-0293-99L Mathematics III (Supplement) W 1 credit 1A A. Caspar, N. Hungerbühler
Simultaneous enrolment in "Mathematics III" (401-0293-00L) is compulsory.

Abstract

Objective
Die Studierenden kennen die wesentlichen Elemente der mathematischen Modellierung. Sie sind in der Lage, Modelle zu erstellen und mathematisch zu diskutieren. Sie können selbständig Unterrichtsssequenzen zur Modellierung entwickeln.

Content
- Modellbildung
  - Lineare Modelle:
  - Vektorräume,
  - Normalformen,
  - Lösungsraum eines Linearen DGL-Systems
- Qualitative Aussagen, Nichtlineare Modelle:
  - Stabilität für eine DGL 1. Ordnung, für allgemeine DGL-Systeme
  - Modelle in Raum und Zeit:
  - Partielle DGL, Fourier-Reihe, -Transformation, Laplace-Operator

Literature

Prerequisites / notice
Grundvorlesungen zur Analysis
Students are familiarised with the subjects taught at high-school level I (the first three years of the full-length high school, or the first year of secondary education). The core subjects include:

- **Finite Geometries II**
- **Combinatorics II**
- **Computer Science in Secondary School Mathematics**

**Lecture notes and literature:**

- A. F. Müller
- M. Akveld, K. Barro, L. Halbeisen, M. Huber, N. Hungerbühler, A. F. Müller
- Margaret Lynn Batten: *Combinatorics of Finite Geometries*. Cambridge University Press
- Albrecht Beutelspacher: *Einführung in die endliche Geometrie I,II*. Bibliographisches Institut 1983

**Prerequisites and notice:**

- Additional courses may be offered in the context of the corresponding module.
- The same content may be offered in subsequent years.
- Enrolment is possible with matriculation in Teaching Diploma at UZH.
- No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.

**Course offerings:**

- **Finite Geometries II**
- **Combinatorics II**
- **Didactics of Mathematics at the College Level I**
- **Computer Science in Secondary School Mathematics**

**Eligibility:**

- Students are familiarised with the subjects taught at high-school level II (the second three years of the full-length high school, or the second year of secondary education). The core subjects include:

- **Finite Geometries I, II**
- **Mentored Work Specialised Courses in the Respective Subject with an Educational Focus Mathematics B**

**Literature:**

- Albrecht Beutelspacher: *Einführung in die endliche Geometrie I,II*. Bibliographisches Institut 1983
- Margaret Lynn Batten: *Combinatorics of Finite Geometries*. Cambridge University Press
- Dembowski: *Finite Geometries*.

**Prerequisites and notice:**

- Additional courses may be offered in the context of the corresponding module.
- The same content may be offered in subsequent years.
- Enrolment is possible with matriculation in Teaching Diploma at UZH.
- No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.

**Course offerings:**

- **Finite Geometries I, II**
- **Mentored Work Specialised Courses in the Respective Subject with an Educational Focus Mathematics B**

**Lecture notes and literature:**

- A. F. Müller
- M. Akveld, K. Barro, L. Halbeisen, M. Huber, N. Hungerbühler, A. F. Müller
- Margaret Lynn Batten: *Combinatorics of Finite Geometries*. Cambridge University Press
- Albrecht Beutelspacher: *Einführung in die endliche Geometrie I,II*. Bibliographisches Institut 1983

**Prerequisites and notice:**

- Additional courses may be offered in the context of the corresponding module.
- The same content may be offered in subsequent years.
- Enrolment is possible with matriculation in Teaching Diploma at UZH.
- No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.
### Abstract
The unit "Computer Science in Secondary School Mathematics" addresses key contributions of computer science to general education, the tight relations between the algorithmic and the mathematical way of thinking, and the thoughtful choice of computer science topics for high school mathematics classes.

### Objective
The general goal of the course consists in presenting ways to teach fundamentals of computer science, which are closely related to contents and methods of mathematics. After attending the course unit, a mathematics teacher is able to teach selected fundamentals of computer science in mathematics classes.

The students understand the fundamental concepts of computer science in the context of a broad and deep knowledge. Through this understanding, they manage to prepare teaching materials for a successful knowledge transfer and to pass their passion for the subject on to their pupils.

The students know various teaching methods as well as their advantages and disadvantages. They can handle inhomogeneous prior knowledge of the learners inside a class. Besides holding classes, the students do care about the individual pupil support.

They encourage the autonomy of the learners, manage to work with diverse target groups and to establish a positive learning environment.

The students are able to express themselves using a comprehensible and refined professional language, both in a spoken and a written way, and they master the basic terminology of computer science. Besides the English terms, they are familiar with the corresponding German expressions. The students are able to produce detailed, matured, linguistically correct and design-wise appealing teaching materials.

### Content
The main topics of the course unit "Computer Science in Secondary School Mathematics" represent a scientific and didactic added value for mathematics classes.

The course covers the didactics of logic, of cryptography, of finite state automata, of computability and of the introduction to programming. The students develop the understanding of fundamental scientific concepts such as algorithm, program, complexity, determinism, computation, automata, verification, testing, security of a cryptosystem and secure communication. They reflect on ways to embed them into a scientifically sound and didactically sustainable mathematics course.

In a semester exercise, the students develop and document an adaptive teaching unit for computer science. They learn to employ the didactics methods and techniques that are introduced at the beginning of the semester.

Lectures in the subject didactics mathematics A provide theoretical backgrounds and practical exercises to the didactics contents. The students are encouraged to apply these contents in their own classes.

### Literature

### Subject Didactics in Mathematics

#### Mathematics as Second Subject

#### Subject Didactics in Mathematics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-3971-11L</td>
<td>Mathematics Didactics I</td>
<td>O</td>
<td>4</td>
<td>2G</td>
<td>K. Barro</td>
</tr>
<tr>
<td></td>
<td>Enrolment only possible with matriculation in Mathematics</td>
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<tr>
<td></td>
<td>Teaching Diploma or Mathematics TC at ETH or in Mathematics</td>
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<tr>
<td></td>
<td>Teaching Diploma at UZH</td>
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</tbody>
</table>

**Abstract**
Students learn about and learn to use findings from empirical research into mathematical didactics and best practice, as well as theoretical approaches to teaching various topics in mathematics. Methodological suggestions are compared and draft tuition concepts discussed.

**Objective**
On the basis of their understanding of mathematics, of the knowledge acquired from research into teaching/learning and subject teaching, and also of best practice, students who have completed this course will be in a position to draft motivating learning arrangements, with cognitive appeal, which trigger and maintain learning processes. The aim here is to implement a corresponding teaching plan, so that the mathematics tuition that is given has a general-education value, on the one hand, and ensures that pupils acquire the fundamental knowledge necessary for studying at university, on the other hand.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-9983-00L</td>
<td>Mentored Work Subject Didactics Mathematics A ■</td>
<td>O</td>
<td>2</td>
<td>4A</td>
<td>M. Akved, K. Barro, L. Halbeisen,</td>
</tr>
<tr>
<td></td>
<td>Mentored Work Subject Didactics in Mathematics for TC,</td>
<td></td>
<td></td>
<td></td>
<td>M. Huber, N. Hungerbühler,</td>
</tr>
<tr>
<td></td>
<td>Teaching Diploma and Teaching Diploma Mathematics as Minor Subject</td>
<td></td>
<td></td>
<td></td>
<td>A. F. Müller</td>
</tr>
</tbody>
</table>

**Abstract**
In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.

**Objective**
The objective is for the students:
- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.
- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

**Content**
Thematic Schwerpunkte
Die Gegenstände der mentorierten Arbeit in Fachdidaktik stammen in der Regel aus dem gymnasialen Unterricht.

**Lecture notes**
Eine kurze Anleitung zur mentorierten Arbeit in Fachdidaktik wird zur Verfügung gestellt.
Die Arbeit sollte vor Beginn des Praktikums abgeschlossen werden.

### Professional Training in Mathematics

#### Number: 401-9987-00L

**Title**: Teaching Internship Including Examination Lessons Mathematics

*Teaching Internship Mathematics for TC and Teaching Diploma Mathematics as Minor Subject.* Repetition of the Teaching Internship is excluded even if Examination Lessons are to be repeated.

- **Type**: O
- **ECTS**: 4 credits
- **Hours**: 9P
- **Lecturers**: N. Hungerbühler

**Abstract**

Students apply the insights, abilities and skills they have acquired within the context of an educational institution. They observe 10 lessons and teach 20 lessons independently. Two of them are as assessed as Examination Lessons.

**Objective**

- Students use their specialist-subject, educational-science and subject-didactics training to draw up concepts for teaching.
- They are able to assess the significance of tuition topics for their subject from different angles (including interdisciplinary angles) and impart these to their pupils.
- They learn the skills of the teaching trade.
- They practise finding the balance between instruction and openness so that pupils can and, indeed, must make their own cognitive contribution.
- Together with the teacher in charge of their teacher training, the students constantly evaluate their own performance.

**Content**


**Lecture notes**

Dokument; schriftliche Vorbereitung für Prüfungslektionen.

### Colloquia

#### Number: 401-5960-00L

**Title**: Colloquium on Mathematics, Computer Science, and Education

*Subject didactics for mathematics and computer science teachers.*

- **Type**: E
- **ECTS**: 0 credits
- **Hours**: N. Hungerbühler

**Abstract**

Didactics colloquium

**Mathematics Teaching Diploma - Key for Type**

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
<tr>
<td>Key for Hours</td>
<td>ECTS</td>
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<td>--------------</td>
<td>-------------------------------------------</td>
</tr>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
</tr>
</tbody>
</table>

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Mathematics Master

▸ Core Courses

For the Master's degree in Applied Mathematics the following additional condition (not manifest in myStudies) must be obeyed: At least 15 of the required 28 credits from core courses and electives must be acquired in areas of applied mathematics and further application-oriented fields.

▸▸ Core Courses: Pure Mathematics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-3225-00L</td>
<td>Introduction to Lie Groups</td>
<td>W</td>
<td>8 credits</td>
<td>4G</td>
<td>P. D. Nelson</td>
</tr>
<tr>
<td>Abstract</td>
<td>Topological groups and Haar measure. Definition of Lie groups, examples of local fields and examples of discrete subgroups: basic properties; Lie subgroups. Lie algebras and relation with Lie groups: exponential map, adjoint representation. Semisimplicity, nilpotency, solvability, compactness: Killing form, Lie's and Engel's theorems. Definition of algebraic groups and relation with Lie groups.</td>
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<tr>
<td>Objective</td>
<td>The goal is to have a broad though foundational knowledge of the theory of Lie groups and their associated Lie algebras with an emphasis on the algebraic and topological aspects of it.</td>
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</tr>
<tr>
<td>Literature</td>
<td>A. Knapp: &quot;Lie groups beyond an Introduction&quot; (Birkhaeuser)</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Topology and basic notions of measure theory. A basic understanding of the concepts of manifold, tangent space and vector field is useful, but could also be achieved throughout the semester.</td>
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</table>

Course webpage: http://www.math.ethz.ch/education/bachelor/lectures/hs2014/math/introlg

▸▸ Core Courses: Applied Mathematics and Further Appl.-Oriented Fields

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>401-3651-00L</td>
<td>Numerical Methods for Elliptic and Parabolic Partial Differential Equations</td>
<td>W</td>
<td>10 credits</td>
<td>4V+1U</td>
<td>C. Schwab</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course gives a comprehensive introduction into the numerical treatment of linear and non-linear elliptic boundary value problems, related eigenvalue problems and linear, parabolic evolution problems. Emphasis is on theory and the foundations of numerical methods. Practical exercises include MATLAB implementations of finite element methods.</td>
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<tr>
<td>Objective</td>
<td>Participants of the course should become familiar with:</td>
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<tr>
<td></td>
<td>* concepts underlying the discretization of elliptic and parabolic boundary value problems</td>
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<td></td>
<td>* analytical techniques for investigating the convergence of numerical methods for the approximate solution of boundary value problems</td>
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<tr>
<td></td>
<td>* methods for the efficient solution of discrete boundary value problems</td>
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<tr>
<td></td>
<td>* implementational aspects of the finite element method</td>
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<tr>
<td>Content</td>
<td>A selection of the following topics will be covered:</td>
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<tr>
<td></td>
<td>* Elliptic boundary value problems</td>
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<tr>
<td></td>
<td>* Galerkin discretization of linear variational problems</td>
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<tr>
<td></td>
<td>* The primal finite element method</td>
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<td>* Mixed finite element methods</td>
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<td></td>
<td>* Discontinuous Galerkin Methods</td>
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<td></td>
<td>* Boundary element methods</td>
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<td></td>
<td>* Spectral methods</td>
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<td></td>
<td>* Adaptive finite element schemes</td>
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<td>* Singularly perturbed problems</td>
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<td></td>
<td>* Sparse grids</td>
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<tr>
<td></td>
<td>* Galerkin discretization of elliptic eigenproblems</td>
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</tr>
<tr>
<td></td>
<td>* Non-linear elliptic boundary value problems</td>
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<tr>
<td></td>
<td>* Discretization of parabolic initial boundary value problems</td>
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<tr>
<td>Lecture notes</td>
<td>Course slides will be made available to the audience.</td>
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</tr>
<tr>
<td>Literature</td>
<td>n.a.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Practical exercises based on MATLAB</td>
<td></td>
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</tbody>
</table>

| 401-3621-00L | Fundamentals of Mathematical Statistics | W    | 10 credits | 4V+1U | F. Balabdaoui |
| Abstract   | The course covers the basics of inferential statistics. |
| Objective  | Advanced level introduction to mathematical finance: |
| | * absence of arbitrage and martingale measures |
| | * option pricing and hedging |
| | * optimal investment problems |
| | * additional topics |
| Content    | This is an advanced level introduction to mathematical finance for students with a good background in probability. We want to give an overview of main concepts, questions and approaches, and we do this in both discrete- and continuous-time models. Topics include absence of arbitrage and martingale measures, option pricing and hedging, optimal investment problems, and probably others. Prerequisites are probability theory and stochastic processes (for which lecture notes are available). |
| Lecture notes | None available |
| Literature | Details will be announced in the course. |
| Prerequisites / notice | Prerequisites are probability theory and stochastic processes (for which lecture notes are available). |
Mathematical Optimization

Abstract
Mathematical treatment of diverse optimization techniques.

Objective
Advanced optimization theory and algorithms.

Content
1. Linear optimization: The geometry of linear programming, the simplex method for solving linear programming problems, Farkas' Lemma and infeasibility certificates, duality theory of linear programming.
3. Integer optimization: Ties between linear and integer optimization, total unimodularity, complexity theory, cutting plane theory.
4. Combinatorial optimization: Network flow problems, structural results and algorithms for matroids, matchings and, more generally, independence systems.

(!) (also Bachelor) Core Courses: Pure Mathematics

Further restrictions apply, but in particular:
401-3531-00L Differential Geometry I can only be recognised for the Master Programme if 401-3532-00L Differential Geometry II has not been recognised for the Bachelor Programme.
Analogously for:
401-3461-00L Functional Analysis I - 401-3462-00L Functional Analysis II
401-3001-61L Algebraic Topology I - 401-3002-12L Algebraic Topology II
401-3132-00L Commutative Algebra - 401-3146-12L Algebraic Geometry
401-3371-00L Dynamical Systems I - 401-3372-00L Dynamical Systems II

For the category assignment take contact with the Study Administration Office (www.math.ethz.ch/studiensekretariat) after having received the credits.

Number Title Type ECTS Hours Lecturers

401-3461-00L Functional Analysis I W 10 credits 4V+1U M. Struwe

Abstract
Baire category; Banach and Hilbert spaces, bounded linear operators; three fundamental principles: Uniform boundedness, open mapping/closed graph theorem, Hahn-Banach; convexity; dual spaces; weak and weak* topologies; Banach-Alaoglu; reflexive spaces; compact operators and Fredholm theory; closed range theorem; spectral theory of self-adjoint operators in Hilbert spaces.

Lecture notes
Lecture Notes on "Funktionalanalyse I" by Michael Struwe

401-3531-00L Differential Geometry I W 10 credits 4V+1U U. Lang

Abstract
Curves in R^n, inner geometry of hypersurfaces in R^n, curvature, Theorema Egregium, special classes of surfaces, Theorem of Gauss-Bonnet. Hyperbolic space. Differentiable manifolds, tangent bundle, immersions and embeddings, Sard's Theorem, mapping degree and intersection number, vector bundles, vector fields and flows, differential forms, Stokes' Theorem.

Objective
Introduction to elementary differential geometry and differential topology.

Content
- Differential geometry in R^n: theory of curves, submanifolds and immersions, inner geometry of hypersurfaces, Gauss map and curvature, Theorema Egregium, special classes of surfaces, Theorem of Gauss-Bonnet, Poincaré Index Theorem.
- The hyperbolic space.
- Differential topology: differentiable manifolds, tangent bundle, immersions and embeddings in R^n, Sard's Theorem, transversality, mapping degree and intersection number, vector bundles, vector fields and flows, differential forms, Stokes' Theorem.

Literature
Differential Geometry in R^n:
- Manfredo P. do Carmo: Differential geometry of curves and surfaces
- Wolfgang Kühnel: Differentialgeometrie. Curves-surfaces-manifolds
- Christian Bär: Elementary differential geometry

Differential Topology:
- Dennis Barden & Charles Thomas: An Introduction to Differential Manifolds
- Victor Guillemin & Alan Pollack: Differential Topology
- Morris W. Hirsch: Differential Topology

401-3371-00L Dynamical Systems I W 10 credits 4V+1U W. Merry

Abstract
This course is a broad introduction to dynamical systems. Topic covered include topological dynamics, ergodic theory and low-dimensional dynamics.

Objective
Mastery of the basic methods and principal themes of some aspects of dynamical systems.
Content

Topics covered include:

1. Topological dynamics
   (transitivity, attractors, chaos, structural stability)

2. Ergodic theory
   (Poincare recurrence theorem, Birkhoff ergodic theorem, existence of invariant measures)

3. Low-dimensional dynamics
   (Poincare rotation number, dynamical systems on [0,1])

Literature

The most relevant textbook for this course is Introduction to Dynamical Systems, Brin and Stuck, CUP, 2002.

I will also produce full lecture notes.

Prerequisites / notice

The material of the basic courses of the first two years of the program at ETH is assumed. In particular, you should be familiar with metric spaces and elementary measure theory.

401-3001-61L Algebraic Topology I W 8 credits 4G P. S. Jossen

Abstract

This is an introductory course in algebraic topology. The course will cover the following main topics: introduction to homotopy theory, homology and cohomology of spaces.


Book can be downloaded for free at: http://www.math.cornell.edu/~hatcher/AT/ATpage.html

See also: http://www.math.cornell.edu/~hatcher/#anchor1772800

3) E. Spanier, "Algebraic topology", Springer-Verlag

General topology, linear algebra.

Prerequisites / notice

Some knowledge of differential geometry and differential topology is useful but not absolutely necessary.

401-3132-00L Commutative Algebra W 10 credits 4V+1U R. Pink

Abstract

This course provides an introduction to commutative algebra as a foundation for and first steps towards algebraic geometry. The material in this course will be assumed in the lecture course "Algebraic Geometry" in the spring semester 2017.

Objective

We shall cover approximately the material from --- most of the textbook by Atiyah-MacDonald, or --- the first half of the textbook by Bosch.

Topics include:
* Basics about rings, ideals and modules
* Localization
* Primary decomposition
* Integral dependence and valuations
* Noetherian rings
* Completions
* Basic dimension theory

Literature

Primary Reference:

Secondary Reference:
2. "Algebraic Geometry and Commutative Algebra" by S. Bosch (Springer 2013)

Tertiary References:

Prerequisites / notice

Prerequisites: Algebra I (or a similar introduction to the basic concepts of ring theory).

401-3601-00L Probability Theory This course counts as a core course in the Bachelor's degree programme in Mathematics. Holders of an ETH Zurich Bachelor's degree in Mathematics who didn't use credits from none of the three course units 401-3642-00L Probability Theory, 401-3642-00L Brownian Motion and Stochastic Calculus nor 401-3602-00L Applied Stochastic Processes has been recognised for the Bachelor Programme.

Further restrictions apply, but in particular:
401-3601-00L Probability Theory can only be recognised for the Master Programme if neither 401-3642-00L Brownian Motion and Stochastic Calculus nor 401-3602-00L Applied Stochastic Processes has been recognised for the Bachelor Programme.

402-0205-00L Quantum Mechanics I is eligible as an applied core course, but only if 402-0224-00L Theoretical Physics (offered for the last time in FS 2016) isn't recognised for credits (neither in the Bachelor's nor in the Master's programme).

For the category assignment take contact with the Study Administration Office (www.math.ethz.ch/studiensekretariat) after having received the credits.

Number Title Type ECTS Hours Lecturers

401-3601-00L Probability Theory This course counts as a core course in the Bachelor's degree programme in Mathematics. Holders of an ETH Zurich Bachelor's degree in Mathematics who didn't use credits from none of the three course units 401-3642-00L Probability Theory, 401-3642-00L Brownian Motion and Stochastic Calculus nor 401-3602-00L Applied Stochastic Processes for their Bachelor's degree still can have recognised this course for the Master's degree. Furthermore, at most one of the three course units 401-3461-00L Functional Analysis I 401-3531-00L Differential Geometry I 401-3601-00L Probability Theory can be recognised for the Master's degree in Mathematics or Applied Mathematics.

W 10 credits 4V+1U A.S. Sznitman

Data: 06.03.2019 12:57 Autumn Semester 2016 Page 1140 of 1571
The circle method, invented by Hardy and Ramanujan and developed by Hardy and Littlewood and Kloosterman, is one of the most versatile methods currently available to determine the asymptotic behavior of the number of integral solutions to polynomial equations, when the number of solutions is sufficiently large.

The goal of the course is to study several classical and important (and beautiful!) topics in group and representation theory, that are otherwise often overlooked in a standard curriculum.

Keywords: Schrödinger equation, basic formalism of quantum mechanics (states, operators, commutators, measuring process), symmetries (translations, rotations), quantum mechanics in one dimension, dimensionally symmetric problems in three dimensions, scattering theory, perturbation theory, variational techniques, spin, addition of angular momenta, relation between QM and classical physics.

Electives:

For the Master's degree in Applied Mathematics, the following additional condition (not manifest in myStudies) must be obeyed: At least 15 of the required 28 credits from core courses and electives must be acquired in areas of applied mathematics and further application-oriented fields.

Electives: Pure Mathematics

Selection: Algebra, Topology, Discrete Mathematics, Logic

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>401-3117-66L</td>
<td>Introduction to the Circle Method</td>
<td>W</td>
<td>6</td>
<td>2V+1U</td>
<td>E. Kowalski</td>
</tr>
</tbody>
</table>

Abstract

The method invented by Hardy and Ramanujan and developed by Hardy and Littlewood and Kloosterman, is one of the most versatile methods currently available to determine the asymptotic behavior of the number of integral solutions to polynomial equations, when the number of solutions is sufficiently large.

Content

The method invented by Hardy and Ramanujan and developed by Hardy and Littlewood and Kloosterman, is one of the most versatile methods currently available to determine the asymptotic behavior of the number of integral solutions to polynomial equations, when the number of solutions is sufficiently large.

Lecture notes

available, will be sold in the course

Literature

H. Bauer, Probability Theory, de Gruyter 1996
J. Jacob and P. Protter, Probability essentials, Springer 2004
A. Klenke, Wahrscheinlichkeitsstatistik, Springer 2006
D. Williams, Probability with martingales, Cambridge University Press 1991

Electives: Geometry

Selection: Abelian Varieties over Finite Fields

<table>
<thead>
<tr>
<th>Number</th>
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<tr>
<td>401-4145-66L</td>
<td>Reading Course: Abelian Varieties over Finite Fields</td>
<td>W</td>
<td>2</td>
<td>4A</td>
<td>J. Fresán, P. S. Jossen</td>
</tr>
</tbody>
</table>

Abstract

The course Combinatorics I and II is an introduction into the field of enumerative combinatorics.

Objective

Upon completion of the course, students are able to classify combinatorial problems and to apply adequate techniques to solve them.

Contents of the lectures Combinatorics I and II: congruence transformation of the plane, symmetry groups of geometric figures, Euler's function, Cayley graphs, formal power series, permutation groups, cycles, Bunsdie's lemma, cycle index, Polya's theorems, applications to graph theory and isomers.

Data: 06.03.2019 12:57  Autumn Semester 2016  Page 1141 of 1571
Content

This course gives an introduction to rigidity theory, which is a set of techniques initially invented to understand the structure of a certain class of discrete subgroups of Lie groups, called lattices, and currently used in more general contexts of groups arising as isometries of non-positively curved geometries. A prominent example of a lattice in the Lie group SL(n, R) is the group SL(n, Z) of integer n x n matrices with determinant 1. Prominent questions concerning this group are:

- Describe all its proper quotients.
- Classify all its finite dimensional linear representations.
- More generally, can this group act by diffeomorphisms on "small" manifolds like the circle?
- Does its Cayley graph considered as a metric space at large scale contain enough information to recover the group structure?

In this course we will give detailed treatment for the answers to the first two questions; they are respectively Margulis' normal subgroup theorem and Margulis' superrigidity theorem. These results, valid for all lattices in simple Lie groups of rank at least 2 – like SL(n, R), with n at least 3 – lead to the arithmeticity theorem, which says that all lattices are obtained by an arithmetic construction.

Literature

- D. Witte-Morris: "Introduction to Arithmetic groups", available on Arxiv.
- Y. Benoist: "Five lectures on lattices in semisimple Lie groups", available on his homepage.
- M. Burger: "Rigidity and Arithmeticity", European School of Group Theory, 1996, handwritten notes, will be put online.

Prerequisites / notice

For this course some knowledge of elementary Lie theory would be good. We will however treat Lie groups by examples and avoid structure theory since this is not the point of the course nor of the techniques.

401-3309-66L Riemann Surfaces (Part 2) W 4 credits 2V A. Buryak

Abstract

The program will be the following:

* Proof of the Serre duality;
* Riemann-Hurwitz formula;
* Functions and differential forms on a compact Riemann surface with prescribed principal parts;
* Weierstrass points on a compact Riemann surface;
* The Jacobian and the Picard group of a compact Riemann surface;
* Holomorphic vector bundles;
* Non-compact Riemann surfaces.

Literature

O. Forster. Lectures on Riemann Surfaces. 

Prerequisites / notice

This is a continuation of 401-3308-16L Riemann Surfaces that was taught in the spring semester (FS 2016), see https://docs.google.com/viewer?a=v&pid=sites&srcid=ZGVmYXVsdGRvbWFpbnxhbGV4YW5kcmJ1cnhha2hbWwYWdlIg4QjQzODM1ZDQI2j2JIE1NWI for the lecture notes. The students are also assumed to be familiar with what would generally be covered in one semester courses on general topology and on algebra.

401-3507-00L Finite Geometries II W 4 credits 2G N. Hungerbühler

Abstract

Finite geometries I, II: Finite geometries combine aspects of geometry, discrete mathematics and the algebra of finite fields. In particular, we will construct models of axioms of incidence and investigate closing theorems. Applications include test design in statistics, block design, and the construction of orthogonal Latin squares.

Objective

Finite geometries I, II: Students will be able to construct and analyse models of finite geometries. They are familiar with closing theorems of the axioms of incidence and are able to design statistical tests by using the theory of finite geometries. They are able to construct orthogonal Latin squares and know the basic elements of the theory of block design.

Content

Finite geometries I, II: finite fields, rings of polynomials, finite affine planes, axioms of incidence, Euler's thirty-six officers problem, design of statistical tests, orthogonal Latin squares, transformation of finite planes, closing theorems of Desargues and Pappus-Pascal, hierarchy of closing theorems, finite coordinate planes, division rings, finite projective planes, duality principle, finite Moebius planes, error correcting codes, block design

Literature

- Max Jeger, Endliche Geometrien, ETH Skript 1988
- Albrecht Beutelspacher: Einführung in die endliche Geometrie I,II. Bibliographisches Institut 1983
- Margaret Lynn Batten: Combinatorics of Finite Geometries. Cambridge University Press
- Dempowski: Finite Geometries.

Selection: Analysis

<table>
<thead>
<tr>
<th>Number</th>
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<tbody>
<tr>
<td>401-3536-11L</td>
<td>Geometric Aspects of Hamiltonian Dynamics</td>
<td>W</td>
<td>6 credits</td>
<td>3V</td>
<td>P. Biran</td>
</tr>
</tbody>
</table>

Abstract

The course will concentrate on the geometry of the group of Hamiltonian diffeomorphisms introduced by Hofer in the early 1990's and its relation to various topics in symplectic geometry such as capacities, Lagrangian submanifolds, holomorphic curves, as well as recent algebraic structures on the group of Hamiltonian diffeomorphisms such as quasi-morphisms.

Literature

- L. Polterovich: "The geometry of the group of symplectic diffeomorphisms"
- H. Hofer & E. Zehnder: "Symplectic invariants and Hamiltonian dynamics"
- M. Burger: "Rigidity and Arithmeticity", European School of Group Theory, 1996, handwritten notes, will be put online.

Prerequisites / notice

Prerequisites. Good knowledge of undergraduate mathematics (analysis, complex functions, topology, and differential geometry). Some knowledge of elementary algebraic topology would be useful.

401-4767-66L Partial Differential Equations (Hyperbolic PDEs) W 7 credits 4V D. Christodoulou

Abstract

The course begins with characteristics, the definition of hyperbolicity, causal structure and the domain of dependence theorem. The course then focuses on nonlinear systems of equations in two independent variables, in particular the Euler equations of compressible fluids with plane symmetry and the Einstein equations of general relativity with spherical symmetry.

Objective

The objective is to introduce students in mathematics and physics to an area of mathematical analysis involving differential geometry which is of fundamental importance for the development of classical macroscopic continuum physics.

Content

The course shall begin with the basic structure associated to hyperbolic partial differential equations, characteristic hypersurfaces and bicharacteristics, causal structure, and the domain of dependence theorem. The course shall then focus on nonlinear systems of equations in two independent variables. The first topic shall be the Euler equations of compressible fluids under plane symmetry where we shall study the formation of shocks, and second topic shall be the Einstein equations of general relativity under spherical symmetry where we shall study the formation of black holes and spacetime singularities.

Prerequisites / notice

Basic real analysis and differential geometry.
### Mathematical Themes in General Relativity I

**Course Code:** 401-4831-66L  
**Type:** W  
**ECTS Credits:** 4  
**Hours:** 2V  
**Instructor:** A. Carlotto

**Abstract:** First part of a one-year course offering a rigorous introduction to general relativity, with special emphasis on aspects of current interest in mathematical research. Topics covered include: initial value formulation of the Einstein equations, causality theory and singularities, constructions of data sets by gluing or conformal methods, asymptotically flat spaces and positive mass theorems.

**Objective:** Acquisition of a solid and broad background in general relativity and mastery of the basic mathematical methods and ideas developed in such context and successfully exploited in the field of geometric analysis.

**Content:** Lorentzian geometry; geometric review of special relativity; the Einstein equations and their basic classes of special solutions; the Einstein equations as an initial-value problem; causality theory and hyperbolicity; singularities and trapped domains; Penrose diagrams; asymptotically flat spaces: ADM invariants, positive mass theorems, Penrose inequalities, geometric properties.

**Lecture notes:** Lecture notes written by the instructor will be provided to all enrolled students.

**Prerequisites / notice:** The content of the basic courses of the first three years at ETH will be assumed. In particular, enrolled students are expected to be fluent both in Differential Geometry (at least at the level of Differentialgeometrie I, II) and Functional Analysis (at least at the level of Funktionalanalysis I, II). Some background on partial differential equations, mainly of elliptic and hyperbolic type, (say at the level of the monograph by L. C. Evans) would also be desirable.

### Fourier Analysis in Function Space Theory

**Course Code:** 401-4463-62L  
**Type:** W  
**ECTS Credits:** 6  
**Hours:** 3V  
**Instructor:** T. Rivièere

**Abstract:** In the most important part of the course, we will present the notion of Singular Integrals and Calderón-Zygmund theory as well as its application to the analysis of linear elliptic operators.

**Content:** During the first lectures we will review the theory of tempered distributions and their Fourier transforms. We will go in particular through the notion of Fréchet spaces, Banach-Steinhaus for Fréchet spaces etc. We will then apply this theory to the Fourier characterization of Hilbert-Sobolev spaces. In the second part of the course we will study fundamental properties of the Hardy-Littlewood Maximal Function in relation with \( L^p \) spaces. We will then make a digression through the notion of Marcinkiewicz weak \( L^p \) spaces and Lorentz spaces. At this occasion we shall give in particular a proof of Aoki-Rollewicz theorem on the metrisability of quasi-normed spaces. We will introduce the preduals to the weak \( L^p \) spaces, the Lorentz \( L^{(p,1)} \) spaces as well as the general \( L^{p,q} \) spaces and show some applications of these dualities as well as the improved Sobolev embeddings. In the third part of the course, the most important one, we will present the notion of Singular Integrals and Calderón-Zygmund theory as well as its application to the analysis of linear elliptic operators. This theory will naturally bring us, via the so called Littlewood-Paley decomposition, to the Fourier characterization of classical Hilbert and non Hilbert Function spaces which is one of the main goals of this course. If time permits we shall present the notion of Paraproduct, Paracompositions and the use of Littlewood-Paley decomposition for estimating products and general non-linearities. We also hope to cover fundamental notions from integrability by compensation theory such as Coifman-Rochberg-Weiss commutator estimates and some of its applications to the analysis of PDE.

2) Javier Duoandikoetxea, “Fourier Analysis” AMS.  
3) Loukas Grafakos, “Classical Fourier Analysis” GTM 249 Springer.  
4) Loukas Grafakos, “Modern Fourier Analysis” GTM 250 Springer.

**Prerequisites / notice:** Notions from ETH courses in Measure Theory, Functional Analysis I and II (Fundamental results in Banach and Hilbert Space theory, Fourier transform of \( L^2 \) Functions).

### Partial Differential Equations and Semigroups of Bounded Linear Operators

**Course Code:** 401-4475-66L  
**Type:** W  
**ECTS Credits:** 4  
**Hours:** 2G  
**Instructor:** A. Jentzen

**Abstract:** In this course we study the concept of a semigroup of bounded linear operators and we use this concept to investigate existence, uniqueness, and regularity properties of solutions of partial differential equations (PDEs) of the evolutionary type.

**Objective:** The aim of this course is to teach the students a decent knowledge (i) on semigroups of bounded linear operators, (ii) on solutions of partial differential equations (PDEs) of the evolutionary type, and (iii) on the analytic concepts used to formulate and study such semigroups and such PDEs.

**Content:** The course includes content (i) on semigroups of bounded linear operators, (ii) on solutions of partial differential equations (PDEs) of the evolutionary type, and (iii) on the analytic concepts used to formulate and study such semigroups and such PDEs. Key example PDEs that are treated in this course are heat and wave equations.

**Lecture notes:** Lecture Notes are available in the lecture homepage (please follow the link in the Learning materials section).

**Literature:** 1. Amnon Pazy, Semigroups of linear operators and applications to partial differential equations. Springer-Verlag, New York (1983).  

**Prerequisites / notice:** Mandatory prerequisites: Functional analysis.
2) in which semester;
3) for which degree programme;
4) your name and first name;
5) your student number;
6) the name and first name of the supervisor of the
Reading Course.

Abstract
For this Reading Course proactive students make an individual agreement with a lecturer to acquire knowledge through independent literature study.

401-3503-66L  Reading Course  
THE ENROLMENT IS DONE BY THE STUDY ADMINISTRATION.

Please send an email to Studiensekretariat D-MATH <studiensekretariat@math.ethz.ch> including the following pieces of information:
1) which Reading Course (60, 90, 120 hours of work, corresponding to 2, 3, 4 ECTS credits) you wish to register;
2) in which semester;
3) for which degree programme;
4) your name and first name;
5) your student number;
6) the name and first name of the supervisor of the Reading Course.

Abstract
For this Reading Course proactive students make an individual agreement with a lecturer to acquire knowledge through independent literature study.

401-3504-66L  Reading Course  
THE ENROLMENT IS DONE BY THE STUDY ADMINISTRATION.

Please send an email to Studiensekretariat D-MATH <studiensekretariat@math.ethz.ch> including the following pieces of information:
1) which Reading Course (60, 90, 120 hours of work, corresponding to 2, 3, 4 ECTS credits) you wish to register;
2) in which semester;
3) for which degree programme;
4) your name and first name;
5) your student number;
6) the name and first name of the supervisor of the Reading Course.

Abstract
For this Reading Course proactive students make an individual agreement with a lecturer to acquire knowledge through independent literature study.

Electives: Applied Mathematics and Further Application-Oriented Fields

Selection: Numerical Analysis

Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
401-4657-00L | Numerical Analysis of Stochastic Ordinary Differential Equations | W | 6 credits | 3V+1U | A. Jentzen

Abstract
Course on numerical approximations of stochastic ordinary differential equations driven by Wiener processes. These equations have several applications, for example in financial option valuation. This course also contains an introduction to random number generation and Monte Carlo methods for random variables.

Objective
The aim of this course is to enable the students to carry out simulations and their mathematical convergence analysis for stochastic models originating from applications such as mathematical finance. For this the course teaches a decent knowledge of the different numerical methods, their underlying ideas, convergence properties and implementation issues.

Content
Generation of random numbers
Monte Carlo methods for the numerical integration of random variables
Stochastic processes and Brownian motion
Stochastic ordinary differential equations (SODEs)
Numerical approximations of SODEs
Multilevel Monte Carlo methods for SODEs
Applications to computational finance: Option valuation

Lecture notes
Lecture Notes are available in the lecture homepage (please follow the link in the Learning materials section).

Literature
P. Glassermann:
Monte Carlo Methods in Financial Engineering.

P. E. Kloeden and E. Platen:
Numerical Solution of Stochastic Differential Equations.
Mathematical and Computational Methods in Photonics

Lecturers

Start of lectures: Wednesday, September 21, 2016
For more details, please follow the link in the Learning materials section.

401-4785-00L Mathematical and Computational Methods in Photonics

W 8 credits 4G H. Ammari

Abstract

The aim of this course is to review new and fundamental mathematical tools, computational approaches, and inversion and optimal design methods used to address challenging problems in nanophotonics. The emphasis will be on analyzing plasmon resonant nanoparticles, super-focusing & super-resolution of electromagnetic waves, photonic crystals, electromagnetical cloaking, metamaterials, and metasurfaces demonstrating how to use the theory of regularity structures to solve singular stochastic PDEs.

Hairer's new theory of regularity structures is introduced taking controlled rough paths as guiding examples. In particular, the course demonstrates how to use the theory of regularity structures to solve singular stochastic PDEs.

Objective

The field of photonics encompasses the fundamental science of light propagation and interactions in complex structures, and its technological applications.

The recent advances in nanoscience present great challenges for the applied and computational mathematics community. In nanophotonics, the aim is to control, manipulate, reshape, guide, and focus electromagnetic waves at nanometer length scales, beyond the resolution limit. In particular, one wants to break the resolution limit by reducing the focal spot and confine light to length scales that are significantly smaller than half the wavelength.

Interactions between the field of photonics and mathematics has led to the emergence of a multitude of new and unique solutions in which today's conventional technologies are approaching their limits in terms of speed, capacity and accuracy. Light can be used for detection and measurement in a fast, sensitive and accurate manner, and thus photonics possesses a unique potential to revolutionize healthcare.

Light-based technologies can be used effectively for the very early detection of diseases, with non-invasive imaging techniques or point-of-care applications. They are also instrumental in the analysis of processes at the molecular level, giving a greater understanding of the origin of diseases, and hence allowing prevention along with new treatments. Photon technologies also play a major role in addressing the needs of our ageing society: from pace-makers to synthetic bones, and from endoscopes to the micro-cameras used in in vivo processes. Furthermore, photonics are also used in advanced lighting technology, and in improving energy efficiency and quality. By using photonic media to control waves across a wide band of wavelengths, we have an unprecedented ability to fabricate new materials with specific microstructures.

The main objective in this course is to report on the use of sophisticated mathematics in diffractive optics, plasmonics, super-resolution, photonic crystals, and metamaterials for electromagnetic invisibility and cloaking. The course merges highly nontrivial multi-mathematics in order to make a breakthrough in the field of mathematical modelling, imaging, and optimal design of optical nanodevices and nanostructures capable of light enhancement, and of the focusing and guiding of light at a subwavelength scale. We demonstrate the power of using potential techniques in solving challenging problems in photonics, when they are combined with asymptotic analysis and the elegant theory of Gohberg and Sigal on meromorphic operator-valued functions.

In this course we shall consider both analytical and computational matters in photonics. The issues we consider lead to the investigation of fundamental problems in various branches of mathematics. These include asymptotic analysis, spectral analysis, mathematical imaging, optimal design, stochastic modelling, and analysis of wave propagation phenomena. On the other hand, deriving mathematical foundations, and new and efficient computational frameworks and tools in photonics, requires a deep understanding of the different scales in the wave propagation problem, an accurate mathematical modelling of the nanodevices, and fine analysis of complex wave propagation phenomena. An emphasis is put on mathematically analyzing plasmon resonant nanoparticles, diffractive optics, photonic crystals, super-resolution, and metamaterials.

►►► Selection: Probability Theory, Statistics

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<tr>
<td>401-4604-66L</td>
<td>Topics in Probability Theory</td>
<td>W</td>
<td>4</td>
<td>2V</td>
<td>W. Werner</td>
</tr>
<tr>
<td>Abstract</td>
<td>The goal of this course is to give a sample of some basic results and features to illustrate various areas of probability theory.</td>
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<td>Objective</td>
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<tr>
<td>401-3604-66L</td>
<td>Special Topics in Probability: Recent Developments in Percolation Theory</td>
<td>W</td>
<td>4</td>
<td>2V</td>
<td>P. Nolin</td>
</tr>
<tr>
<td>Abstract</td>
<td>The goal of this course is to present recent developments in Percolation Theory</td>
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<tr>
<td>Objective</td>
<td>The goal of this course is to present recent developments in Percolation Theory</td>
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</table>

We will first present classical tools and properties of percolation theory: in particular correlation inequalities, exponential decay of connection probabilities, and uniqueness of the infinite connected component. We will then discuss recent developments: for example percolation on Cayley graphs, and continuum limits in two dimensions.

Literature

B. Bollobas, O. Riordan: Percolation, CUP 2006

Prerequisites

- Prerequisites:
  - 401-2604-00L Probability and Statistics (mandatory)
  - 401-3601-00L Probability Theory (recommended)

401-4611-66L Rough Path Theory and Regularity Structures

W 6 credits 3V J. Teichmann, D. Prömel

Abstract

The course provides an introduction to the theory of controlled rough paths with focus on stochastic differential equations. In parallel, Martin Hairer's new theory of regularity structures is introduced taking controlled rough paths as guiding examples. In particular, the course demonstrates how to use the theory of regularity structures to solve singular stochastic PDEs.

Objective

The main goal is to develop simultaneously the basic concepts of rough path theory and Hairer's regularity structures.
"High-Dimensional Statistics" deals with modern methods and theory for statistical inference when the number of unknown parameters is of much larger order than sample size. Statistical estimation and algorithms for complex models and aspects of multiple testing will be discussed.

Knowledge of methods and basic theory for high-dimensional statistical inference

Lasso and Group Lasso for high-dimensional linear and generalized linear models; Additive models and many smooth univariate functions; Non-convex loss functions and l1-regularization; Stability selection, multiple testing and construction of p-values; Undirected graphical modeling

Knowledge of basic concepts in probability theory, and intermediate knowledge of statistics (e.g. a course in linear models or computational statistics).

Statistical analysis and modeling of observations in temporal order, which exhibit dependence. Stationarity, trend estimation, seasonal decomposition, autocorrelations, spectral and wavelet analysis, ARIMA-, GARCH- and state space models. Implementations in the software R.

Understanding of the basic models and techniques used in time series analysis and their implementation in the statistical software R. This course deals with modeling and analysis of variables which change randomly in time. Their essential feature is the dependence between successive observations. Applications occur in geophysics, engineering, economics and finance. Topics covered: Stationarity, trend estimation, seasonal decomposition, autocorrelations, spectral and wavelet analysis, ARIMA-, GARCH- and state space models. The models and techniques are illustrated using the statistical software R.

This course provides an introduction to statistical Monte Carlo methods. This includes applications of simulations in various fields (Bayesian statistics, statistical mechanics, operations research, financial mathematics), algorithms for the generation of random variables (accept-reject, importance sampling), estimating the precision, variance reduction, introduction to Markov chain Monte Carlo.

Basic knowledge in probability and statistics

This course covers selected advanced topics in computational statistics, including various classification methods, the EM algorithm, clustering, handling missing data, and graphical modelling.

The course is roughly divided in three parts: (1) Supervised learning via (variations of) nearest neighbor methods, (2) the EM algorithm and clustering, (3) handling missing data and graphical models.

We assume a solid background in mathematics, an introductory lecture in probability and statistics, and at least one more advanced course on modeling.

Does not take place this semester.

Does not take place this semester.
The classical life insurance model is presented together with the important insurance types (insurance on one and two lives, term and ECTS 2V+1U Life Insurance Mathematics P. Blum Financial Risk Management in Social and Pension The lecture aims at providing a basis in non-life insurance mathematics which forms a core subject of actuarial sciences. It discusses Faraway (2005): Linear Models with R Faraway (2006): Extending the Linear Model with R Draper & Smith (1998): Applied Regression Analysis Fox (2008): Applied Regression Analysis and GLMs Montgomery et al. (2006): Introduction to Linear Regression Analysis Prerequisites / notice The exercises, but also the classes will be based on procedures from the freely available, open-source statistical software package R, for which an introduction will be held.

In the Mathematics Bachelor and Master programmes, the two course units 401-0649-00L "Applied Statistical Regression" and 401-3622-00L "Regression" are mutually exclusive. Registration for the examination of one of these two course units is only allowed if you have not registered for the examination of the other course unit.


Objective Participants will be able to plan and analyze efficient experiments in the fields of natural sciences. They will gain practical experience by using the software R.


Prerequisites / notice The exercises, but also the classes will be based on procedures from the freely available, open-source statistical software R, for which an introduction will be held.

Selection: Financial and Insurance Mathematics

In the Master's programmes in Mathematics resp. Applied Mathematics 401-3913-01L Mathematical Foundations for Finance is eligible as an elective course, but only in the Bachelor's or in the Master's programme). For the category assignment take contact with the Study Administration Office (www.math.ethz.ch/studiensekretariat) after having received the credits.

Number Title Type ECTS Hours Lecturers
401-3925-01L Applied Analysis of Variance and Experimental W 5 credits 2V+1U L. Meier

401-3925-00L Non-Life Insurance: Mathematics and Statistics W 6 credits 4G M. V. Wüthrich

Abstract The lecture aims at providing a basis in non-life insurance mathematics which forms a core subject of actuarial sciences. It discusses collective risk modeling, individual claim size modeling, approximations for compound distributions, ruin theory, premium calculation principles, tariffication with generalized linear models, credibility theory, claims reserving and solvency.

Objective The student is familiar with the basics in non-life insurance mathematics and statistics. This includes the basic mathematical models for insurance liability modeling, pricing concepts, stochastic claims reserving models and ruin and solvency considerations.

Content The following topics are treated: Collective Risk Modeling Individual Claim Size Modeling Approximations for Compound Distributions Ruin Theory in Discrete Time Premium Calculation Principles Tariffication and Generalized Linear Models Bayesian Models and Credibility Theory Claims Reserving Solvency Considerations


Prerequisites / notice The exams ONLY take place during the official ETH examination period.

This course will be held in English and counts towards the diploma of "Aktuar SAV". For the latter, see details under www.actuaries.ch.

Prerequisites: knowledge of probability theory, statistics and applied stochastic processes.

401-3922-00L Life Insurance Mathematics W 4 credits 2V M. Koller

Abstract The classical life insurance model is presented together with the important insurance types (insurance on one and two lives, term and endowment insurance and disability). Besides that the most important terms such as mathematical reserves are introduced and calculated. The profit and loss account and the balance sheet of a life insurance company is explained and illustrated.

401-3929-00L Financial Risk Management in Social and Pension Insurance W 4 credits 2V P. Blum

Abstract Investment returns are an important source of funding for social and pension insurance, and financial risk is an important threat to stability. We study short-term and long-term financial risk and its interplay with other risk factors, and we develop methods for the measurement and management of financial risk and return in an asset/liability context with the goal of assuring sustainable funding.
Objective
Understand the basic asset-liability framework: essential principles and properties of social and pension insurance; cash flow matching, duration matching, valuation portfolio and loose coupling; the notion of financial risk; long-term vs. short-term risk; coherent measures of risk.

Understand the conditions for sustainable funding: derivation of required returns; interplay between return levels, contribution levels and other parameters; influence of guaranteed benefits.

Understand the notion of risk-taking capability: capital process as a random walk; measures of long-term risk and relation to capital; short-term solvency vs. long-term stability; effect of embedded options and guarantees; interplay between required return and risk-taking capability.

Be able to study empirical properties of financial assets: the Normal hypothesis and the deviations from it; statistical tools for investigating relevant risk and return properties of financial assets; time aggregation properties; be able to conduct analysis of real data for the most important asset classes.

Understand and be able to carry out portfolio construction: the concept of diversification; limitations to diversification / correlation breakdown / what happened in 2008; the Kuhn-Tucker Theorem and optimization (mean-variance, mean-downside); incorporation of constraints; sensitivity and shortcomings of optimized portfolios.

Understand and interpret the asset-liability interplay: the optimized portfolio in the asset-liability framework; short-term risk vs. long-term risk; the influence of constraints; feasible and non-feasible solutions; practical considerations.

Content
- Required return for a sustainable funding of the institution,
- Risk-taking capability of the institution,
- Returns available from financial assets in the market,
- Risks incurred by investing in these assets.

This task must be accomplished under a number of constraints. Financial risk management in social insurance also means reconciling the long time horizon of the promised insurance benefits with the short time horizon of financial markets and financial risk.

It is not the goal of this lecture to provide the students with any cookbook recipes that can readily be applied without further reflection. The goal is rather to enable the students to develop their own understanding of the problems and possible solutions associated with the management of financial risks in social and pension insurance.

To this end, a rigorous intellectual framework will be developed and a powerful set of mathematical tools from the fields of actuarial mathematics and quantitative risk management will be applied. When analyzing the properties of financial assets, an empirical viewpoint will be taken using statistical tools and considering real-world data.

Lecture notes
Since this is the first instance of this course, there is not yet a full script. However, to complement the blackboard notes, extensive handouts will be provided. Moreover, practical examples and data sets in Excel and Octave / Matlab will be made available to play around with and deepen the understanding of the subject matter.

Prerequisites / notice
Solid base knowledge of probability and statistics is indispensable. Specialized concepts from financial and insurance mathematics as well as quantitative risk management will be introduced in the lecture as needed, but some prior knowledge in some of these areas would be an advantage.

This course counts towards the diploma of "Aktuar SAV".

The exams ONLY take place during the official ETH examination period.

401-4947-66L elective course <title tba> W 4 credits 2V P. Cheridito

Does not take place this semester.

444 Selection: Mathematical Physics, Theoretical Physics

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>402-0843-00L</td>
<td>Quantum Field Theory I</td>
<td>W</td>
<td>10</td>
<td>4V+2U</td>
<td>C. Anastasiou</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course discusses the quantisation of fields in order to introduce a coherent formalism for the combination of quantum mechanics and special relativity. Topics include: - Relativistic quantum mechanics - Quantisation of bosonic and fermionic fields - Interactions in perturbation theory - Scattering processes and decays - Radiative corrections</td>
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</table>

Objective
The goal of this course is to provide a solid introduction to the formalism, the techniques, and important physical applications of quantum field theory. Furthermore, it prepares students for the advanced course in quantum field theory (Quantum Field Theory II), and for work on research projects in theoretical physics, particle physics, and condensed-matter physics.

402-0861-00L Statistical Physics W 10 credits 4V+2U G. Blatter

Abstract
This lecture covers the concepts of classical and quantum statistical physics, and some aspects of kinetic gas theory and hydrodynamics. In a more advanced part degenerate Fermions, Bose-Einstein condensation, real Bose gases, magnetism, general mean field theory and critical phenomena will be addressed.

Objective
This lecture gives an introduction in the basic concepts and applications of statistical physics for the general use in physics and, in particular, as a preparation for the theoretical solid state physics education.
Content
Basics of phenomenological thermodynamics, three laws of thermodynamics.
Hydrodynamics.
Classical statistical physics: microcanonical ensembles, canonical ensembles and grandcanonical ensembles, applications to simple systems.
Quantum statistical physics: single particle, ideal quantum gases, fermions and bosons.
Degenerate fermions: Fermi gas, electrons in magnetic field.
Bosons: Bose-Einstein condensation, Bogoliubov theory, superfluidity.
Critical phenomena: mean field, series expansions, scaling behavior, universality.
Renormalization group: fixed points, simple models.

Lecture notes
No specific book is used for the course. Relevant literature will be given in the course.

402-0830-00L General Relativity W 10 credits 4V+2U P. Jetzer
Abstract
Manifold, Riemannian metric, connection, curvature; Special Relativity; Lorentzian metric; Equivalence principle; Tidal force and spacetime curvature; Energy-momentum tensor, field equations, Newtonian limit; Post-Newtonian approximation; Schwarzschild solution; Mercury's perihelion precession, light deflection.
Objective
Basic understanding of general relativity, its mathematical foundations, and some of the interesting phenomena it predicts.

Literature
Suggested textbooks:
- C. Misner, K. Thorne and J. Wheeler: Gravitation
- S. Caroll - Spacetime and Geometry: An Introduction to General Relativity
- R. Wald - General Relativity
- S. Weinberg - Gravitation and Cosmology
- N. Straumann - General Relativity with applications to Astrophysics

402-0822-13L Introduction to Integability W 6 credits 2V+1U N. Beisert
Abstract
This course gives an introduction to the theory of integrable systems, related symmetry algebras and efficient calculational methods. Integrrable systems are a special class of physical models that can be solved exactly due to an exceptionally large number of symmetries. Examples of integrable models appear in many different areas of physics, including classical mechanics, condensed matter, 2d quantum field theories and lately in string- and gauge theories. They offer a unique opportunity to gain a deeper understanding of generic phenomena in a simplified, exactly solvable setting. In this course we introduce the various notions of integrability in classical mechanics, quantum mechanics and quantum field theory. We discuss efficient methods for solving such models as well as the underlying enhanced symmetries.

Content
- Classical Integrability
- Integrable Field Theory
- Integrable Spin Chains
- Quantum Integrability
- Integrable Statistical Mechanics
- Quantum Algebra
- Bethe Ansatz and Related Methods
- Ads/CFT Integrability

Literature

Selection: Mathematical Optimization, Discrete Mathematics

Number Title Type ECTS Hours Lecturers
401-3054-14L Probabilistic Methods in Combinatorics W 6 credits 2V+1U B. Sudakov
Abstract
This course provides a gentle introduction to the Probabilistic Method, with an emphasis on methodology. We will try to illustrate the main ideas by showing the application of probabilistic reasoning to various combinatorial problems.
Content
The topics covered in the class will include (but are not limited to): linearity of expectation, the second moment method, the local lemma, correlation inequalities, martingales, large deviation inequalities, Janson and Talagrand inequalities and pseudo-randomness.

Literature
- Graph Coloring and the Probabilistic Method, by M. Molloy and B. Reed, Springer, 2002.

Auswahl: Theoretical Computer Science

Number Title Type ECTS Hours Lecturers
252-1425-00L Geometry: Combinatorics and Algorithms W 6 credits 2V+2U+1A B. Gärtner, E. Welzl, M. Hoffmann, A. Pilz
Abstract
Geometric structures are useful in many areas, and there is a need to understand their structural properties, and to work with them algorithmically. The lecture addresses theoretical foundations concerning geometric structures. Central objects of interest are triangulations. We study combinatorial (Does a certain object exist?) and algorithmic questions (Can we find a certain object efficiently?)
Objective
The goal is to make students familiar with fundamental concepts, techniques and results in combinatorial and computational geometry, so as to enable them to model, analyze, and solve theoretical and practical problems in the area and in various application domains.
In particular, we want to prepare students for conducting independent research, for instance, within the scope of a thesis project.

Content
- Planar and geometric graphs, embeddings and their representation (Whitney's Theorem, canonical orderings, DCEL), polygon triangulations and the art gallery theorem, convexity in R^d, planar convex hull algorithms (Jarvis Wrap, Graham Scan, Chan's Algorithm), point set triangulations, Delaunay triangulations (Lawson flips, lifting map, randomized incremental construction), Voronoi diagrams, the Crossing Lemma and incidence bounds, line arrangements (duality, Zone Theorem, ham-sandwich cuts), 3-SUM hardness, counting planar triangulations.

Lecture notes
yes

Data: 06.03.2019 12:57
The Internet is a typical example of a large-scale distributed computer system without central control, with users that are typically only interested in their own good. For instance, they are interested in getting high bandwidth for themselves, but don’t care about others, and the same is true for computational load or download rates. Game theory provides a particularly well-suited model for the behavior and interaction of such selfish users and programs. Classic game theory dates back to the 1930s and typically does not consider algorithmic aspects at all. Only a few years back, algorithms and game theory have been considered together, in an attempt to reconcile selfish behavior of independent agents with the common good.

This course discusses algorithmic aspects of game-theoretic models, with a focus on recent algorithmic and mathematical developments. Rather than giving an overview of such developments, the course aims to study selected important topics in depth.

Outline:
- Introduction to classic game-theoretic concepts.
- Existence of stable solutions (equilibria), algorithms for computing equilibria, computational complexity.
- Speed of convergence of natural game playing dynamics such as best-response dynamics and regret minimization.
- Techniques for bounding the quality-loss due to selfish behavior versus optimal outcomes under central control (a.k.a. the ‘Price of Anarchy’).
- Design and analysis of mechanisms that induce truthful behavior or near-optimal outcomes at equilibrium.
- Selected current research topics, such as Google’s Sponsored Search Auction, the U.S. FCC Spectrum Auction, Kidney Exchange.

Prerequisites / notice

Audience: Although this is a Computer Science course, we encourage the participation from all students who are interested in this topic.

Requirements: You should enjoy precise mathematical reasoning. You need to have passed a course on algorithms and complexity. No knowledge of game theory is required.

Several copies of both books are available in the Computer Science library.

The course will introduce lattice-based cryptography, which is one of the main candidates for quantum-resistant cryptography. The objective of the course is to bring the students up to a level where they should be able to read academic papers on state-of-the-art designs of lattice-based primitives.

In this course, we will study lattice-based cryptography. We will cover the basic algorithms associated with integer lattices such as Gram-Schmidt orthogonalization, algorithms for finding short and near lattice vectors, as well as the critical algorithm for sampling lattice points according to a discrete Gaussian distribution. We will then proceed to build up a toolbox of lattice-based cryptographic primitives beginning from collision-resistant hash functions, then moving on to digital signatures, encryption, identity-based encryption, and fully-homomorphic encryption. Particular emphasis will be placed on concrete parameters and practical instantiations. For this purpose, we will also study cryptographic constructions based on the hardness of ideal lattices, which are ideals of polynomial rings.

There are no formal mathematical pre-requisites, but students should have “mathematical maturity”, which entails dealing with abstract concepts and being comfortable with doing mathematical proofs. Some previous exposure to linear algebra, abstract algebra, and cryptography would be useful.
For this Reading Course proactive students make an individual agreement with a lecturer to acquire knowledge through independent literature study.

Abstract

For this Reading Course proactive students make an individual agreement with a lecturer to acquire knowledge through independent literature study.

Application Area

Only necessary and eligible for the Master degree in Applied Mathematics. One of the application areas specified must be selected for the category Application Area for the Master degree in Applied Mathematics. At least 8 credits are required in the chosen application area.

Atmospherical Physics

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<tr>
<th>Number</th>
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<th>ECTS</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>701-1221-00L</td>
<td>Dynamics of Large-Scale Atmospheric Flow</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>H. Wernli, S. Pfahl</td>
</tr>
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</table>

Objective
Dynamic, synoptic Meteorology

Content
Understanding the dynamics of large-scale atmospheric flow

Dynamical Meteorology is concerned with the dynamical processes of the earth's atmosphere. The fundamental equations of motion in the atmosphere will be discussed along with the dynamics and interactions of synoptic system - i.e. the low and high pressure systems that determine our weather. The motion of such systems can be understood in terms of quasi-geostrophic theory. The lecture course provides a derivation of the mathematical basis along with some interpretations and applications of the concept.

Lecture notes
Dynamics of large-scale atmospheric flow

Literature
- Pichler H., Dynamik der Atmosphäre, Bibliographisches Institut, 456 pp. 1997

Prerequisites / notice
Physics I, II, Environmental Fluid Dynamics

Biology

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<tr>
<th>Number</th>
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<tr>
<td>551-0015-00L</td>
<td>Biology I</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>R. Glockshuber, E. Hafen</td>
</tr>
</tbody>
</table>

Abstract
The lecture Biology I, together with the lecture Biology II in the following summer semester, is a basic, introductory course into Biology for Students of Materials Sciences and other students with biology as subsidiary subject.

Objective
The goal of this course is to give the students a basic understanding of the molecules that build a cell and make it function, and the basic principles of metabolism and molecular genetics.
Die folgenden Kapitelnummern beziehen sich auf das der Vorlesung zugrundeliegende Lehrbuch "Biology" (Campbell & Rees, 10th edition, 2015)
Kapitel 1-4 des Lehrbuchs werden als Grundwissen vorausgesetzt

1. Aufbau der Zelle
Kapitel 5: Struktur und Funktion biologischer Makromoleküle
Kapitel 6: Eine Tour durch die Zelle
Kapitel 7: Membranstruktur und-funktion
Kapitel 8: Einführung in den Stoffwechsel
Kapitel 9: Zelluläre Atmung und Speicherung chemischer Energie
Kapitel 10: Photosynthese
Kapitel 12: Der Zellzyklus
Kapitel 17: Vom Gen zum Protein

2. Allgemeine Genetik
Kapitel 13: Meiose und Reproduktionszyklen
Kapitel 14: Mendelsche Genetik
Kapitel 15: Die chromosomale Basis der Vererbung
Kapitel 16: Die molekulare Grundlage der Vererbung
Kapitel 18: Genetik von Bakterien und Viren
Kapitel 46: Tierische Reproduktion

Grundlagen des Stoffwechsels und eines Überblicks über molekulare Genetik

Lecture notes
Das folgende Lehrbuch ist Grundlage für die Vorlesungen Biologie I und II:

Das folgende Lehrbuch ist Grundlage für die Vorlesungen Biologie I und II:

Prerequisites / notice


636-0017-00L Computational Biology  W  4 credits  3G  T. Stadler, C. Magnus

Abstract
The aim of the course is to provide up-to-date knowledge on how we can study biological processes using genetic sequencing data. Computational algorithms extracting biological information from genetic sequence data are discussed, and statistical tools to understand this information in detail are introduced.

Objective
Attendees will learn which information is contained in genetic sequencing data and how to extract information from them using computational tools. The main concepts introduced are:
* stochastic models in molecular evolution
* phylogenetic & phylodynamic inference
* maximum likelihood and Bayesian statistics

Attendees will apply these concepts to a number of applications yielding biological insight into:
* epidemiology
* pathogen evolution
* macroevolution of species

Content
The course consists of four parts. We first introduce modern genetic sequencing technology, and algorithms to obtain sequence alignments from the output of the sequencers. We then present methods to directly analyze this alignment (such as BLAST algorithm, GWAS approaches). Second, we introduce mechanisms and concepts of molecular evolution, i.e. we discuss how genetic sequences change over time. Third, we employ evolutionary concepts to infer ancestral relationships between organisms based on their genetic sequences, i.e. we discuss methods to infer genealogies and phylogenies. We finally introduce the field of phyldynamics. The aim of that field is to understand and quantify the population dynamic processes (such as transmission in epidemiology or speciation & extinction in macroevolution) based on a phylogeny. Throughout the class, the models and methods are illustrated on different datasets giving insight into the epidemiology and evolution of a range of infectious diseases (e.g. HIV, HCV, influenza, Ebola). Applications of the methods to the field of macroevolution provide insight into the evolution and ecology of different species clades. Students will be trained in the algorithms and their application both on paper and in silico as part of the exercises.

Lecture notes
Slides of the lecture will be available online.
https://www.bsse.ethz.ch/cevo/education/cb-materials.html

Literature
The course is not based on any of the textbooks below, but they are excellent choices as accompanying material:
* Yang, Z. 2006. Computational Molecular Evolution.
* Drummond, A. & Bouckaert, R. 2015. Bayesian evolutionary analysis with BEAST

Prerequisites / notice
Basic knowledge in linear algebra, analysis, and statistics will be helpful. Some programming experience will be useful for the exercises, but is not required. Programming skills will not be tested in the examination.

Computational Electromagnetics

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<tr>
<td>227-2037-00L</td>
<td>Physical Modelling and Simulation</td>
<td>W</td>
<td>5</td>
<td>4G</td>
<td>C. Hafner, J. Leuthold, J. Smajic</td>
</tr>
</tbody>
</table>

Abstract
This module consists of (a) an introduction to fundamental equations of electromagnetics, mechanics, and heat transfer, (b) a detailed overview of numerical methods for field simulations, and (c) practical examples solved in form of small projects.

Objective
Basic knowledge of the fundamental equations and effects of electromagnetics, mechanics, and heat transfer. Knowledge of the main concepts of numerical methods for physical modelling and simulation. Ability (a) to develop own simple field simulation programs, (b) to select an appropriate field solver for a given problem, (c) to perform field simulations, (d) to evaluate the obtained results, and (e) to interactively improve the models until sufficiently accurate results are obtained.

Content
The module begins with an introduction to the fundamental equations and effects of electromagnetics, mechanics, and heat transfer. After the introduction follows a detailed overview of the available numerical methods for solving electromagnetic, thermal and mechanical boundary value problems. This part of the course contains a general introduction into numerical methods, differential and integral forms, linear equation systems, Finite Difference Method (FDM), Boundary Element Method (BEM), Method of Moments (MoM), Multiple Multipole Program (MMP) and Finite Element Method (FEM). The theoretical part of the course finishes with a presentation of multiphysics simulations through several practical examples of HF-engineering such as coupled electromagnetic-mechanical and electromagnetic-thermal analysis of MEMS.

In the second part of the course the students will work in small groups on practical simulation problems. For solving practical problems the students can develop and use own simulation programs or chose an appropriate commercial field solver for their specific problem. This practical simulation work of the students is supervised by the lecturers.

Data: 06.03.2019 12:57 Autumn Semester 2016 Page 1152 of 1571
Lecture notes, exercises and reference material can be downloaded from Moodle.

### Dynamic Programming and Optimal Control

**Title:** Dynamic Programming and Optimal Control  
**Type:** W  
**ECTS:** 4 credits  
**Hours:** 2V+1U  
**Lecturers:** R. D’Andrea

**Objective:**
Introduction to Dynamic Programming and Optimal Control. Covers the fundamental concepts of Dynamic Programming & Optimal Control.

**Content:**
Dynamic Programming Algorithm; Deterministic Systems and Shortest Path Problems; Infinite Horizon Problems, Bellman Equation; Deterministic Continuous-Time Optimal Control.

**Literature:**

**Prerequisites / notice:**
Requirements: Knowledge of advanced calculus, introductory probability theory, and matrix-vector algebra.

### Economics

**Title:** Resource and Environmental Economics  
**Type:** W  
**ECTS:** 3 credits  
**Hours:** 2G  
**Lecturers:** L. Bretschger, A. Brausmann

**Objective:**
Understanding of the basic issues and methods in resource and environmental economics; ability to solve typical problems in the field using the appropriate tools, which are concise verbal explanations, diagrams or mathematical expressions.

**Topics are:**
- Introduction to resource and environmental economics
- Importance of resource and environmental economics
- Main issues of resource and environmental economics
- Normative basis
- Utilitarianism
- Fairness according to Rawls
- Economic growth and environment
- Externalities in the environmental sphere
- Governmental internalisation of externalities
- Private internalisation of externalities: the Coase theorem
- Free rider problem and public goods
- Types of public policy
- Efficient level of pollution
- Tax vs. permits
- Command and Control Instruments
- Empirical data on non-renewable natural resources
- Optimal price development: the Hotelling-rule
- Effects of exploration and Backstop-technology
- Effects of different types of markets.
- Biological growth function
- Optimal depletion of renewable resources
- Social inefficiency as result of over-use of open-access resources
- Cost-benefit analysis and the environment
- Measuring environmental benefit
- Measuring costs
- Concept of sustainability
- Technological feasibility
- Conflicts sustainability / optimality
- Indicators of sustainability
- Problem of climate change
- Cost and benefit of climate change
- Climate change as international ecological externality
- International climate policy: Kyoto protocol
- Implementation of the Kyoto protocol in Switzerland

**Content:**
- Economy and natural environment, welfare concepts and market failure, external effects and public goods, measuring externalities and contingent valuation, internalising externalities; economics of non-renewable resources, economics of renewable resources, cost-benefit analysis, sustainability, and international aspects of resource and environmental economics.

**Lecture notes:**
Learning material and script can be found here: https://moodle-app2.let.ethz.ch/course/view.php?id=328

**Literature:**

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**Number:** 363-0503-00L  
**Title:** Principles of Microeconomics  
**Type:** W  
**ECTS:** 3 credits  
**Hours:** 2G  
**Lecturers:** M. Filippini

**Objective:**
The course introduces basic principles, problems and approaches of microeconomics.

- The learning objectives of the course are:
  - (1) Students must be able to discuss basic principles, problems and approaches in microeconomics. (2) Students can analyse and explain simple economic principles in a market using supply and demand graphs. (3) Students can contrast different market structures and describe firm and consumer behaviour. (4) Students can identify market failures such as externalities related to market activities and illustrate how these affect the economy as a whole. (5) Students can apply simple mathematical treatment of some basic concepts and can solve utility maximization and cost minimization problems.

**Lecture notes:**
Lecture notes, exercises and reference material can be downloaded from Moodle.

**Literature:**

- The book can also be used for the course 'Principles of Macroeconomics' (Sturm)

For students taking only the course 'Principles of Microeconomics' there is a shorter version of the same book: N. Gregory Mankiw and Mark P. Taylor (2014), "Microeconomics", 3rd edition, South-Western Cengage Learning.

**Complementary:**

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**Number:** 363-0565-00L  
**Title:** Principles of Macroeconomics  
**Type:** W  
**ECTS:** 3 credits  
**Hours:** 2V  
**Lecturers:** J.E. Sturm
This course examines the behaviour of macroeconomic variables, such as gross domestic product, unemployment and inflation rates. It tries to answer questions like: How can we explain fluctuations of national economic activity? What can economic policy do against unemployment and inflation? What significance do international economic relations have for Switzerland?

**Objective**

This lecture will introduce the fundamentals of macroeconomic theory and explain their relevance to everyday economic problems.

**Content**

This course helps you understand the world in which you live. There are many questions about the macroeconomy that might spark your curiosity. Why are living standards so meagre in many African countries? Why do some countries have high rates of inflation while others have stable prices? Why have some European countries adopted a common currency? These are just a few of the questions that this course will help you answer.

Furthermore, this course will give you a better understanding of the potential and limits of economic policy. As a voter, you help choose the policies that guide the allocation of society's resources. When deciding which policies to support, you may find yourself asking various questions about economics. What are the burdens associated with alternative forms of taxation? What are the effects of free trade with other countries? What is the best way to protect the environment? How does the government budget deficit affect the economy? These and similar questions are always on the minds of policy makers.

**Lecture notes**

The course webpage (to be found at https://moodle-app2.let.ethz.ch/course/view.php?id=2467) contains announcements, course information and lecture slides.

**Literature**


We advise you to also buy access to Aplia. This internet platform will support you in learning for this course. To save money, you should buy the book together with Aplia. This is sold as a bundle (ISBN: 978147/3715998).

Besides this textbook, the slides and lecture notes will cover the content of the lecture and the exam questions.

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### Monetary Policy

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
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<tr>
<td>363-1021-00L</td>
<td>Monetary Policy</td>
<td>W</td>
<td>3 credits</td>
<td>2V</td>
<td>J.E. Sturm, D. Kaufmann</td>
</tr>
</tbody>
</table>

**Abstract**

The main aim of this course is to analyse the goals of monetary policy and to review the instruments available to central banks in order to pursue these goals. It will focus on the transmission mechanisms of monetary policy and the differences between monetary policy rules and discretionary policy. It will also make connections between theoretical economic concepts and current real world issues.

**Objective**

This lecture will introduce the fundamentals of monetary economics and explain the working and impact of monetary policy.

**Literature**

The course will be based on chapters of:


**Prerequisites / notice**

Basic knowledge in international economics and a good background in macroeconomics. The course website can be found at: https://moodle-app2.let.ethz.ch/course/view.php?id=2457

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### Environmental Science

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<th>Lecturers</th>
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<tr>
<td>701-0535-00L</td>
<td>Environmental Soil Physics/Vadose Zone Hydrology</td>
<td>W</td>
<td>3 credits</td>
<td>2G+2U</td>
<td>D. Or</td>
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</table>

**Abstract**

The course provides theoretical and practical foundations for understanding and characterizing physical and transport properties of soils/near-surface earth materials, and quantifying hydrological processes and fluxes of mass and energy at multiple scales. Emphasis is given to land-atmosphere interactions, the role of plants on hydrological cycles, and biophysical processes in soils.

**Objective**

Students are able to:
- characterize quantitative knowledge needed to measure and parameterize structural, flow and transport properties of partially-saturated porous media,
- quantify driving forces and resulting fluxes of water, solute, and heat in soils,
- apply modern measurement methods and analytical tools for hydrological data collection
- conduct and interpret a limited number of experimental studies
- explain links between physical processes in the vadose-zone and major societal and environmental challenges
Content

Weeks 1 to 3: Physical Properties of Soils and Other Porous Media. Units and dimensions, definitions and basic mass-volume relationships between the solid, liquid and gaseous phases; soil texture; particle size distributions; surface area; soil structure. Soil colloids and clay behavior.

Soil Water Content and its Measurement - Definitions; measurement methods - gravimetric, neutron scattering, gamma attenuation; and time domain reflectometry; soil water storage and water balance.

Weeks 4 to 5: Soil Water Retention and Potential (Hydrostatics) - The energy state of soil water; total water potential and its components; properties of water (molecular, surface tension, and capillary rise); modern aspects of capillarity in porous media; units and calculations and measurement of equilibrium soil water potential components; soil water characteristic curves definitions and measurements; parametric models; hysteresis. Modern aspects of capillarity.

Demo-Lab: Laboratory methods for determination of soil water characteristic curve (SWC), sensor pairing.


Lab #1: Measurement of saturated hydraulic conductivity in uniform and layered soil columns using the constant head method.

Part 2 - Unsaturated steady state flow; unsaturated hydraulic conductivity models and applications; non-steady flow and Richards Eq.; approximate solutions to infiltration (Green-Ampt, Philip); field methods for estimating soil hydraulic properties.

Midterm exam.

Lab #2: Measurement of vertical infiltration into dry soil column - Green-Ampt, and Philip's approximations; infiltration rates and wetting front propagation.

Part 3 - Use of Hydrus model for simulation of unsaturated flow.

Week 10 to 11: Energy Balance and Land Atmosphere Interactions - Radiation and energy balance; evapotranspiration definitions and estimation; transpiration, plant development and transpiration coefficients small and large scale influences on hydrological cycle; surface evaporation.

Week 12 to 13: Solute Transport in Soils. Transport mechanisms of solutes in porous media; breakthrough curves; convection-dispersion eq.; solutions for pulse and step solute application; parameter estimation; salt balance.

Lab #3: Miscible displacement and breakthrough curves for a conservative tracer through a column; data analysis and transport parameter estimation.

Additional topics:

Temperature and Heat Flow in Porous Media - Soil thermal properties; steady state heat flow; nonsteady heat flow; estimation of thermal properties; engineering applications.

Biological Processes in the Vadose Zone An overview of below-ground biological activity (plant roots, microbial, etc.); interplay between physical and biological processes. Focus on soil-atmosphere gaseous exchange; and challenges for bio- and phytoremediation.

Lecture notes

Classnotes on website: Vadose Zone Hydrology, by Or D., J.M. Wraith, and M. Tuller (available at the beginning of the semester)

http://www.step.ethz.ch/education/active-courses/vadose-zone-hydrology

Literature

Supplemental textbook (not mandatory) - Environmental Soil Physics, by: D. Hillel

Finance

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<tr>
<th>Number</th>
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<td>401-8905-00L</td>
<td>Financial Engineering (University of Zurich)</td>
<td>W</td>
<td>4.5 credits</td>
<td>3G</td>
<td>University lecturers</td>
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<td>corresponding module directly at UZH. UZH Module</td>
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<td><a href="http://www.uzh.ch/studies/application/mobilitaet_en.html">http://www.uzh.ch/studies/application/mobilitaet_en.html</a></td>
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<tr>
<td>Abstract</td>
<td>This lecture is intended for students who would like</td>
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<td></td>
<td>to learn more on equity derivatives modelling and pricing.</td>
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<tr>
<td>Objective</td>
<td>Quantitative models for European option pricing (including stochastic volatility and jump models), volatility and variance derivatives, American and exotic options.</td>
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<td>Content</td>
<td>After introducing fundamental concepts of mathe</td>
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<td>matical finance including no-arbitrage, portfolio</td>
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<td>replication and risk-neutral measure, we will present the principal models that can be used for pricing and hedging European options e.g. Black-Scholes model, stochastic and jump-diffusion models, and highlight their assumptions and limitations. We will cover several types of derivatives such as American and European options, Barrier options and Variance-Swaps. Basic knowledge in probability theory and stochastic calculus is required. Besides attending class, we strongly encourage students to stay informed on financial matters, especially by reading daily financial newspapers such as the Financial Times or the Wall Street Journal.</td>
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<tr>
<td>Lecture notes</td>
<td>Script.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Basic knowledge of probability theory and stochastic calculus. Asset Pricing.</td>
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<tr>
<td>401-8913-00L</td>
<td>Advanced Corporate Finance I (University of Zurich)</td>
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<td>6 credits</td>
<td>4G</td>
<td>University lecturers</td>
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Image Processing and Computer Vision

<table>
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<tr>
<td>227-0447-00L</td>
<td>Image Analysis and Computer Vision</td>
<td>W</td>
<td>6</td>
<td>3V+1U</td>
<td>L. Van Gool, O. Göksel, E. Konukoglu</td>
</tr>
</tbody>
</table>

Abstract

Objective
Overview of the most important concepts of image formation, perception and analysis, and Computer Vision. Gaining own experience through practical computer and programming exercises.

Content
The first part of the course starts off from an overview of existing and emerging applications that need computer vision. It shows that the realm of image processing is no longer restricted to the factory floor, but is entering several fields of our daily life. First it is investigated how the parameters of the electromagnetic waves are related to our perception. Also the interaction of light with matter is considered. The most important hardware components of technical vision systems, such as cameras, optical devices and illumination sources are discussed. The course then turns to the steps that are necessary to arrive at the discrete images that serve as input to algorithms. The next part describes necessary preprocessing steps of image analysis, that enhance image quality and/or detect specific features. Linear and non-linear filters are introduced for that purpose. The course will continue by analyzing procedures allowing to extract additional types of basic information from multiple images, with motion and depth as two important examples. The estimation of image velocities (optical flow) will get due attention and methods for object tracking will be presented. Several techniques are discussed to extract three-dimensional information about objects and scenes. Finally, approaches for the recognition of specific objects as well as object classes will be discussed and analyzed.

Information and Communication Technology

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<tr>
<th>Number</th>
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<th>Lecturers</th>
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<td>227-0427-00L</td>
<td>Signal and Information Processing: Modeling, Filtering, Learning</td>
<td>W</td>
<td>6</td>
<td>4G</td>
<td>H.A. Loeliger</td>
</tr>
</tbody>
</table>

Abstract
Fundamentals in signal processing, detection/estimation, and machine learning
I. Linear signal representation and approximation: Hilbert spaces, LMMSE estimation, regularization and sparsity.

Objective
The course is an introduction to some basic topics in signal processing, detection/estimation theory, and machine learning.

Content

Lecture notes
Lecture notes.

Prerequisites / notice
- local bachelors: course "Discrete-Time and Statistical Signal Processing" (5. Sem.)
- others: solid basics in linear algebra and probability theory.
The course introduces some fundamental topics of digital signal processing with a bias towards applications in communications: discrete-time linear filters, equalization, DFT, discrete-time stochastic processes, elements of detection theory and estimation theory, LMMSE estimation and LMMSE filtering, LMS algorithm, Viterbi algorithm.

Objective: The course introduces some fundamental topics of digital signal processing with a bias towards applications in communications. The two main themes are linearity and probability. In the first part of the course, we deepen our understanding of discrete-time linear filters. In the second part of the course, we review the basics of probability theory and discrete-time stochastic processes. We then discuss some basic concepts of detection theory and estimation theory, as well as some practical methods including LMMSE estimation and LMMSE filtering, the LMS algorithm, and the Viterbi algorithm. A recurrent theme throughout the course is the stable and robust "inversion" of a linear filter.

Content: 1. Discrete-time linear systems and filters: state-space realizations, z-transform and spectrum, decimation and interpolation, digital filter design, stable realizations and robust inversion. 2. The discrete Fourier transform and its use for digital filtering. 3. The statistical perspective: probability, random variables, discrete-time stochastic processes; detection and estimation: MAP, ML, Bayesian MMSE, LMMSE; Wiener filter, LMS adaptive filter, Viterbi algorithm.

Lecture notes: Lecture Notes.

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<tr>
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<tr>
<td>529-0003-00L</td>
<td>Advanced Quantum Chemistry</td>
<td>W</td>
<td>7</td>
<td>3G</td>
<td>M. Reiher, S. Knecht</td>
</tr>
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</table>

Abstract: Advanced, but fundamental topics central to the understanding of theory in chemistry and for solving actual chemical problems with a computer.

Examples are:
* Operators derived from principles of relativistic quantum mechanics
* Relativistic effects + methods of relativistic quantum chemistry
* Open-shell molecules + spin-density functional theory
* New electron-correlation theories
Objective
The aim of the course is to provide an in-depth knowledge of theory and method development in theoretical chemistry. It will be shown that this is necessary in order to be able to solve actual chemical problems on a computer with quantum chemical methods.

The relativistic re-derivation of all concepts known from (nonrelativistic) quantum mechanics and quantum chemistry lectures will finally explain the form of all operators in the molecular Hamiltonian - usually postulated rather than deduced. From this, we derive operators needed for molecular spectroscopy (like those required by magnetic resonance spectroscopy). Implications of other assumptions in standard non-relativistic quantum chemistry shall be analyzed and understood, too. Examples are the Born-Oppenheimer approximation and the expansion of the electronic wave function in a set of pre-defined many-electron basis functions (Slater determinants). Overcoming these concepts, which are so natural to the theory of chemistry, will provide deeper insights into many-particle quantum mechanics. Also revisiting the workhorse of quantum chemistry, namely density functional theory, with an emphasis on open-shell electronic structures (radicals, transition-metal complexes) will contribute to this endeavor. It will be shown how these insights allow us to make more accurate predictions in chemistry in practice - at the frontier of research in theoretical chemistry.

Content
1) Introductory lecture: basics of quantum mechanics and quantum chemistry
2) Einstein's special theory of relativity and the (classical) electromagnetic interaction of two charged particles
3) Klein-Gordon and Dirac equation; the Dirac hydrogen atom
4) Numerical methods based on the Dirac-Fock-Coulomb Hamiltonian, two-component and scalar relativistic Hamiltonians
5) Response theory and molecular properties, derivation of property operators, Breit-Pauli-Hamiltonian
6) Relativistic effects in chemistry and the emergence of spin
7) Spin in density functional theory
8) New electron-correlation theories: Tensor network and matrix product states, the density matrix renormalization group
9) Quantum chemistry without the Born-Oppenheimer approximation

Lecture notes
A set of detailed lecture notes will be provided, which will cover the whole course.

Literature
2) F. Schwabl: Quantenmechanik für Fortgeschrittene (QM II), Springer-Verlag, 1997
3) R. McWeeny: Methods of Molecular Quantum Mechanics, Academic Press, 1992
http://pubs.rsc.org/en/Content/ArticleLanding/2011/CP/c1cp01863d
http://pra.aps.org/abstract/PRA/v83/i5/e052512

Note also the standard textbooks:
A) N. Szabo, N.S. Ostlund, Verlag, Dover Publications
B) I. N. Levine, Quantum Chemistry, Pearson

Prerequisites / notice
Strongly recommended (preparatory) courses are: quantum mechanics and quantum chemistry

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### Simulation of Semiconductor Devices

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<th>Lecturers</th>
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<tr>
<td>227-0157-00L</td>
<td>Semiconductor Devices: Physical Bases and Simulation</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>A. Schenk</td>
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**Abstract**
The course addresses the physical principles of modern semiconductor devices and the foundations of their modeling and numerical simulation. Necessary basic knowledge on quantum-mechanics, semiconductor physics and device physics is provided. Computer simulations of the most important devices and of interesting physical effects supplement the lectures.

**Objective**
The course aims at the understanding of the principle physics of modern semiconductor devices, of the foundations in the physical modeling of transport and its numerical simulation. During the course also basic knowledge on quantum-mechanics, semiconductor physics and device physics is provided.

**Content**
The main topics are: transport models for semiconductor devices (quantum transport, Boltzmann equation, drift-diffusion model), hydrodynamic model, physical characterization of silicon (intrinsic properties, scattering processes), mobility of cold and hot carriers, recombination (Shockley-Read-Hall statistics, Auger recombination), impact ionization, metal-semiconductor contact, metal-insulator-semiconductor structure, and heterojunctions.

The exercises are focussed on the theory and the basic understanding of the operation of special devices, as single-electron transistor, resonant tunneling diode, pn-diode, bipolar transistor, MOSFET, and laser. Numerical simulations of such devices are performed with an advanced simulation package (Sentaurus-Synopsys). This enables to understand the physical effects by means of computer experiments.

**Lecture notes**

**Literature**
The script (in book style) is sufficient. Further reading will be recommended in the lecture.

**Prerequisites / notice**

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### Systems Design

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<tr>
<td>363-0541-00L</td>
<td>Systems Dynamics and Complexity</td>
<td>W</td>
<td>3</td>
<td>3G</td>
<td>F. Schweitzer, G. Casiraghi, V. Narumyan</td>
</tr>
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</table>

**Abstract**
Finding solutions: what is complexity, problem solving cycle.

Implementing solutions: project management, critical path method, quality control feedback loop.

Controlling solutions: Vensim software, feedback cycles, control parameters, instabilities, chaos, oscillations and cycles, supply and demand, production functions, investment and consumption

**Objective**
A successful participant of the course is able to:
- understand why most real problems are not simple, but require solution methods that go beyond algorithmic and mathematical approaches
- apply the problem solving cycle as a systematic approach to identify problems and their solutions
- calculate project schedules according to the critical path method
- setup and run systems dynamics models by means of the Vensim software
- identify feedback cycles and reasons for unintended systems behavior
- analyse the stability of nonlinear dynamical systems and apply this to macroeconomic dynamics

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Why are problems not simple? Why do some systems behave in an unintended way? How can we model and control their dynamics? The course provides answers to these questions by using a broad range of methods encompassing systems oriented management, classical systems dynamics, nonlinear dynamics and macroeconomic modeling.

The course is structured along three main tasks:
1. Finding solutions
2. Implementing solutions
3. Controlling solutions

PART 1 introduces complexity as a system immanent property that cannot be simplified. It introduces the problem solving cycle, used in systems oriented management, as an approach to structure problems and to find solutions.

PART 2 discusses selected problems of project management when implementing solutions. Methods for identifying the critical path of subtasks in a project and for calculating the allocation of resources are provided. The role of quality control as an additional feedback loop and the consequences of small changes are discussed.

PART 3, by far the largest part of the course, provides more insight into the dynamics of existing systems. Examples come from biology (population dynamics), management (inventory modeling, technology adoption, production systems) and economics (supply and demand, investment and consumption). For systems dynamics models, the software program VENSIM is used to evaluate the dynamics. For economic models analytical approaches, also used in nonlinear dynamics and control theory, are applied. These together provide a systematic understanding of the role of feedback loops and instabilities in the dynamics of systems. Emphasis is on oscillating phenomena, such as business cycles and other life cycles.

Lecture notes
Weekly self-study tasks are used to apply the concepts introduced in the lectures and to come to grips with the software program VENSIM. The lecture slides are provided as handouts - including notes and literature sources - to registered students only. All material is to be found on the Moodle platform. More details during the first lecture.

Prerequisites / notice
Self-study tasks (discussion exercises, Vensim exercises), are provided as home work. Weekly exercise sessions (45 min) are used to discuss selected solutions. Regular participation in the exercises is an efficient way to understand the concepts relevant for the final exam.

Theoretical Physics

In the Master's programme in Applied Mathematics 402-0205-00L Quantum Mechanics I is eligible as a course unit in the application area Theoretical Physics. but only if 402-0234-00L Theoretical Physics wasn't or isn't recognised for credits (neither in the Bachelor's nor in the Master's programme).

For the category assignment take contact with the Study Administration Office (www.math.ethz.ch/studiensekreterat) after having received the credits.

Number Title Type ECTS Hours Lecturers
402-0809-00L Introduction to Computational Physics W 8 credits 2V+2U H. J. Herrmann

Abstract
This course offers an introduction to computer simulation methods for physics problems and their implementation on PCs and super computers: classical equations of motion, partial differential equations (wave equation, diffusion equation, Maxwell's equation), Monte Carlo simulations, percolation, phase transitions

Content

Lecture notes
Lecture notes are available in german, exams in English or in German.

402-2203-01L Classical Mechanics W 7 credits 4V+2U G. M. Graf

Abstract
A conceptual introduction to theoretical physics: Newtonian mechanics, central force problem, oscillations, Lagrangian mechanics, symmetries and conservation laws, spinning top, relativistic space-time structure, particles in an electromagnetic field, Hamiltonian mechanics, canonical transformations, integrable systems, Hamilton-Jacobi equation.

402-0861-00L Statistical Physics W 10 credits 4V+2U G. Blatter

Abstract
This lecture covers the concepts of classical and quantum statistical physics, and some aspects of kinetic gas theory and hydrodynamics. In a more advanced part degenerate Fermions, Bose-Einstein condensation, real Bose gases, magnetism, general mean field theory and critical phenomena will be addressed.

Content

Lecture notes
Lecture notes available in german.

402-0843-00L Quantum Field Theory I W 10 credits 4V+2U C. Anastasiou

Abstract
This course discusses the quantisation of fields in order to introduce a coherent formalism for the combination of quantum mechanics and special relativity. Topics include:
- Relativistic quantum mechanics
- Quantisation of bosonic and fermionic fields
- Interactions in perturbation theory
- Scattering processes and decays
- Radiative corrections

Objective
The goal of this course is to provide a solid introduction to the formalism, the techniques, and important physical applications of quantum field theory. Furthermore it prepares students for the advanced course in quantum field theory (Quantum Field Theory II), and for work on research projects in theoretical physics, particle physics, and condensed-matter physics.

402-0830-00L General Relativity W 10 credits 4V+2U P. Jetzer

Abstract
This lecture gives an introduction in the basic concepts and applications of statistical physics for the general use in physics and, in particular, as a preparation for the theoretical solid state physics education.

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<td>Introduction to Computational Physics</td>
<td>W</td>
<td>8 credits</td>
<td>2V+2U</td>
<td>H. J. Herrmann</td>
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<tr>
<td>402-2203-01L</td>
<td>Classical Mechanics</td>
<td>W</td>
<td>7 credits</td>
<td>4V+2U</td>
<td>G. M. Graf</td>
</tr>
<tr>
<td>402-0861-00L</td>
<td>Statistical Physics</td>
<td>W</td>
<td>10 credits</td>
<td>4V+2U</td>
<td>G. Blatter</td>
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<tr>
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<td>Quantum Field Theory I</td>
<td>W</td>
<td>10 credits</td>
<td>4V+2U</td>
<td>C. Anastasiou</td>
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<tr>
<td>402-0830-00L</td>
<td>General Relativity</td>
<td>W</td>
<td>10 credits</td>
<td>4V+2U</td>
<td>P. Jetzer</td>
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**Abstract**

Manifold, Riemannian metric, connection, curvature; Special Relativity; Lorentzian metric; Equivalence principle; Tidal force and spacetime curvature; Energy-momentum tensor, field equations, Newtonian limit; Post-Newtonian approximation; Schwarzschild solution; Mercury's perihelion precession, light deflection.

**Objective**

Basic understanding of general relativity, its mathematical foundations, and some of the interesting phenomena it predicts.

**Literature**

Suggested textbooks:

- C. Misner, K. Thorne and J. Wheeler: Gravitation
- S. Carroll - Spacetime and Geometry: An Introduction to General Relativity
- R. Wald - General Relativity
- S. Weinberg - Gravitation and Cosmology
- N. Straumann - General Relativity with applications to Astrophysics

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**Elections Theoretical Physics**

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**Transportation Science**

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<td>101-0417-00L</td>
<td>Transport Planning Methods</td>
<td>W</td>
<td>6</td>
<td>4G</td>
<td>K. W. Axhausen</td>
</tr>
</tbody>
</table>

**Abstract**

The course provides the necessary knowledge to develop models supporting the solution of given planning problems. This is done by dividing the forecasting problem into sub-problems.

The course is composed of a lecture part, providing the theoretical knowledge, and a applied part, in which students develop their own models.

- Knowledge of methods and algorithms commonly used in transport planning
- Ability to independently develop a transport model able to solve / answer the given problem / questions
- Understanding of algorithms and their implementations commonly used in transport planning

**Content**

The course provides the necessary knowledge to develop models supporting the solution of given planning problems. Examples of such planning problems are the estimation of traffic volumes, prediction of estimated utilization of new public transport lines, and evaluation of effects (e.g. change in emissions of a city) triggered by building new infrastructure and changes to operational regulations.

To cope with the forecasting problem it is first divided into sub-problems. Then, these are solved using various algorithms like iterative proportional fitting, shortest path algorithms and the method of successive averages.

The course is composed of a lecture part, providing the theoretical knowledge, and a applied part, in which students create their own models. This part takes place in form of a tutorial and consists in the development of a computer program. The programming part is closely guided and particularly suitable for students with little programming experience.

**Lecture notes**

The slides of the lecture are provided electronically.

**Literature**


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**Seminars and Semester Papers**

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**Seminars**

Early enrolments for seminars in myStudies are encouraged, so that we will recognize need for additional seminars in a timely manner. Some seminars have waiting lists. Nevertheless, register for at most two mathematics seminars. In this case, you express a stronger preference for the seminar for which you register earlier.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-4580-66L</td>
<td>Characteristic Classes and Elliptic Genus</td>
<td>W</td>
<td>4</td>
<td>2S</td>
<td>Q. Chen, G. Felder</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>Characteristic classes, spin structures and Dirac operator, applications of the Atiyah-Singer index theorem, elliptic genus and modular forms.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>Tentative Syllabus</td>
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</tr>
<tr>
<td><strong>Content</strong></td>
<td>1. Vector bundles and differential forms (1 lectures)</td>
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<tr>
<td></td>
<td>2. Basics for Characteristic classes such as Stiefel-Whitney classes, Wu Classes, Chern Classes and Pontryagin classes (3 lectures)</td>
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<tr>
<td></td>
<td>3. Spin structures and Dirac operators (2 lectures)</td>
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<tr>
<td></td>
<td>4. Atiyah-Singer Index theorem and its application (1-2 lectures)</td>
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<td></td>
<td>5. Multiplicative sequences and various genera (1 lecture)</td>
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<td></td>
<td>6. Elliptic genus and modular forms (1 lecture)</td>
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<td></td>
<td>7. Miraculous cancellation formulas for Hirzebruch L genus (1 lecture)</td>
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<tr>
<td></td>
<td>8. Miscellaneous topics (1 lecture)</td>
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<tr>
<td><strong>Literature</strong></td>
<td>1. Characteristic Classes by Milnor</td>
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<tr>
<td></td>
<td>2. Differential Forms in Algebraic Topology by Bott &amp; Tu</td>
<td></td>
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<tr>
<td></td>
<td>3. Manifolds and Modular Forms by Hirzebruch, Berger and Jung</td>
<td></td>
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<tr>
<td><strong>Prerequisites / notice</strong></td>
<td>Prerequisite: Algebraic Topology.</td>
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</tbody>
</table>

| 401-3570-66L | Algebraic Number Theory | W    | 4    | 2S    | J. Fresán |
| **Abstract** | Much of the progress in algebraic number theory aims at solving concrete Diophantine equations. At the heart of the problem lies the fact that the ring of integers of a number field does not have unique factorization. The "class group" measures how much this property fails. The seminar will present basic results around this invariant, including finiteness and the relation to zeta functions. |

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Data: 06.03.2019 12:57  Autumn Semester 2016  Page 1160 of 1571
The following topics will be covered:
- The quadratic reciprocity law
- The geometry of numbers
- Integral quadratic forms
- Number fields and rings of integers
- Finiteness of the class number
- Unique factorization of ideals
- The Dedekind zeta function of a number field and the class number formula

The seminar will be (probably) followed by a more advanced course on Class Field Theory on the Spring Semester.

Our basic reference will be chapters I and VII of Neukirch's book "Algebraic number theory" (Grundlehren Math. Wiss. 322. Springer-Verlag, Berlin, 1999). Additional references will be given at the beginning of the seminar.

Basic knowledge of algebraic structures (groups, rings, fields) and Galois theory, at the level of Algebra I and II. More advanced topics will be explained when needed.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
<th>Semester</th>
<th>Instructor(s)</th>
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<tbody>
<tr>
<td>401-3180-66L</td>
<td>Homological Algebra</td>
<td>4</td>
<td>2S</td>
<td>C. Busch</td>
</tr>
<tr>
<td>401-4600-66L</td>
<td>Student Seminar in Probability</td>
<td>4</td>
<td>2S</td>
<td>A.S. Sznitman, J. Bertoin, P. Nolin, W. Werner</td>
</tr>
<tr>
<td>401-3640-66L</td>
<td>Monte Carlo and Quasi-Monte Carlo Methods</td>
<td>4</td>
<td>2S</td>
<td>C. Schwab</td>
</tr>
</tbody>
</table>

Prerequisites / notice
The seminar covers measure theoretic tools used for the analysis and approximation of nonlinear hyperbolic partial differential equations.

The student seminar in probability is held at times at the undergraduate level (typically during the spring term) and at times at the graduate level (typically during the autumn term). The themes vary each semester.

The number of participants to the seminar is limited. Registration to the seminar will only be effective once confirmed by email from the organizers.

Prerequisites:
- Good knowledge of real/functional analysis required, knowledge of hyperbolic partial differential equations and/or numerical analysis of PDEs.

Literature
- J. M. Ball. A version of the fundamental theorem for Young measures (1989).

The seminar is centered around a topic in probability theory which changes each semester.

The seminar covers measure theoretic tools for the analysis and approximation of nonlinear PDEs. In particular, we will discuss Young measures, compensated compactness, weak-strong uniqueness and algorithms for the approximation of measure-valued solutions. The participants will present individual topics based on the study of research papers.

Objectives
- To read and understand a research paper and present it in an understandable way to other students.
- To learn some measure theoretic tools for the analysis and approximation of nonlinear PDEs.

Content
Partial differential equations can be used to model an abundance of natural and physical phenomena, as well as industrial processes. Many of the more sophisticated and more realistic models involve nonlinear PDEs, among others, PDEs in fluid dynamics, astrophysics, elasticity or weather modeling. The solutions to these often exhibit complex structures, such as shocks, oscillations, singularities that are difficult to deal with mathematically and numerically. In our seminar we aim to get a better understanding of the difficulties that arise when dealing with nonlinear PDEs. In particular, we will discuss problems related to the PDEs of fluid dynamics. Solutions to these equations may exhibit shocks and oscillations, and have less regularity than what the definition of a classical solution requires. Therefore, the solution concept has to be relaxed. One way of doing this, is to look for solutions in the space of measures instead of actual functions. Our goal in this seminar is to try to understand this concept better by studying research papers related to this issue. Specifically, we will discuss weak convergence in general, the notion of Young measures as a means to represent weak limits of nonlinear functions, and its application to compensated compactness, existence of solutions to scalar hyperbolic conservation laws, Euler equations, turbulence and statistical solutions of Navier-Stokes equations. We will also discuss algorithms to approximate solutions in the space of measures.

We are open to extend the list of topics by others that are of special interests to the attending students.

J. M. Ball. A version of the fundamental theorem for Young measures (1989).
We first present and analyze toy models of Mean Field Games in order to familiarize with the subject and to understand what kind of problems can be solved with this theory.

We explore two different approaches to Mean Field Games. From an analytic point of view it consists of a coupled system of PDEs. From a probabilistic point of view it amounts to a particular type of stochastic differential equations.

We recall some basic principles of optimal control theory and stochastic differential equations.

There are several course units "Semester Paper" that are all equivalent. If, during your studies, you write several semester papers, choose among the different numbers in order to be able to obtain credits again.

Semester Papers

There are several course units "Semester Paper" that are all equivalent. If, during your studies, you write several semester papers, choose among the different numbers in order to be able to obtain credits again.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
</table>
| 401-3750-01L | Semester Paper I  
No direct enrolment to this course unit in myStudies. Please fill in the online application form. Requirements and application form under www.math.ethz.ch/intranet/students/study-administration/theses.html (Afterwards the enrolment will be done by the Study Administration.) | W     | 8 credits | 11A    | Professors |

Semester Papers help to deepen the students' knowledge of a specific subject area. Students are offered a selection of topics. These papers serve to develop the students' ability for independent mathematical work as well as to enhance skills in presenting mathematical results in writing.

Prerequisites / notice

There are several course units "Semester Paper" that are all equivalent. If, during your studies, you write several semester papers, choose among the different numbers in order to be able to obtain credits again.

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
</table>
| 401-3750-02L | Semester Paper II  
No direct enrolment to this course unit in myStudies. Please fill in the online application form. Requirements and application form under www.math.ethz.ch/intranet/students/study-administration/theses.html (Afterwards the enrolment will be done by the Study Administration.) | W     | 8 credits | 11A    | Professors |

Semester Papers help to deepen the students' knowledge of a specific subject area. Students are offered a selection of topics. These papers serve to develop the students' ability for independent mathematical work as well as to enhance skills in presenting mathematical results in writing.

Prerequisites / notice

There are several course units "Semester Paper" that are all equivalent. If, during your studies, you write several semester papers, choose among the different numbers in order to be able to obtain credits again.

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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</table>
| 401-3750-03L | Semester Paper III  
No direct enrolment to this course unit in myStudies. Please fill in the online application form. Requirements and application form under www.math.ethz.ch/intranet/students/study-administration/theses.html (Afterwards the enrolment will be done by the Study Administration.) | W     | 8 credits | 11A    | Professors |

Semester Papers help to deepen the students' knowledge of a specific subject area. Students are offered a selection of topics. These papers serve to develop the students' ability for independent mathematical work as well as to enhance skills in presenting mathematical results in writing.

Prerequisites / notice

There are several course units "Semester Paper" that are all equivalent. If, during your studies, you write several semester papers, choose among the different numbers in order to be able to obtain credits again.

GESS Science in Perspective

Recommended Science in Perspective (Type B) for D-MATH.

see Science in Perspective: Type A: Enhancement of Reflection Capability

see Science in Perspective: Language Courses ETH/UZH

Master's Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
</table>
| 401-2000-00L | Scientific Works in Mathematics  
Target audience: Third year Bachelor students: Master students who cannot document to have received an adequate training in working scientifically. | O     | 0 credits |       | E. Kowalski |
Mandatory for all Bachelor and Master students with matriculation in the autumn semester 2014 or later.


Abstract
Introduction to scientific writing for students with focus on publication standards and ethical issues, especially in the case of citations (references to works of others.)

Objective
Learn the basic standards of scientific works in mathematics.

Content
- Types of mathematical works
- Publication standards in pure and applied mathematics
- Data handling
- Ethical issues
- Citation guidelines

Lecture notes
Moodle of the Mathematics Library: https://moodle-app2.let.ethz.ch/course/view.php?id=519

Prerequisites / notice
This course is completed by the optional course "Recherchieren in der Mathematik" (held in German) by the Mathematics Library. For more details see: http://www.math.ethz.ch/library/services/schulungen

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-4990-00L</td>
<td>Master's Thesis</td>
<td>O</td>
<td>30</td>
<td>57D</td>
<td>Professors</td>
</tr>
</tbody>
</table>
|             | Only students who fulfill the following criteria are allowed to begin with their master's thesis:  
|             | a. successful completion of the bachelor programme;  
|             | b. fulfilling of any additional requirements necessary to gain admission to the master programme.  
|             | No direct enrolment to this course unit in myStudies.  
|             | Please fill in the online application form.  
|             | Requirements and application form under  
|             | www.math.ethz.ch/intranet/students/study-administration/theses.html  
|             | (Afterwards the enrolment will be done by the Study Administration.)  
|             | The master's thesis concludes the study programme. Writing up the master's thesis allows students to independently produce a major piece of work on a mathematical topic. It generally involves consulting the literature, solving any ensuing problems, and putting together the results in writing. |

Additional Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-5000-00L</td>
<td>Zurich Colloquium in Mathematics</td>
<td>E-</td>
<td>0</td>
<td></td>
<td>W. Werner, P. L. Bühlmann, M. Burger, S. Mishra, R. Pandharipande, University lecturers</td>
</tr>
<tr>
<td>401-5990-00L</td>
<td>Zurich Graduate Colloquium (University of Zurich)</td>
<td>E-</td>
<td>0</td>
<td>1K</td>
<td>University lecturers</td>
</tr>
</tbody>
</table>
|             | No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.  
|             | UZH Module Code: MAT075  
|             | Mind the enrolment deadlines at UZH:  
|             | http://www.uzh.ch/studies/application/mobilitaet_en.html |
|             | The Graduate Colloquium is an informal seminar aimed at graduate students and postdocs whose purpose is to provide a forum for communicating one's interests and thoughts in mathematics. |
| 401-5350-00L| Analysis Seminar                                      | E-   | 0    | 1K    | M. Struwe, A. Carolatto, D. Christodoulou, F. Da Lio, A. Figalli, N. Hungerbühler, T. Ilmanen, T. Kappeler, T. Rivière, D. A. Salamon |
| 401-5530-00L| Geometry Seminar                                      | E-   | 0    | 1K    | M. Burger, M. Einsiedler, U. Lang, University lecturers |
| 401-5580-00L| Symplectic Geometry Seminar                          | E-   | 0    | 2K    | D. A. Salamon, P. Biran, A. Cannas da Silva |
| 401-5330-00L| Talks in Mathematical Physics                         | E-   | 0    | 1K    | A. Cattaneo, G. Felder, M. Gaberdiel, G. M. Graf, H. Knörrer, T. H. Willwacher, University lecturers |
| 401-5600-00L| Seminar on Stochastic Processes                       | E-   | 0    | 1K    | J. Bertoin, A. Nikeghbali, P. Nolin, B. D. Schlein, A.S. Sznitman, W. Werner |

Data: 06.03.2019 12:57  Autumn Semester 2016  Page 1163 of 1571
Research Seminar on Statistics  
**Objective**: Expose graduate students to ongoing research activities (including applications) in the domain of optimization.  
**Content**: Lectures on current topics in optimization.  
**Abstract**: About 5 talks on applied statistics.  
**Prerequisites**: None.  
**Large**: 0 credits  
**Lecturers**: P. Cheridito, M. Schweizer, M. Soner, J. Teichmann, M. V. Wüthrich

ZüKoSt: Seminar on Applied Statistics  
**Objective**: Expose graduate students to ongoing research activities (including applications) in the domain of optimization.  
**Content**: See how statistical methods are applied in practice.  
**Abstract**: About 5 talks on applied statistics.  
**Prerequisites**: None.  
**Large**: 0 credits  
**Lecturers**: P. Cheridito, M. Schweizer, M. Soner, J. Teichmann, M. V. Wüthrich

Talks in Financial and Insurance Mathematics  
**Objective**: Expose graduate students to ongoing research activities (including applications) in the domain of optimization.  
**Content**: See how statistical methods are applied in practice.  
**Abstract**: About 5 talks on applied statistics.  
**Prerequisites**: None.  
**Large**: 0 credits  
**Lecturers**: P. Cheridito, M. Schweizer, M. Soner, J. Teichmann, M. V. Wüthrich

Optimization Seminar  
**Objective**: Expose graduate students to ongoing research activities (including applications) in the domain of optimization.  
**Content**: Lectures on current topics in optimization.  
**Abstract**: About 5 talks on applied statistics.  
**Prerequisites**: None.  
**Large**: 0 credits  
**Lecturers**: R. Weismantel, R. Zenklusen

Colloquium on Mathematics, Computer Science, and Education  
**Objective**: Expose graduate students to ongoing research activities (including applications) in the domain of optimization.  
**Content**: Didactics colloquium.  
**Abstract**: Didactics colloquium.  
**Prerequisites**: None.  
**Large**: 0 credits  
**Lecturers**: N. Hungerbühler, M. Akveld, J. Hromkovic, H. Klemenz

The Zurich Physics Colloquium  
**Objective**: The Zurich Physics Colloquium is jointly organized by the University of Zurich and ETH Zurich. Its mission is to bring both students and faculty with diverse interests in theoretical physics together. Leading experts explain the basic questions in their field of research and communicate the fascination for their work.  
**Content**: Occasionally, talks may be delivered in German.  
**Abstract**: Research colloquium.  
**Prerequisites**: None.  
**Large**: 0 credits  

The Zurich Theoretical Physics Colloquium  
**Objective**: The Zurich Theoretical Physics Colloquium is jointly organized by the University of Zurich and ETH Zurich. Its mission is to bring both students and faculty with diverse interests in theoretical physics together. Leading experts explain the basic questions in their field of research and communicate the fascination for their work.  
**Content**: Occasionally, talks may be delivered in German.  
**Abstract**: Research colloquium.  
**Prerequisites**: None.  
**Large**: 0 credits  

Computer Science Colloquium  
**Objective**: Invited talks, covering the entire scope of computer science. External Listeners are welcome at no charge. A detailed schedule is published at the beginning of each semester.  
**Content**: Talk at the end of each year.  
**Abstract**: Research colloquium.  
**Prerequisites**: None.  
**Large**: 0 credits  
**Lecturers**: Lecturers

Seminar in Theoretical Computer Science  
**Objective**: Presentation of recent publications in theoretical computer science, including results by diploma, masters and doctoral candidates.  
**Content**: Talk at the end of each year.  
**Abstract**: Research colloquium.  
**Prerequisites**: None.  
**Large**: 2 credits  
**Lecturers**: E. Welzl, B. Gärtner, M. Hoffmann, J. Lengler, A. Steger, B. Sudakov

**Course Units for Additional Admission Requirements**

The courses below are only available for MSc students with additional admission requirements.
<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Lecturers</th>
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<tr>
<td>406-2004-AAL</td>
<td>Algebra II</td>
<td>E-</td>
<td>5</td>
<td>11</td>
<td>R. Pink</td>
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<tr>
<td></td>
<td>Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement. Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<tr>
<td></td>
<td>Galois theory and Representations of finite groups, algebras.</td>
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<tr>
<td></td>
<td><strong>Objective</strong></td>
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<tr>
<td></td>
<td>Introduction to fundamentals of Galois theory, and representation theory of finite groups and algebras</td>
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<tr>
<td></td>
<td><strong>Content</strong></td>
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<tr>
<td></td>
<td>Fundamentals of Galois theory</td>
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<td></td>
<td>Representation theory of finite groups and algebras</td>
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<td></td>
<td><strong>Lecture notes</strong></td>
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<td></td>
<td>For a summary of the content and exercises with solutions of my lecture course in FS2016 see: <a href="https://www2.math.ethz.ch/education/bachelor/lectures/fs2016/math/algebra2/">https://www2.math.ethz.ch/education/bachelor/lectures/fs2016/math/algebra2/</a></td>
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<td><strong>Literature</strong></td>
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<tr>
<td></td>
<td>S. Lang, Algebra, Springer Verlag</td>
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<td></td>
<td>B.L. van der Waerden: Algebra I and II, Springer Verlag</td>
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<td></td>
<td>I.R. Shafarevich, Basic notions of algebra, Springer verlag</td>
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<td></td>
<td>G. Mislin: Algebra I, vdf Hochschulverlag</td>
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<td></td>
<td>U. Stammbach: Algebra, in der Polybuchhandlung erhältlich</td>
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<td></td>
<td>G. Wüstholz, Algebra, vieweg-Verlag, 2004</td>
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<td></td>
<td>J-P. Serre, Linear representations of finite groups, Springer Verlag</td>
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<td></td>
<td><strong>Prerequisites / notice</strong></td>
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<tr>
<td></td>
<td>Algebra I</td>
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<tr>
<td>406-2005-AAL</td>
<td>Algebra I and II</td>
<td>E-</td>
<td>12</td>
<td>26</td>
<td>R. Pink</td>
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<td>Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement. Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.</td>
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<td><strong>Abstract</strong></td>
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<td></td>
<td>Introduction and development of some basic algebraic structures - groups, rings, fields including Galois theory, representations of finite groups, algebras.</td>
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<td></td>
<td>Basic notions and examples of groups; Subgroups, Quotient groups and Homomorphisms, Group actions and applications</td>
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<td>Basic notions and examples of rings; Ring Homomorphisms, ideals, and quotient rings, rings of fractions</td>
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<td>Euclidean domains, Principal ideal domains, Unique factorization domains</td>
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<td>Basic notions and examples of fields; Field extensions, Algebraic extensions, Classical straight edge and compass constructions</td>
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<td>Fundamentals of Galois theory</td>
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<td>Representation theory of finite groups and algebras</td>
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<td>S. Lang, Algebra, Springer Verlag</td>
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<td>B.L. van der Waerden: Algebra I and II, Springer Verlag</td>
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<td>I.R. Shafarevich, Basic notions of algebra, Springer verlag</td>
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<td>G. Mislin: Algebra I, vdf Hochschulverlag</td>
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<td>U. Stammbach: Algebra, in der Polybuchhandlung erhältlich</td>
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<td>G. Wüstholz, Algebra, vieweg-Verlag, 2004</td>
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<td></td>
<td>J-P. Serre, Linear representations of finite groups, Springer Verlag</td>
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<tr>
<td>406-2303-AAL</td>
<td>Complex Analysis</td>
<td>E-</td>
<td>6</td>
<td>13</td>
<td>R. Pandharipande</td>
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<td></td>
<td>Complex functions of one variable, Cauchy-Riemann equations, Cauchy theorem and integral formula, singularities, residue theorem, index of closed curves, analytic continuation, conformal mappings, Riemann mapping theorem.</td>
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<td>R.Remmert: Theory of Complex Functions.. Springer Verlag</td>
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<td>E.Hille: Analytic Function Theory. AMS Chelsea Publication</td>
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<tr>
<td>406-2284-AAL</td>
<td>Measure and Integration</td>
<td>E-</td>
<td>6</td>
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<td><strong>Literature</strong></td>
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Data: 06.03.2019 12:57  Autumn Semester 2016  Page 1165 of 1571
### Abstract
Introduction to the abstract measure theory and integration, including the following topics: Lebesgue measure and Lebesgue integral, Lp-spaces, convergence theorems, differentiation of measures, product measures (Fubini's theorem), abstract measures, Radon-Nikodym theorem, probabilistic language.

### Objective
Basic acquaintance with the theory of measure and integration, in particular, Lebesgue's measure and integral.

### Literature
1. Lecture notes by Professor Michael Struwe (http://www.math.ethz.ch/~struwe/Skripten/AnalysisIII-SS2007-18-4-08.pdf)
2. L. Evans and R.F. Gariepy "Measure theory and fine properties of functions"
3. Walter Rudin "Real and complex analysis"
4. R. Bartle The elements of Integration and Lebesgue Measure

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<tr>
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<th>Title</th>
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<tr>
<td>406-2554-AAL</td>
<td>Topology</td>
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### Abstract
Topological spaces, continuous maps, connectedness, compactness, separation axioms, metric spaces, quotient spaces, homotopy, fundamental group and covering spaces, van Kampen Theorem, surfaces and manifolds.

### Literature
Klaus Jänich: Topologie (Springer-Verlag) http://www.springerlink.com/content/978-3-540-21393-2/fulltext/#section=592889&page=1
James Munkres: Topology (Prentice Hall)
William Massey: Algebraic Topology: an Introduction (Springer-Verlag)

### Prerequisites / notice
The precise content changes with the examiner. Candidates must therefore contact the examiner in person before studying the material.

<table>
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<tr>
<th>Course Code</th>
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<td>406-2604-AAL</td>
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### Abstract
Introduction to probability and statistics with many examples, based on chapters from the books "Probability and Random Processes" by G. Grimmett and D. Stirzaker and "Mathematical Statistics and Data Analysis" by J. Rice.

### Objective
The goal of this course is to provide an introduction to the basic ideas and concepts from probability theory and mathematical statistics. In addition to a mathematically rigorous treatment, also an intuitive understanding and familiarity with the ideas behind the definitions are emphasized. Measure theory is not used systematically, but it should become clear why and where measure theory is needed.

### Content
#### Probability:
- Chapters 1-5 (Probabilities and events, Discrete and continuous random variables, Generating functions) and Sections 7.1-7.5 (Convergence of random variables) from the book "Probability and Random Processes". Most of this material is also covered in Chap. 1-5 of "Mathematical Statistics and Data Analysis"; on a slightly easier level.

#### Statistics:
- Sections 8.1 - 8.5 (Estimation of parameters), 9.1 - 9.4 (Testing Hypotheses), 11.1 - 11.3 (Comparing two samples) from "Mathematical Statistics and Data Analysis".

### Literature

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<th>Course Code</th>
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<tr>
<td>406-3461-AAL</td>
<td>Functional Analysis I</td>
<td>E-</td>
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### Abstract
Baire category; Banach spaces and linear operators; Fundamental theorems: Open Mapping Theorem, Closed Range Theorem, Uniform Boundedness Principle, Hahn-Banach Theorem; Convexity; reflexive spaces; Spectral theory.

### Lecture notes
Lecture notes by Professor Michael Struwe (http://www.math.ethz.ch/~struwe/Skripten/FA-I-II-26-8-08.pdf) or Lecture notes by Prof. Einsiedler and Ward (https://dl.dropboxusercontent.com/u/2098511/FAnotes.pdf)

### Literature
Numerous texts in English or German

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<th>Course Code</th>
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<tr>
<td>406-3621-AAL</td>
<td>Fundamentals of Mathematical Statistics</td>
<td>E-</td>
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</table>

### Abstract
The course covers the basics of inferential statistics.

### Mathematics Master - Key for Type
- **O**: Compulsory
- **W**: Eligible for credits
- **W+**: Eligible for credits and recommended
- **E-**: Recommended, not eligible for credits
- **Z**: Courses outside the curriculum
- **Dr**: Suitable for doctorate
### Key for Hours

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
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<tbody>
<tr>
<td>V</td>
<td>lecture</td>
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<td>G</td>
<td>lecture with exercise</td>
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<td>U</td>
<td>exercise</td>
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<td>S</td>
<td>seminar</td>
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<td>K</td>
<td>colloquium</td>
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<td>P</td>
<td>practical/laboratory course</td>
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<td>A</td>
<td>independent project</td>
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<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
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**ECTS**

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
### Therapeutic Proteins

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<th>Number</th>
<th>Title</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>535-0030-00L</td>
<td>Therapeutic Proteins</td>
<td>O</td>
<td>3</td>
<td>3G</td>
<td>C. Halin Winter, D. Neri</td>
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</table>

**Abstract**

In this course, various topics related to the development, GMP production and application of therapeutic proteins will be discussed. Furthermore, students will expand their training in pharmaceutical immunology and will be introduced to the basic concepts of pharmaceutical product quality management.

**Objective**

Students know and understand:
- basic mechanisms and regulation of the immune response
- the pathogenic mechanisms of the most important immune-mediated disorders
- the most frequently used expression systems for the production of therapeutic proteins
- the use of protein engineering tools for modifying different features of therapeutic proteins
- the mechanism of action of selected therapeutic proteins and their application
- basic concepts in the GMP production of therapeutic proteins

**Content**

The course consists of two parts:

1. A first part, students will complete their training in pharmaceutical immunology (Chapter 13 - 16 Immunobiology VIII textbook). This part particularly focuses on the pathogenic mechanisms of immune-mediated diseases. Deepened knowledge of immunology will be relevant for understanding the mechanism of action of many therapeutic proteins, as well as for understanding one major concern related to the use of protein-based drugs, namely, immunogenicity.
2. The second part focuses on topics related to the development and application of therapeutic proteins, such as protein expression, protein engineering, reducing immunogenicity, and GMP production of therapeutic proteins. Furthermore, selected examples of approved therapeutic proteins will be discussed.

**Lecture notes**

Handouts to the lectures will be available for downloading under http://www.pharma.ethz.ch/scripts/index

**Literature**

- Chapters 13-16 of the Immunobiology VIII book (Janeway et al.)
- Lecture Handouts
- Paper References provided in the Scripts
- EMEA Dossier for Humira

### Pharmacology and Toxicology III

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<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
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<tr>
<td>535-0041-00L</td>
<td>Pharmacology and Toxicology III</td>
<td>O</td>
<td>2</td>
<td>2G</td>
<td>M. Detmar, U. Quitterer</td>
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</table>

**Abstract**

The course advances basic knowledge in pharmacology and toxicology. Special emphasis is placed on the interrelationship between pharmacological, pathophysiological and clinical aspects of drug therapy in the fields of infectious diseases and cancer. The course also provides an overview of the field of pharmacogenomics, with a special focus on the role of genetic polymorphisms in disease susceptibility, drug response and adverse effects.

**Objective**

The course advances basic knowledge in pharmacology and toxicology. Special emphasis is placed on the interrelationship between pharmacological, pathophysiological and clinical aspects of drug therapy in the fields of infectious diseases and cancer. The course also provides an overview of the field of pharmacogenomics, with a special focus on the role of genetic polymorphisms in disease susceptibility, drug response and adverse effects.

**Content**

Topics include the pharmacology and pharmacotherapy of infectious diseases and cancer. In the field of pharmacogenomics, the course is focused on genetics, genome-wide association studies, genetic disease predisposition, examples of genetic variability of drug metabolism and drug responses, identification of new drug targets, relevance of pharmacogenomics for clinical drug development, and toxicogenomics.

**Lecture notes**

A script is provided for each lecture course. The scripts define important and exam-relevant contents of lectures. Scripts do not replace the lecture.

**Literature**

- Recommended reading:
  - The classic textbook in Pharmacology: Goodman and Gilman’s The Pharmacological Basis of Therapeutics
  - Lawrence Brunton, Bruce Chabner, Bjorn Knollman. 12th edition - 1808 pages
  - or

### Pharmacoepidemiology and Drug Safety

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<tr>
<td>535-0050-00L</td>
<td>Pharmacoepidemiology and Drug Safety</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>S. Russmann</td>
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**Abstract**

Introduction to the principles, methods and applications of pharmacoepidemiology and drug safety. Drug safety in the pharmaceutical industry and regulatory authorities, but also for hospital and office pharmacists. Another focus is the evaluation and interpretation of pharmacoepidemiology drug safety studies in the medical literature and the evaluation of benefits vs. risks.

**Objective**

- To familiarize participants with the principle methods and applications of pharmacoepidemiology and drug safety that is relevant for industry, regulatory affairs, but also for clinical pharmacists in hospitals and office pharmacies.
- Perform independently a causality assessment of suspected adverse drug reactions in patients
- Study designs and biostatistics used for the quantitative evaluation of drug safety
- Setup of programs that can effectively reduce medication errors and improve drug safety in clinical practice, particularly in hospitals

**Content**

- Historical landmarks of drug safety
- Pharmacovigilance and causality assessment
- Drug safety in premarketing clinical trials
- Descriptive, cohort and case-control drug safety study designs; Data analysis and control of confounding
- Pharmacoepidemiology and regulatory decision making in drug safety; Risk management plans (RMPs)
- Medication errors, clinical pharmacy / clinical pharmacy
- Clinical Decision Support Systems, Interventional Pharmacoepidemiology
- Pharmacoepidemiological databases, Big Data
- Interactive discussion of many real-life examples for each topic

**Lecture notes**

This course will be a combination of formal lectures, group discussions and self-directed studies. Course material will be taught through seminars, case studies in small groups.

**Literature**

- Recommended literature:
  - Rothman: Introduction to Epidemiology
  - Strom, Kimmel, Hennessy: Textbook of Pharmacoepidemiology

### Drug Seminars I

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<tr>
<th>Number</th>
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<td>Drug Seminars I</td>
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<td>D. Neri</td>
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6 credit points are awarded after successful presentation
Drug therapy is nothing less than interference with a highly complex biological system, which is affected by various internal and external factors. A profound understanding of drug effects thus requires a transdisciplinary approach of investigation. The drug seminars provide a platform for the presentation and discussion of these transdisciplinary approaches for the investigation of drug action.

The course covers the following topics: drug targeting and delivery principles, radiopharmaceuticals, macromolecular drug carriers, liposomes, micelles, micro/nanoparticles, gels and implants, administration of vaccines, delivery of active agents in tissue engineering, targeting at the gastrointestinal level, synthetic carriers for nucleic acid drugs, ophthalmic devices and novel trends in transdermal and nasal drug delivery.

Further references will be provided in the course.

535-0250-00L Biotransformation of Drugs and Xenobiotics

Abstract
Knowledge of the major reactions of biotransformation in drug therapy, prediction of possible metabolites of drugs and xenobiotics, recognition of structure elements and reactions which can lead to toxic metabolites. Knowledge of inter- and intraindividual factors influencing metabolism.

Objective
Goals: knowledge of the major reactions of biotransformation in drug therapy, prediction of possible metabolites of drugs and xenobiotics, recognition of structure elements and reactions which can lead to toxic metabolites. Knowledge of inter- and intraindividual factors influencing metabolism.

Content
Major reactions of biotransformation. Major enzymes and reaction partners involved in the biotransformation of drugs and xenobiotics. Toxic reactions of metabolites. Factors which affect the biotransformation.

Literature

Lecture notes
Biotransformation of drugs and xenobiotics

S.D. Krämer

7. Trademarks, types of trademarks, grounds for refusal, peculiarities of pharma-trademarks.
8. Social, political and ethical aspects (patents and prices for medicinal products, traditional knowledge and ethnomedicine, bioprospecting and biopiracy, human DNA inventions);
9. Licensing of drug patents, patent pools, and biopiracy, human DNA inventions;

Prerequisites / notice
Requirement: basic knowledge in clinical chemistry and laboratory diagnostics
Recommended textbooks:


Prerequisites / notice

Requirements: Basic knowledge in immunology, molecular biology, protein chemistry and analytics. Basic knowledge in pharmacology.

Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
535-0310-00L | Glycobiology in Drug Development | W | 1 credit | 1V | V. I. Otto

Abstract

Protein-based drugs constitute around 25% of new approvals and most of them are glycoproteins. Using selected examples the course aims at providing insight into our present knowledge on glycosylation-activity relationships and the production and analysis of glycoprotein-based drugs.

Objective

Gaining insight into the glycobiology of therapeutically used glycoproteins. This implies knowing and understanding
- the major types of protein-linked glycans and their biosynthesis
- the most important expression systems for production of recombiant glycoproteins
- methods used to alter or manipulate glycosylation
- the most prominent clinically used glycoproteins and how glycosylation influences their therapeutic profile.
- Current methods for the qualitative and quantitative characterization of glycoproteins and being able to apply this knowledge in other contexts.

Content

lecture plan:
1. Introduction: Carbohydrates - "life’s first language"
2. Tissue plasminogen activator (t-PA), glucocebrosidease and the biosynthesis of N-glycans
3. PSGL-1 and the biosynthesis of O-glycans; P-selectin and other lectins
4. The glycoprotein hormones and the production and analysis of therapeutic glycoproteins
5. Monoclonal antibodies and the modification of their therapeutical profile through glycoengineering
6. EPO "the same but different"

Lecture notes

The slides used for the lectures will be provided online

Literature


Prerequisites / notice

Requirements: Basic knowledge in immunology, molecular biology, protein chemistry and analytics. Basic knowledge in pharmacology.

Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
535-0300-00L | Molecular Mechanisms of Drug Actions and Targets | W | 1 credit | 1V | V. I. Otto

Abstract

On average one drug per year is withdrawn from the market. Using selected examples of such drug failures, the course aims at analyzing and discussing the present explanations of drug actions as well as the design and predictive power of animal models and clinical trials. In addition, the ethical, societal, and economical expectations in new drugs shall be reflected.

Objective

To critically appraise the ethical, societal, economical and political expectations in the development of new drugs.

Content

In December 2006, Pfizer stopped a large phase III study on the use of Torcetrapib for the prevention of atherosclerosis and cardiovascular disease. 800 million $ in development costs and 21 billion $ in stocks were annihilated overnight. The failure of Torcetrapib has pinpointed the limitations of an extremely reductionist view of atherosclerosis and it’s prevention by drug therapy. It has also highlighted what high expectations we have in a safe and wide applicability of drugs and of their economical success.

Torcetrapib is not a single case. In the last 10 years, on average one drug per year was withdrawn from the market due to lack of efficay, unexpected side effects or toxicity. This clearly shows that the common investigations and the modern understanding of drug actions are often not sufficient to predict the effects a drug will have in large patient populations.

These are the topics of the present course. Using three particularly informative examples of drug failures, the problems encountered and the concepts and informative value of preclinical and clinical studies will be analyzed and discussed. Furthermore, the ethical, societal, economical and political expectations in new drugs shall be reflected.

Lecture notes

Printouts of the slides used for the lectures and literature for reading and discussions will be available online.

Literature

Recommended reading: John Abramson, Overdo$ed America, Harper Perennial, New York 2008

Prerequisites / notice

Requirements: basic knowledge in Medicinal Chemistry and Pharmacology. Ability to read and understand scientific publications written in English.

Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
535-0022-00L | Computer-Assisted Drug Design | W | 1 credit | 1V | G. Schneider

Abstract

The lecture series provides an introduction to computer applications in medicinal chemistry. A focus is on molecular representations, property predictions, molecular similarity concepts, virtual screening techniques, and de novo drug design. All theoretical concepts and algorithms presented are illustrated by practical applications and case studies

Objective

The students will learn how computer simulation generates ideas for drug design and development, understand the theoretical principles of property prediction and computer-generated compound generation, and understand possibilities and limitations of computer-assisted drug design in pharmaceutical chemistry. As a result, they are prepared for professional assessment of computer-assisted drug design projects in medicinal chemistry projects.

Literature

Recommended textbooks:

Prerequisites / notice

Successful participation in this course is required for a research project ("Forschungspraktikum") in the CADD group.

Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
851-0180-00L | Research Ethics | W | 2 credits | 2G | G. Achermann

Abstract

This course has its focus on the responsible conduct of research (RCR) and the ethical dimensions of the biological and biomedical sciences.
Objective

The main goal of this course is to enhance the student's ability to:
- recognize and identify ethical issues and conflicts,
- analyze and develop well-reasoned responses to the kinds of ethical problems a scientist is likely to encounter.

Additionally, students will become familiar with regulations and ethical guidelines relevant for their research field on the international, governmental, institutional and professional level.

To achieve these objectives, teaching methods will include lectures, discussions, case study work (alone and in groups), moral games, paper work and exercises.

Content

I. Ethics & the Process of Ethical Inquiry

Introduction in Ethics and Research Ethics
- What is ethics? What ethics is not...;
- Awareness: what constitutes an ethical question? Distinguishing ethical questions from other kinds of questions; Science & ethics: a comparison;
- The ethics movement in the biological and health sciences;
- What is research ethics and why is it important?
- Values (personal, cultural & ethical) in science & principles for ethical conduct in research;
- Professional codes of conduct: functions and limitations

Ethical approaches in the conduct of research (Normative Ethics)
- Overview over important theories for research ethics: virtue theories, duty-based theories (rights theory, categorical imperative, prima facie duties), consequentialist theories, other theories);
- The plurality of ethical theories and its consequences;
- The concept of dignity

Moral reasoning I: Arguments
- Why arguments? What is a good argument? The structure of (moral) arguments;
- Deductive and inductive arguments; Validity and soundness;
- Assessing moral arguments

Moral reasoning II: Decision-making
- How (not) to approach ethical issues...; Is there a correct method for answering moral questions?
- Models of method in Applied Ethics: a) Top-down approaches; b) the reflective equilibrium; c) a bottom-up approach: casuistry (or reasoning-by-analogy);
- Is there a right answer?

II. Research Ethics / Responsible Conduct of Research (RCR)

Integrity in Research & Research Misconduct
- What is "integrity" in scientific research? What is research misconduct (falsification, fabrication, plagiarism - FFP) and questionable research practices (QRP)?
- Factors leading to misconduct; Procedure for responding to allegations of research misconduct;
- The confidant of ETH Zurich

Data Management
- Data collection and recordkeeping; Analysis and selection of data;
- Ownership of data; retention and sharing of data;
- Falsification and fabrication of data

Research involving animals
- The moral status of animals; Ethical approaches to animal experimentation: Animal welfare (Peter Singer) and Animal rights (Tom Regan);)
- The 3 R's (replacement, reduction, refinement);
- Ethical assessment of conflicting issues in animal experimentation;
- The dignity of animals in the Swiss constitution;

Research involving human subjects
- History & guidelines (Nuremberg Code; Declaration of Helsinki; Belmont Report; International Ethical Guidelines for Biomedical Research Involving Human Subjects (CIOMS Guidelines); Convention on Human Rights and Biomedicine (Oviedo Convention);
- Informed consent; confidentiality and anonymity; research risks and benefits; vulnerable subjects;
- Clinical trials;
- Biobanks
- Ethics Committees / Institutional Review Boards (IRB)

Authorship & Peer review
- Criteria for authorship;
- Plagiarism;
- Challenges to openness and freedom in scientific publication;
- Open access
- Peer review

Social responsibility
- What is social responsibility? Social responsibility: whose obligation?
- Public advocacy by researchers

Lecture notes
Course material (handouts, case studies, exercises, surveys and papers) will be available during the lectures and on the course homepage.
Discovering Management combines in an innovative format a set of lectures and an advanced business game. The learning model for Discovering Management aims to broaden the students' understanding of the principles of business management, emphasizing the theoretical and conceptual foundations, the experiential learning outcomes result from the interactive business game. The purpose of the business game is to analyze the innovative needs of a large multinational company and develop a business case for the company to grow. This business case is as relevant to someone exploring innovation within an organization as it is if you are planning to start your own business. By discovering the key aspects of entrepreneurial management, the purpose of the course is to advance students' understanding of factors driving innovation, entrepreneurship, and company success.

Prerequisites / notice
- Discovering Management is designed to suit the needs and expectations of Bachelor students at all levels as well as Master and PhD students not belonging to D-MTEC. By providing an overview of Business Management, this course is an ideal enrichment of the standard curriculum at ETH Zurich. No prior knowledge of business or economics is required to successfully complete this course.

Objective
Discovering Management combines in an innovative format a set of lectures and an advanced business game. The learning model for Discovering Management involves learning by doing. The objective is to introduce the students to the relevant topics of the management literature and give them a good introduction in entrepreneurship topics too. The course is a series of lectures on the topics of strategy, innovation, corporate finance, leadership, design thinking and corporate social responsibility. While the 14 different lectures provide the theoretical and conceptual foundations, the experiential learning outcomes result from the interactive business game. The purpose of the business game is to analyze the innovative needs of a large multinational company and develop a business case for the company to grow. This business case is as relevant to someone exploring innovation within an organization as it is if you are planning to start your own business. By discovering the key aspects of entrepreneurial management, the purpose of the course is to advance students’ understanding of factors driving innovation, entrepreneurship, and company success.

Content
Discovering Management offers an introduction to the field of business management and entrepreneurship for engineers and natural scientists. The module provides an overview of the principles of management, teaches knowledge about management that is highly complementary to the students’ technical knowledge, and provides a basis for advancing the knowledge of the various subjects offered at D-MTEC.

Course Units for Additional Admission Requirements
The courses below are only available for MSc students with additional admission requirements.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>406-0603-AAL</td>
<td>Stochastics (Probability and Statistics)</td>
<td>E-</td>
<td>4</td>
<td>9R</td>
<td>M. Kalisch</td>
</tr>
</tbody>
</table>
### Fundamentals of Biology II: Cell Biology (551-0103-AAL)

**Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.**

<table>
<thead>
<tr>
<th>Topic/Lecturer/Chapter/Pages:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analyzing cells &amp; molecules / Gebhard Schertler/8/ 439-463; Membrane Structure / Gebhard Schertler/10/ 565-595; Compartments and Sorting/ Ulrike Kutay/12/14-6/641-694/755-758/782-783/315-320/325 -333/Table 6-2/Figure 6-20, 6-21, 6-32, 6-34; Intracellular Membrane Traffic/ Ulrike Kutay/13/695-752; The Cytoskeleton/ Ulrike Kutay/16/889 - 948 (only the essentials); Membrane Transport of Small Molecules and the Electrical Properties of Membranes/Sabine Werner/11/597 - 633; Mechanisms of Cell Communication/Sabine Werner/15/813-876; Cancer/Sabine Werner/20/1091-1141; Cell Junctions and Extracellular Matrix/Ueli Suter/1035-1081; Stem Cells and Tissue Renewal/Ueli Suter/1217-1262; Development of Multicellular Organisms/Ernst Hafen/ 21/1145-1179; Cell Migration/Joao Matos/951-960; Cell Death/Joao Matos/1021-1032; Cell Cycle/chromosome segregation/Cell division/Meliosis/Joao Matos/1091-1098.</td>
</tr>
</tbody>
</table>

**Literature**


### Clinical Chemistry I (535-0135-AAL)

**Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.**

<table>
<thead>
<tr>
<th>Topic/Lecturer/Chapter/Pages:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction to basic methods and fundamental concepts of statistics and probability theory for non-mathematicians. The concepts are presented on the basis of some descriptive examples. Learning the statistical program R for applying the acquired concepts will be a central theme.</td>
</tr>
</tbody>
</table>

**Abstract**

The objective of this course is to build a solid fundament in probability and statistics. The student should understand some fundamental concepts and be able to apply these concepts to applications in the real world. Furthermore, the student should have a basic knowledge of the statistical programming language "R".

**Objective**

From "Statistics for research" (online)

1. **Ch 1: Basics**
2. **Ch 2: The R Environment**
3. **Ch 3: Probability and distributions**
4. **Ch 4: Descriptive statistics and tables**
5. **Ch 5: One- and two-sample tests**
6. **Ch 6: Regression and correlation**

**Literature**

- "Introductory Statistics with R" by S. Dowdy et al. (3rd edition); Print ISBN: 9780471267355; Online ISBN: 9780471477433; DOI: 10.1002/0471477435

From within the ETH, this book is freely available online under:


http://www.springerlink.com/content/m17578/

<table>
<thead>
<tr>
<th>Prerequisites / notice</th>
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<tbody>
<tr>
<td>none</td>
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</tbody>
</table>

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Data: 06.03.2019 12:57  Autumn Semester 2016  Page 1173 of 1571
Pharmaceutical Analytics
Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract Theoretical and practical comprehension of analytical chemistry in order to solve pharmaceutical problems.

Objective Knowledge in Pharmaceutical Analytics in order to solve fundamental analytical problems. Handling of the most important pharmacopeial texts and monographs.

Content Introduction in Pharmaceutical Analytics. Theoretical and practical considerations concerning a lot of methods in different Pharmacopeias. Identification, purity testing, stability testing, assays of drugs and drug formulations.

Lecture notes A script can be purchased at the HCI-Shop, HCI-Building, D floor.

Literature David G. Watson, Pharmaceutical Analysis, Elsevier.

Biopharmacy
Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract Introduction to the Basics in Biopharmacy. Pharmacokinetic processes (absorption, distribution, metabolism and excretion, ADME), which determine the fate of a drug in the body. Knowledge of the most important pharmacokinetic parameters. Interpretation of concentration-time-profiles of drugs. Pharmacokinetic profiling of drugs in view of therapy optimization and analysis of interaction potential.

Objective Introduction to pharmacokinetics; definition of the most important pharmacokinetic parameters and their calculation from clinical data (compartment model, statistical model); kinetics of absorption (absorption profiles); distribution of drugs and role of protein binding; kinetics of elimination: excretion and biotransformation (physiological model); pharmacokinetic profiling of drugs for therapy optimization and for the analysis of the interaction potential; dosage regimen design.

Quality Management in Pharmaceutical Business
Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract The students know the relevance and the role of quality assurance measures to assure quality, efficacy and safety of drugs. The students know the most important Swiss regulations, including the associated European regulations, which are relevant from a quality assurance point of view and they are able to interpret the content of this regulations.

Objective Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Fundamentals of Biology II: Microbiology
Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract Structure, function, genetics of prokaryotic microorganisms and fungi.


Lecture notes none


Prerequisites / notice none

Fundamentals of Biology II: Plant Biology
Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract Water balance, assimilation, transport in plants; developmental biology, stress physiology.

Objective Water balance, assimilation, transport in plants; developmental biology, stress physiology.


Literature none

Prerequisites / notice none

Fundamentals of Biology II: Biochemistry and Molecular Biology
Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract The course provides an introduction to Biochemistry / Molecular Biology with some emphasis on chemical and biophysical aspects.

Objective Topics include the structure-function relationship of proteins / nucleic acids, protein folding, enzymatic catalysis, cellular pathways involved in bioenergetics and the biosynthesis and breakdown of amino acids, glycans, nucleotides, fatty acids and phospholipids, and steroids. There will also be a discussion of DNA replication and repair, transcription, and translation.

Lecture notes none

### Medicinal and Industrial Pharmaceutical Sciences Master - Key for Type

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Code</th>
<th>Description</th>
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<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
<td>Suitable for doctorate</td>
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</tbody>
</table>

### Key for Hours

<table>
<thead>
<tr>
<th>Code</th>
<th>Activity</th>
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<tbody>
<tr>
<td>V</td>
<td>lecture</td>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
<td>A</td>
<td>independent project</td>
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<tr>
<td>U</td>
<td>exercise</td>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
<td>R</td>
<td>revision course / private study</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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</tbody>
</table>

**ECTS**
- European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
Integrated circuits are responsible for much of the progress in electronics in the last 50 years, particularly the revolutions in the Information Age. Analog Integrated Circuits

The main topics of the course include

- Sensors, sensor signal processing, data fusion, time series (segmentation, similarity measures), supervised learning (Bayes Decision Theory, Decision Trees, Random Forest, kNN-Methods, Support Vector Machine, Adaboost, Deep Learning), clustering (k-means, dbscan, topic models), Recommender Systems, Collaborative Filtering, Crowdsourcing.

- The exercises show concrete design problems like motion and gesture recognition using distributed sensors, detection of activity patterns and identification of the local environment.

- Presentations of the PhD students and the visit at the Wearable Computing Lab introduce in current research topics and international research projects.

Lecture notes
Lecture notes for all lessons, assignments and solutions.
http://www.ife.ee.ethz.ch/education/wearable_systems_1

Literature
Literature will be announced during the lessons.

Prerequisites / notice
No special prerequisites

Semiconductor Nanostructures

The course covers the foundations of semiconductor nanostructures, e.g., materials, band structures, bandgap engineering and doping, field-effect transistors. The physics of the quantum Hall effect and of common nanostructures based on two-dimensional electron gases will be discussed, i.e., quantum point contacts, Aharonov-Bohm rings and quantum dots.

At the end of the lecture the student should understand four key phenomena of electron transport in semiconductor nanostructures:
1. The integer quantum Hall effect
2. Conductance quantization in quantum point contacts
3. the Aharonov-Bohm effect
4. Coulomb blockade in quantum dots
In this lecture the basics as well as practical aspects (from modelling to design and fabrication) are described from a solid and fluid physical perspective with applications to microsystems and lab-on-a-chip devices. Notice: The exercise part is a mixture of presentation, lab session and hand in homework.

### Material, Surfaces, and Properties

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0524-00L</td>
<td>Continuum Mechanics I</td>
<td>W+</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>E. Mazza</td>
</tr>
<tr>
<td>Abstract</td>
<td>The lecture deals with constitutive models that are relevant for design and calculation of structures. These include anisotropic linear elasticity, linear viscoelasticity, plasticity, viscoplasticity. Homogenization theories and laminate theory are presented. Theoretical models are complemented by examples of engineering applications and experiments.</td>
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<tr>
<td>Objective</td>
<td>Basic theories for solving continuum mechanics problems of engineering applications, with particular attention to material models.</td>
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<tr>
<td>Content</td>
<td>Anisotropy, Elasticity, Linear elasticity and linear viscoelasticity, plasticity, viscoplasticity. Homogenization theories and laminate theory are presented. Theoretical models are complemented by examples of engineering applications and experiments.</td>
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</tr>
<tr>
<td>Prerequisites / notice</td>
<td>The course is taught in English. Basic knowledge of solid state physics is recommended. Very ambitious students in the third year may be able to follow. The course can be chosen as part of the PhD-program.</td>
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<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>327-0505-00L</td>
<td>Surfaces, Interfaces and their Applications I</td>
<td>W</td>
<td>3 credits</td>
<td>2V+1U</td>
<td>N. Spencer, M. P. Heuberger, L. Isa</td>
</tr>
<tr>
<td>Abstract</td>
<td>After being introduced to the physical/chemical principles and importance of surfaces and interfaces, the student is introduced to the most important techniques that can be used to characterize surfaces. Later, liquid interfaces are treated, followed by an introduction to the fields of tribology (friction, lubrication, and wear) and corrosion.</td>
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<tr>
<td>Objective</td>
<td>To gain an understanding of the physical and chemical principles, as well as the tools and applications of surface science, and to be able to choose appropriate surface-analytical approaches for solving problems.</td>
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<tr>
<td>Content</td>
<td>Introduction to Surface Science Physical Structure of Surfaces Surface Forces (static and dynamic) Adsorbates on Surfaces Surface Thermodynamics and Kinetics The Solid-Liquid Interface Electron Spectroscopy Vibrational Spectroscopy on Surfaces Scanning Probe Microscopy Introduction to Tribology Introduction to Corrosion Science</td>
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### Modelling and Simulation

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<thead>
<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0509-00L</td>
<td>Microscale Acoustofluidics</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>J. Dual</td>
</tr>
<tr>
<td>Abstract</td>
<td>In this lecture the basics as well as practical aspects (from modelling to design and fabrication) are described from a solid and fluid mechanics perspective with applications to microsystems and lab on a chip devices.</td>
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<tr>
<td>Objective</td>
<td>Understanding acoustophoresis, the design of devices and potential applications</td>
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<tr>
<td>Content</td>
<td>Linear and nonlinear acoustics, foundations of fluid and solid mechanics and piezoelectricity, Gorkov potential, numerical modelling, acoustic streaming, applications from ultrasonic microrobots to surface acoustic wave devices</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Solid and fluid continuum mechanics. Notice: The exercise part is a mixture of presentation, lab session and hand in homework.</td>
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### Physical Modelling and Simulation

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<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>227-2037-00L</td>
<td>Physical Modelling and Simulation</td>
<td>W+</td>
<td>5 credits</td>
<td>4G</td>
<td>C. Hafner, J. Leuthold, J. Smajic</td>
</tr>
</tbody>
</table>

### Script Download: [Link to Script](https://www.ethz.ch/content/specialinterest/matl/surface/en/education/SI-A-1.html)
Abstract
This module consists of (a) an introduction to fundamental equations of electromagnetics, mechanics and heat transfer, (b) a detailed overview of numerical methods for field simulations, and (c) practical examples solved in form of small projects.

Objective
Basic knowledge of the fundamental equations and effects of electromagnetics, mechanics, and heat transfer. Knowledge of the main concepts of numerical methods for physical modelling and simulation. Ability (a) to develop own simple field simulation programs, (b) to select an appropriate field solver for a given problem, (c) to perform field simulations, (d) to evaluate the obtained results, and (e) to interactively improve the models until sufficiently accurate results are obtained.

Content
The module begins with an introduction to the fundamental equations and effects of electromagnetics, mechanics, and heat transfer. After the introduction follows a detailed overview of the available numerical methods for solving electromagnetic, thermal and mechanical boundary value problems. This part of the course contains a general introduction into numerical methods, differential and integral forms, linear equation systems, Finite Difference Method (FDM), Boundary Element Method (BEM), Method of Moments (MoM), Multiple Multipole Program (MMP) and Finite Element Method (FEM). The theoretical part of the course finishes with a presentation of multiphysics simulations through several practical examples of HF-engineering such as coupled electromagnetic-mechanical and electromagnetic-thermal analysis of MEMS.

In the second part of the course the students will work in small groups on practical simulation problems. For solving practical problems the students can develop and use own simulation programs or chose an appropriate commercial field solver for their specific problem. This practical simulation work of the students is supervised by the lecturers.

151-0107-20L High Performance Computing for Science and Engineering (HPCSE) I

Abstract
This gives an introduction into algorithms and numerical methods for parallel computing for multi and many-core architectures and for applications from problems in science and engineering.

Objective
Introduction to HPC for scientists and engineers
Fundamental of:
1. Parallel Computing Architectures
2. MultiCores
3. ManyCores

Content
Programming models and languages:
1. C++ threading (2 weeks)
2. OpenMP (4 weeks)
3. MPI (5 weeks)

Computers and methods:
1. Hardware and architectures
2. Libraries
3. Particles: N-body solvers
4. Fields: PDEs
5. Stochastics: Monte Carlo

Lecture notes
http://www.cse-lab.ethz.ch/index.php/teaching/42-teaching/classes/615-hpcse1

Class notes, handouts

Labatory Course

Number Title Type ECTS Hours Lecturers
151-0520-00L Embedded MEMS Lab W 5 credits 3P C. Hierold, S. Blunier, M. Haluska

Abstract
Practical course: Students are introduced to the process steps required for the fabrication of MEMS (Micro Electro Mechanical System) and carry out the fabrication and testing steps in the clean rooms by themselves. Additionally, they learn the requirements for working in clean rooms. Processing and characterization will be documented and analyzed in a final report. Limited access

Objective
Students learn the individual process steps that are required to make a MEMS (Micro Electro Mechanical System). Students carry out the process steps themselves in laboratories and clean rooms. Furthermore, participants become familiar with the special requirements (cleanliness, safety, operation of equipment and handling hazardous chemicals) of working in the clean rooms and laboratories. The entire production, processing, and characterization of the MEMS is documented and evaluated in a final report.

Content
With guidance from a tutor, the individual silicon microsystem process steps that are required for the fabrication of an accelerometer are carried out:
- Photolithography, dry etching, wet etching, sacrificial layer etching, critical point drying, various cleaning procedures
- Packaging and electrical connection of a MEMS device
- Testing and characterization of the MEMS device
- Written documentation and evaluation of the entire production, processing and characterization

Lecture notes
A document containing theory, background and practical course content is distributed at the first meeting of the course.

Literature
The document provides sufficient information for the participants to successfully participate in the course.

Attention students are required to attend all scheduled lectures and meetings of the course.

Participating students are required to provide proof that they have personal accident insurance prior to the start of the laboratory portion of the course.

This master's level course is limited to 15 students per semester for safety and efficiency reasons. If there are more than 15 students registered, we regret to restrict access to this course by the following rules:

Priority 1: master students of the master's program in "Micro and Nanosystems"
Priority 2: master students of the master's program in "Mechanical Engineering" with a specialization in Microsystems and Nanoscale Engineering (MAVT-tutors Profs. Daraio, Dual, Hierold, Koumoutsakos, Nelson, Norris, Park, Poulikakos, Pratsinis, Stemmer), who attended the bachelor course "151-0621-00L Microsystems Technology" successfully.

Priority 3: master students, who attended the bachelor course "151-0621-00L Microsystems Technology" successfully.

Priority 4: all other students (PhD, bachelor, master) with a background in silicon or Microsystems process technology.

If there are more students in one of these priority groups than places available, we will decide by drawing lots.

Students will be notified at the first lecture of the course (introductory lecture) as to whether they are able to participate.

The course is offered in autumn and spring semester.

Elective Core Courses

Number Title Type ECTS Hours Lecturers
151-0525-00L Wave Propagation in Solids W 4 credits 2V+1U J. Dual, D. Mohr
Nanosystems
From atoms to molecules to condensed matter: characteristic properties of simple nanosystems and how they evolve when moving towards 2V+1U, J.N. Tisserant
M. Gysel
Theory and application of energy conversion at the cellular level. Understanding of the basic features governing solutes transport in the cell. Organization and function of the cell membrane and of the cell cytoskeleton. The role of molecular motors in cellular force generation and their function in cell migration. Description of the functionality of these systems and of analytical experimental and computational techniques for understanding of their operation. Introduction to cell metabolism, cellular energy transport and cellular thermodynamics.

Lecture notes
Literature
Various books will be recommended pertaining to the topics covered.
Language according to the wishes of students.

151-0255-00L
Energy Conversion and Transport in Biosystems
4 credits
2V+1U
D. Poulikakos, A. Ferrari
Abstract
Theory and application of thermodynamics and energy conversion in biological systems with focus on the cellular level.
Objective
Content
Mass transfer models for the transport of chemical species in the human cell. Organization and function of the cell membrane and of the cell cytoskeleton. The role of molecular motors in cellular force generation and their function in cell migration. Description of the functionality of these systems and of analytical experimental and computational techniques for understanding of their operation. Introduction to cell metabolism, cellular energy transport and cellular thermodynamics.

Lecture notes
Literature
Material in the form of hand-outs will be distributed.
Lecture notes and references therein.

402-0572-00L
Aerosols I: Physical and Chemical Principles
4 credits
2V+1U
M. Gysel, U. Baltensperger, H. Burtscher
Abstract
Aerosols deals with basic physical and chemical properties of aerosol particles. The importance of aerosols in the atmosphere and in other fields is discussed.
Objective
Content
Topics are treated in 2 blocks:
(I) From Quantum to Continuum
From atoms to molecules to condensed matter: characteristic properties of simple nanosystems and how they evolve when moving towards complex ensembles.

(II) Interaction Forces on the Micro and Nano Scale
Intermolecular forces, their macroscopic manifestations, and ways to control such interactions. Self-assembly and directed assembly of 2D and 3D structures.

Special emphasis is placed on the emerging field of molecular electronic devices. Special emphasis is placed on the emerging field of molecular electronic devices, their working principles, applications, and how they may be assembled.

Topics are treated in 2 blocks:
(I) From Quantum to Continuum
From atoms to molecules to condensed matter: characteristic properties of simple nanosystems and how they evolve when moving towards complex ensembles.

(II) Interaction Forces on the Micro and Nano Scale
Intermolecular forces, their macroscopic manifestations, and ways to control such interactions. Self-assembly and directed assembly of 2D and 3D structures.

Prerequisites /
notice
Lectures and Mini-Review presentations: Thursday 10-13, ML F 36
Language according to the wishes of students.

151-0605-00L
Nanosystems
4 credits
4G
A. Stemmer, J.N. Tisserant
Abstract
From atoms to molecules to condensed matter: characteristic properties of simple nanosystems and how they evolve when moving towards complex ensembles.
Objective
Content
Topics are treated in 2 blocks:
(I) From Quantum to Continuum
From atoms to molecules to condensed matter: characteristic properties of simple nanosystems and how they evolve when moving towards complex ensembles.

(II) Interaction Forces on the Micro and Nano Scale
Intermolecular forces, their macroscopic manifestations, and ways to control such interactions. Self-assembly and directed assembly of 2D and 3D structures.

Prerequisites /
notice
Course format:
Lectures and Mini-Review presentations: Thursday 10-13, ML F 36
Homework: Mini-Reviews
Students select a paper (list distributed in class) and expand the topic into a Mini-Review that illuminates the particular field beyond the immediate results reported in the paper.

529-0611-00L
Characterization of Catalysts and Surfaces
7 credits
3G
J. A. van Bokhoven, D. Ferri
Abstract
Basic elements of surface science important for materials and catalysis research. Physical and chemical methods important for research in surface science, material science and catalysis are considered and their application is demonstrated on practical examples.
Methods which are covered embrace: Gas adsorption and surface area analysis, IR-Spectroscopy, X-ray diffraction, X-ray photoelectron spectroscopy, X-ray absorption, solid state NMR, Electron Microscopy and others.

The main topics are: transport models for semiconductor devices (quantum transport, Boltzmann equation, drift-diffusion model, flowsheet solution algorithm).

Lecture notes: no script


Prerequisites / notice: Prerequisite: Thermal Unit Operations

The course is focused on the design of Chemical Processes, with emphasis on the preliminary stage of the design approach, where process creation and quick selection among many alternatives are important. The main concepts behind more detailed process design and process simulation are also examined in the last part of the course.


The exercises are focussed on the theory and the basic understanding of the operation of special devices, as single-electron transistor, insulator-semiconductor structure, and heterojunctions.

Recombination (Shockley-Read-Hall statistics, Auger recombination), impact ionization, metal-semiconductor contact, metal-insulator-semiconductor structure, and heterojunctions. The exercises are focussed on the theory and the basic understanding of the operation of special devices, as single-electron transistor, resonant tunneling diode, pn-diode, bipolar transistor, MOSFET, and laser. Numerical simulations of such devices are performed with an advanced simulation package (Sentaurus-Synopsys). This enables to understand the physical effects by means of computer experiments.


Literature: Provided in the lecture notes.

Prerequisites: Qualifications: Physics I-II, Semiconductor devices (4. semester).

The course addresses the physical principles of modern semiconductor devices and the foundations of their modeling and numerical simulation. Necessary basic knowledge on quantum-mechanics, semiconductor physics and device physics is provided. Computer simulations of the most important devices and of interesting physical effects supplement the lectures.

Objective: The course aims at the understanding of the principle physics of modern semiconductor devices, of the foundations in the physical modeling of transport and its numerical simulation. During the course also basic knowledge on quantum-mechanics, semiconductor physics and device physics is provided.

Content: The main topics are: transport models for semiconductor devices (quantum transport, Boltzmann equation, drift-diffusion model, hydrodynamic model), physical characterization of silicon (intrinsic properties, scattering processes), mobility of cold and hot carriers, recombination (Shockley-Read-Hall statistics, Auger recombination), impact ionization, metal-semiconductor contact, metal-insulator-semiconductor structure, and heterojunctions. The exercises are focussed on the theory and the basic understanding of the operation of special devices, as single-electron transistor, resonant tunneling diode, pn-diode, bipolar transistor, MOSFET, and laser. Numerical simulations of such devices are performed with an advanced simulation package (Sentaurus-Synopsys). This enables to understand the physical effects by means of computer experiments.

Lecture notes: The script (in book style) is sufficient. Further reading will be recommended in the lecture.

Literature: Provided in the lecture notes.

Prerequisites: Qualifications: Physics I-II, Semiconductor devices (4. semester).

The class is intended to provide a comprehensive overview of the theory of linear dynamical systems, their use in control, filtering, and estimation and their applications to areas ranging from avionics to systems biology.

Objective: By the end of the class students should be comfortable with the fundamental results in linear system theory and the mathematical tools used to derive them.

Content: - Rings, fields and linear spaces, normed linear spaces and inner product spaces.
- Ordinary differential equations, existence and uniqueness of solutions.
- Continuous and discrete time, time varying linear systems. Time domain solutions. Time invariant systems treated as a special case.
- Controllability and observability, canonical forms, Kalman decomposition. Time invariant systems treated as a special case.
- Stability and stabilization, observers, state and output feedback, separation principle.
- Realization theory.


Prerequisites / notice: Prerequisites: Control Systems I (227-0103-00) or equivalent and sufficient mathematical maturity.

The course is focused on the design of Chemical Processes, with emphasis on the preliminary stage of the design approach, where process creation and quick selection among many alternatives are important. The main concepts behind more detailed process design and process simulation are also examined in the last part of the course.


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Content: The main topics are: transport models for semiconductor devices (quantum transport, Boltzmann equation, drift-diffusion model, hydrodynamic model), physical characterization of silicon (intrinsic properties, scattering processes), mobility of cold and hot carriers, recombination (Shockley-Read-Hall statistics, Auger recombination), impact ionization, metal-semiconductor contact, metal-insulator-semiconductor structure, and heterojunctions. The exercises are focussed on the theory and the basic understanding of the operation of special devices, as single-electron transistor, resonant tunneling diode, pn-diode, bipolar transistor, MOSFET, and laser. Numerical simulations of such devices are performed with an advanced simulation package (Sentaurus-Synopsys). This enables to understand the physical effects by means of computer experiments.


Literature: Provided in the lecture notes.

Prerequisites / notice: Prerequisites: Control Systems I (227-0103-00) or equivalent and sufficient mathematical maturity.

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Students are introduced to the basics of micromachining and silicon process technology and will learn about the fabrication of microsystem devices by a sequence of defined processing steps (process flow).

Subjects covered in lectures and practical lab exercises include:
- The application of C-programming on a microprocessor
- Digital I/O and serial communication
- Quadrature decoding for wheel position sensing
- Queued analog-to-digital conversion to interface with the analog world
- Pulse width modulation
- Timer interrupts to create sampling time intervals
- System dynamics and virtual worlds with haptic feedback
- Introduction to rapid prototyping

This course is restricted to 33 students due to limited lab infrastructure. Interested students please contact Marianne Schmid (E-Mail: marischm@ethz.ch).

After your reservation has been confirmed please register online at www.mystudies.ethz.ch.

Detailed information can be found on the course website http://www.idsc.ethz.ch/education/lectures/embedded-control-systems.html

**Buried Passivation**

End-of-year examination: Mid-year examination counts as 20% of the final grade.
2- Final exam: Written exam during the regular examination session. It counts as 80% of the final grade.

**Lectures**

1. Mid-term examination: Mid-term exam grade counts as 20% of the final grade.
2. Final exam: Written exam during the regular examination session. It counts as 80% of the final grade.

**Prerequisites**

Undergraduate physics, mathematics, semiconductor devices

**Recommended background:**

Undergraduate physics, mathematics, semiconductor devices

**Literature**

- S.M. Sze: Semiconductor Devices, Physics and Technology
- W. Menz, J. Mohr, O. Paul: Microsystem Technology
- G. Kovacs: Micromachined Transducer Sourcebook

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Prerequisites / Literature</th>
<th>Objective</th>
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<tbody>
<tr>
<td>202-0811-00L</td>
<td>Programming Techniques for Scientific Simulations I</td>
<td>5</td>
<td></td>
<td></td>
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<tr>
<td>151-0911-00L</td>
<td>Introduction to Plasmonics</td>
<td>4</td>
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<tr>
<td>207-0663-00L</td>
<td>Nano-Optics</td>
<td>6</td>
<td></td>
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<tr>
<td>151-0104-00L</td>
<td>Uncertainty Quantification for Engineering &amp; Life Sciences</td>
<td>4</td>
<td></td>
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<tr>
<td>227-0486-00L</td>
<td>Analog Signal Processing and Filtering</td>
<td>6</td>
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</table>
Objective
This lecture provides a wide overview over analog filters (continuous-time and discrete-time), signal-processing systems, and sigma-delta conversion, and gives examples with sensor interfaces and class-D audio drivers. All systems and circuits are treated using a signal-flow view. The lecture is suitable for both analog and digital designers. The way the exam is done allows for the different interests of the two groups.

The learning goal is that the students can apply signal-flow graphs and can understand the signal flow in such circuits and systems (including nonideal effects) well enough to gain an understanding of further circuits and systems by themselves.

Content
At the beginning, signal-flow graphs in general and driving-point signal-flow graphs in particular are introduced. We will use them during the whole term to analyze circuits and understand how signals propagate through them. The theory and CMOS implementation of active filters is then discussed in detail using the example of Op-amp and active-RC filters. The detail and nonideal behaviour of opamps, current conveyors, and inductor simulators follows. The link to the practical design of circuits and systems is done with an overview over different quality measures and figures of merit used in scientific literature and datasheets. Finally, an introduction to discrete-time and mixed-domain filters and circuits is given, including sensor read-out amplifiers, correlated double sampling, and chopping, and an introduction to sigma-delta A/D and D/A conversion on a system level.

Lecture notes
The base for these lectures are lecture notes and two or three published scientific papers. From these papers we will together develop the technical content.

Details: https://people.ee.ethz.ch/~haschmid/asfwiki/

Some material is protected by password; students from ETHZ who are interested can write to haschmid@ethz.ch to ask for the password even if they do not attend the lecture.

Prerequisites / notice
Prerequisites: Recommended (but not required): Stochastic models and signal processing, Communication Electronics, Analog Integrated Circuits, Transmission Lines and Filters.

Knowledge of the Laplace transform and z transform and their interpretation (transfer functions, poles and zeros, bode diagrams, stability criteria ...) and of the main properties of linear systems is necessary.

ECTS 4 credits

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0735-00L</td>
<td>Dynamic Behavior of Materials and Structures</td>
<td>W</td>
<td>4 credits</td>
<td>2V+2U</td>
<td>D. Mohr</td>
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<tr>
<td>151-0532-00L</td>
<td>Nonlinear Dynamics and Chaos I</td>
<td>W</td>
<td>4 credits</td>
<td>2V+2U</td>
<td>G. Haller, F. Koglbauer</td>
</tr>
</tbody>
</table>

Semester Project

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
</table>

Data: 06.03.2019 12:57 Autumn Semester 2016 Page 1183 of 1571
The subject of the Semester Project and the choice of the supervisor (ETH-professor) are to be approved in advance by the tutor.

Objective

The semester project is designed to train the students in the solution of specific engineering problems. This makes use of the technical and social skills acquired during the master's program. Tutors propose the subject of the project, elaborate the project plan, and define the roadmap together with their students, as well as monitor the overall execution.

Abstract

The semester project is designed to train the students in the solution of specific engineering problems. This makes use of the technical and social skills acquired during the master's program. Tutors propose the subject of the project, elaborate the project plan, and define the roadmap together with their students, as well as monitor the overall execution.

## Industrial Internship

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>151-1013-00L</td>
<td>Industrial Internship Micro and Nanosystems</td>
<td>O</td>
<td>8 credits</td>
<td></td>
<td>external organisers</td>
</tr>
</tbody>
</table>

Objective

The main objective of the 12-week internship is to expose master's students to the industrial work environment. During this period, students have the opportunity to be involved in on-going projects at the host institution.

Abstract

The main objective of the 12-week internship is to expose master's students to the industrial work environment.

## Master's Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-1006-00L</td>
<td>Master's Thesis Micro- and Nanosystems</td>
<td>O</td>
<td>30 credits</td>
<td>64D</td>
<td>Professors</td>
</tr>
</tbody>
</table>

Abstract

Master's programs are concluded by the master's thesis. The thesis is aimed at enhancing the student's capability to work independently toward the solution of a theoretical or applied problem. The subject of the master's thesis, as well as the project plan and roadmap, are proposed by the tutor and further elaborated with the student.

Objective

The thesis is aimed at enhancing the student's capability to work independently toward the solution of a theoretical or applied problem.

---

**Micro- and Nanosystems Master - Key for Type**

- **O**: Compulsory
- **W**+: Eligible for credits and recommended
- **W**: Eligible for credits
- **E-**: Recommended, not eligible for credits
- **Z**: Courses outside the curriculum
- **Dr**: Suitable for doctorate

**Key for Hours**

- **V**: lecture
- **G**: lecture with exercise
- **U**: exercise
- **S**: seminar
- **K**: colloquium
- **P**: practical/laboratory course
- **A**: independent project
- **D**: diploma thesis
- **R**: revision course / private study

---

ECTS European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
Exchange Students

Courses for Exchange Students

Prepare a study plan
In case the course catalogue of the upcoming semester is not available yet, please expect it to be like the year before.
You can study at ETH Zurich as an exchange student for 1 or 2 semesters, starting in the autumn or in the spring semester.
Exchange students may choose courses from different curricula and years, provided that at least two thirds of all courses are taken in the ETH Zurich department they are registered in. Please be sure to coordinate your schedule with your home university.

Exam sessions and End-of-semester examinations
Like all ETH Zurich students, exchange students are obliged to sit their exams during the official examination periods. Students are requested to be present at ETH Zurich during these periods. You are therefore expected to plan your studies, internships, jobs, and financial means accordingly.

by individual arrangement

D-ITET (Exchange Students)

Electrical Engineering and Information Technology MSc

Number Title Type ECTS Hours Lecturers
227-1501-00L Master’s Thesis W 30 credits 68D Supervisors

Admission only if ALL of the following apply:
a) bachelor program successfully completed;
b) acquired (if applicable) all credits from additional requirements for admission to master program;
c) successfully completed both semester projects.

Note: the conditions above are not applicable to incoming exchange students.

Biomedical Engineering MSc

Number Title Type ECTS Hours Lecturers
227-1772-10L Semester Project W 8 credits 20A Professors

Abstract
The semester project is designed to train the students in solving specific biomedical engineering problems. This project uses the technical and social skills acquired during the master's program. The semester project is advised by a professor.

Objective
see above

Nuclear Engineering MSc

Number Title Type ECTS Hours Lecturers
151-1009-00L Master’s Thesis Nuclear Engineering W 30 credits 64D Supervisors

Abstract
Master's programs are concluded by the master's thesis. The thesis is aimed at enhancing the student's capability to work independently toward the solution of a theoretical or applied problem. The subject of the master's thesis, as well as the project plan and roadmap, are proposed by the tutor and further elaborated with the student.

Objective
The thesis is aimed at enhancing the student's capability to work independently toward the solution of a theoretical or applied problem.

Mechanical Engineering MSc

Number Title Type ECTS Hours Lecturers
151-1001-00L Master’s Thesis Mechanical Engineering W 30 credits 64D Professors

Abstract
Master's programs are concluded by the master's thesis. The thesis is aimed at enhancing the student's capability to work independently toward the solution of a theoretical or applied problem. The subject of the master's thesis, as well as the project plan and roadmap, are proposed by the tutor and further elaborated with the student.

Objective
The thesis is aimed at enhancing the student's capability to work independently toward the solution of a theoretical or applied problem.
The Master's Thesis must be approved in advance by the tutor and is supervised by a professor of ETH Zurich. To choose a titular professor as a supervisor, please contact the D-MAVT Student Administration.

Abstract

Master's programs are concluded by the master's thesis. The thesis is aimed at enhancing the student's capability to work independently toward the solution of a theoretical or applied problem. The subject of the master's thesis, as well as the project plan and roadmap, are proposed by the tutor and further elaborated with the student.

Objective

The thesis is aimed at enhancing the student's capability to work independently toward the solution of a theoretical or applied problem.

Micro- and Nanosystems MSc

<table>
<thead>
<tr>
<th>Number</th>
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<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-1006-00L</td>
<td>Master's Thesis Micro- and Nanosystems</td>
<td>W</td>
<td>30 credits</td>
<td>64D</td>
<td>Professors</td>
</tr>
</tbody>
</table>

Students who fulfill the following criteria are allowed to begin with their Master's Thesis:

- Successful completion of the bachelor program;
- Fulfilling of any additional requirements necessary to gain admission to the master programme;
- Successful completion of the semester project;
- Achievement of 32 ECTS in the category "Core Courses".

The Master's Thesis must be approved in advance by the tutor and is supervised by a professor of ETH Zurich. To choose a titular professor as a supervisor, please contact the D-MAVT Student Administration.

Robotics, Systems and Control MSc

<table>
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<tr>
<th>Number</th>
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<tbody>
<tr>
<td>151-1016-00L</td>
<td>Master's Thesis Robotics, Systems and Control</td>
<td>W</td>
<td>30 credits</td>
<td>64D</td>
<td>Professors</td>
</tr>
</tbody>
</table>

Students who fulfill the following criteria are allowed to begin with their Master's Thesis:

- Successful completion of the bachelor program;
- Fulfilling of any additional requirements necessary to gain admission to the master programme;
- Successful completion of the semester project;
- Achievement of 28 ECTS in the category "Core Courses".

The Master's Thesis must be approved in advance by the tutor and is supervised by a professor of ETH Zurich or an adjunct faculty of RSC. To choose a titular professor as a supervisor, please contact the D-MAVT Student Administration.

Process Engineering MSc

<table>
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<tr>
<th>Number</th>
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<tr>
<td>151-1005-00L</td>
<td>Master's Thesis Process Engineering</td>
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<td>64D</td>
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Students who fulfill the following criteria are allowed to begin with their Master's Thesis:

- Successful completion of the bachelor program;
- Fulfilling of any additional requirements necessary to gain admission to the master programme;
- Successful completion of the semester project and industrial internship;
- Achievement of 28 ECTS in the category "Core Courses".

The Master's Thesis must be approved in advance by the tutor and is supervised by a professor of ETH Zurich. To choose a titular professor as a supervisor, please contact the D-MAVT Student Administration.

D-MTEC (Exchange Students)

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>363-0600-00L</td>
<td>Master's Thesis</td>
<td>W</td>
<td>30 credits</td>
<td>57D</td>
<td>Professors</td>
</tr>
</tbody>
</table>

Only students who fulfill the following criteria are allowed to begin with their master thesis:

- Successful completion of the bachelor programme;
b. fulfilling of any additional requirements necessary to
gain admission to the master programme;
c. internship fulfilled;
d. academic writing course has been completed (students
from Spring Semester 2015 onwards).

Abstract

In the Master thesis students prove their ability to independent, structured and scientific working. The Master thesis is supervised by the tutor and normally deals with a subject contained in the major fields. The research will be performed normally within a private company or at the ETH Zurich.

Objective

In the Master thesis students prove their ability to independent, structured and scientific working. The Master thesis is supervised by the tutor and normally deals with a subject contained in the major fields. The research will be performed normally within a private company or at the ETH Zurich.

<table>
<thead>
<tr>
<th>Exchange Students - Key for Type</th>
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<tbody>
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<td>W+</td>
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<td>W</td>
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<td>Dr</td>
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<th>Key for Hours</th>
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</table>

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Neural Systems and Computation Master

Core Courses

Compulsory Core Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>227-1045-00L</td>
<td>Readings in Neuroinformatics (University of Zurich)</td>
<td>O</td>
<td>3</td>
<td>1S</td>
<td>G. Indiveri, M. Cook, D. Kiper</td>
</tr>
</tbody>
</table>

Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

Abstract

Thirteen major areas of research have been selected, which cover the key concepts that have led to our current ideas of how the nervous system is built and functions. We will read both original papers and explore the conceptual links between them and discuss the 'sociology' of science, the pursuit of basic science questions over a century of research.

Objective

It is a commonplace that scientists rarely cite literature that is older than 10 years and when they do, they usually cite one paper that serves as the representative for a larger body of work that has long since been incorporated anonymously in textbooks. Worse than that, many authors have not even read the papers they cite in their own publications. This course, Foundations of Neuroscience, is one antidote. Thirteen major areas of research have been selected, which cover the key concepts that have led to our current ideas of how the nervous system is built and functions. Unusually, we will explore these areas of research by reading the original publications, instead of reading someone else's digested summary from a textbook or review. By doing this, we will learn how the discoveries were made, what instrumentation was used, how the scientists interpreted their own findings, and how their work, often over many decades and linked together with related findings from many different scientists, generate the current views of mechanism and structure of the nervous system.

Content

It is a commonplace that scientists rarely cite literature that is older than 10 years and when they do, they usually cite one paper that serves as the representative for a larger body of work that has long since been incorporated anonymously in textbooks. Worse than that, many authors have not even read the papers they cite in their own publications. This course, Foundations of Neuroscience, is one antidote. Thirteen major areas of research have been selected, which cover the key concepts that have led to our current ideas of how the nervous system is built and functions. Unusually, we will explore these areas of research by reading the original publications, instead of reading someone else's digested summary from a textbook or review. By doing this, we will learn how the discoveries were made, what instrumentation was used, how the scientists interpreted their own findings, and how their work, often over many decades and linked together with related findings from many different scientists, generate the current views of mechanism and structure of the nervous system.

Preferences

- For each part, students must hand in a written report and present a live demonstration of their measurement setup to the respective supervisor.
- For Part I, the teaching assistant, and the supervisor of Part II is task specific. Admission to Part II is conditional on completion of Part I (report + live demonstration).

Reports must contain detailed descriptions of the measurement goal, the measurement procedure, and the measurement outcome. Either confidence or significance of measurements must be provided. Acquisition and analysis software must be documented.
Elective Core Courses

Systems Neurosciences

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-1051-00L</td>
<td>Systems Neuroscience (University of Zurich)</td>
<td>W</td>
<td>6</td>
<td>2V+1U</td>
<td>D. Kiper</td>
</tr>
</tbody>
</table>

Abstract
The course provides an introduction to the functional properties of neurons. Particularly the description of membrane electrical properties (action potentials, channels), neuronal anatomy, synaptic structures, and neuronal networks. Simple models of computation, learning, and behavior will be explained. Some artificial systems (robot, chip) are presented.

Objective
Understanding computation by neurons and neuronal circuits is one of the great challenges of science. Many different disciplines can contribute their tools and concepts to solving mysteries of neural computation. The goal of this introductory course is to introduce the monocultures of physics, maths, computer science, engineering, biology, psychology, and even philosophy and history, to discover the enchantments and challenges that we all face in taking on this major 21st century problem and how each discipline can contribute to discovering solutions.

Theoretical Neurosciences

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-1037-00L</td>
<td>Introduction to Neuroinformatics</td>
<td>W</td>
<td>6</td>
<td>2V+1U</td>
<td>K. A. Martin, M. Cook, V. Mante, M. Pfeiffer</td>
</tr>
</tbody>
</table>

Computational Sciences

No course offerings in this semester

Neuromorphic Engineering

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-1033-00L</td>
<td>Neuromorphic Engineering I</td>
<td>W</td>
<td>6</td>
<td>2V+3U</td>
<td>T. Deibrück, G. Indiveri, S.C. Liu</td>
</tr>
</tbody>
</table>

Abstract
This course covers analog circuits with emphasis on neuromorphic engineering: MOS transistors in CMOS technology, static circuits, dynamic circuits, systems (silicon neuron, silicon retina, silicon cochlea) with an introduction to multi-chip systems. The lectures are accompanied by weekly laboratory sessions.

Objective
Understanding of the characteristics of neuromorphic circuit elements.
Contents

Neuromorphic circuits are inspired by the organizing principles of biological neural circuits. Their computational primitives are based on physics of semiconductor devices. Neuromorphic architectures often rely on collective computation in parallel networks. Adaptation, learning and memory are implemented locally within the individual computational elements. Transistors are often operated in weak inversion (below threshold), where they exhibit exponential I-V characteristics and low currents. These properties lead to the feasibility of high-density, low-power implementations of functions that are computationally intensive in other paradigms. Application domains of neuromorphic circuits include silicon retinas and cochleas for machine vision and audition, real-time emulations of networks of biological neurons, and the development of autonomous robotic systems. This course covers devices in CMOS technology (MOS transistor below and above threshold, floating-gate MOS transistor, phototransducers), static circuits (differential pair, current mirror, transconductance amplifiers, etc.), dynamic circuits (linear and nonlinear filters, adaptive circuits), systems (silicon neuron, silicon retina and cochlea) and an introduction to multi-chip systems that communicate events analogous to spikes. The lectures are accompanied by weekly laboratory sessions on the characterization of neuromorphic circuits, from elementary devices to systems.

Prerequisites / notice

Particular: The course is highly recommended for those who intend to take the spring semester course ‘Neuromorphic Engineering II’, that teaches the conception, simulation, and physical layout of such circuits with chip design tools.

Electives

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-0151-00L</td>
<td>Linear Algebra</td>
<td>W</td>
<td>4 credits</td>
<td>3G+2U</td>
<td>V. C. Gradinaru, R. Käppeli</td>
</tr>
<tr>
<td>Abstract</td>
<td>Contents: Linear systems - the Gaussian algorithm, matrices - LU decomposition, determinants, vector spaces, least squares - QR decomposition, linear maps, eigenvector problem, normal forms - singular value decomposition; numerical aspects; introduction to MATLAB.</td>
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</tr>
<tr>
<td>Objective</td>
<td>Einführung in die Lineare Algebra für Ingenieure unter Berücksichtigung numerischer Aspekte</td>
<td></td>
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</tr>
<tr>
<td>Lecture notes</td>
<td>K. Nipp / D. Stoffer, Lineare Algebra, vdf Hochschulverlag, S. Auflage 2002</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Literature</td>
<td>K. Nipp / D. Stoffer, Lineare Algebra, vdf Hochschulverlag, S. Auflage 2002</td>
<td></td>
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</tr>
<tr>
<td>401-0603-00L</td>
<td>Stochastics (Probability and Statistics)</td>
<td>W</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>M. H. Maathuis</td>
</tr>
<tr>
<td>Abstract</td>
<td>This class covers the following concepts: random variables, probability, discrete and continuous distributions, joint and conditional probabilities and distributions, the law of large numbers, the central limit theorem, descriptive statistics, statistical inference, inference for normally distributed data, point estimation, and two-sample tests.</td>
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<tr>
<td>Objective</td>
<td>Knowledge of the basic principles of probability and statistics.</td>
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<tr>
<td>Lecture notes</td>
<td>Lecture notes</td>
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<tr>
<td>Literature</td>
<td>Lecture notes</td>
<td></td>
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</tr>
<tr>
<td>401-0613-00L</td>
<td>Probability and Statistics</td>
<td>W</td>
<td>6 credits</td>
<td>3V+2U</td>
<td>J. Teichmann</td>
</tr>
</tbody>
</table>
| Abstract | Basic concepts from probability and statistics:  
- introduction to probability theory  
- short introduction to basic concepts and methods from statistics  
- probabilistic thinking and stochastic modelling  
- ability to perform basic statistical tests and to interpret the results |
| Objective | a) ability to understand the covered methods from probability theory and to apply them in other contexts  
b) probabilistic thinking and stochastic modelling  
c) ability to perform basic statistical tests and to interpret the results |
| Content | Basic concepts from probability and statistics with special emphasis on the topics needed in computer science  
- the laws of randomness and probabilistic thinking (thinking in probabilities)  
- understanding and intuition for stochastic modelling  
- simple and basic methods from statistics  
- - an introduction to probability theory: basic concepts (probability space, probability measure), independence, random variables, discrete and continuous distributions, conditional probability, expectation and variance, limit theorems  
- methods from statistics: parameter estimation, maximum likelihood and moment methods, tests, confidence intervals  
- lecture notes for the course (in German) will be made available electronically at the beginning of the course. |
| Lecture notes | Lecture notes |
| 227-1044-00L | Auditory Informatics (University of Zurich) | W    | 2 credits | 1S    | R. Stoop |
| Abstract | No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.  
UZH Module Code: INI413  
Mind the enrolment deadlines at UZH:  
http://www.uzh.ch/studies/application/mobilitaet_en.html |
| Objective | Invited talks on current research from the following areas: Auditory information processing, auditory sensors (biological and electrical), coding of information, perception, scene-segmentation. |
| Content | Exchange with researchers in the domain of auditory informatics. Preparing and giving a presentation on a suitable topic in front of a scientific audience.  
The semester program is available under:  
http://stoop.ini.uzh.ch/teaching/seminar-on-auditory-informatics  
On request the "Lehrsprache" may be changed to German. |
| Prerequisites / notice | On request the "Lehrsprache" may be changed to German. |
| 402-0811-00L | Programming Techniques for Scientific Simulations I | W    | 5 credits | 4G    | M. Troyer |
| Abstract | This lecture provides an overview of programming techniques for scientific simulations. The focus is on advances C++ programming techniques and scientific software libraries. Based on an overview over the hardware components of PCs and supercomputer, optimization methods for scientific simulation codes are explained. |
| 402-0809-00L | Introduction to Computational Physics | W    | 8 credits | 2V+2U | H. J. Herrmann |
This course offers an introduction to computer simulation methods for physics problems and their implementation on PCs and supercomputers: classical equations of motion, partial differential equations (wave equation, diffusion equation, Maxwell’s equation), Monte Carlo simulations, percolation, phase transitions.


Lecture and exercise lessons in English, exams in German or in English.

327-0703-00L Electron Microscopy in Material Science W 4 credits 2V+2U K. Kunze, R. Erni, S. Gerstl, F. Gramm, F. Krumeich

Abstract
A comprehensive understanding of the interaction of electrons with condensed matter and details on the instrumentation and methods designed to use these probes in the structural and chemical analysis of various materials.

Objective
A comprehensive understanding of the interaction of electrons with condensed matter and details on the instrumentation and methods designed to use these probes in the structural and chemical analysis of various materials.

Content
This course provides a general introduction into electron microscopy of organic and inorganic materials. In the first part, the basics of transmission- and scanning electron microscopy are presented. The second part includes the most important aspects of specimen preparation, imaging and image processing. In the third part, recent applications in materials science, solid state physics, structural biology, structural geology and structural chemistry will be reported.

Lecture notes
Englisch

Literature

227-0147-00L VLSI II: Design of Very Large Scale Integration Circuits W 7 credits 5G H. Kaeslin, F. K. Gürkaynak, M. Korb

Abstract
This second course in our VLSI series is concerned with how to turn digital circuit netlists into safe, testable and manufacturable mask layout, taking into account various parasitic effects. Low-power circuit design is another important topic. Economic aspects and management issues of VLSI projects round off the course.

Objective
Know how to design digital VLSI circuits that are safe, testable, durable, and make economic sense.

Content
The second course begins with a thorough discussion of various technical aspects at the circuit and layout level before moving on to economic issues of VLSI. Topics include:
- The difficulties of finding fabrication defects in large VLSI chips.
- How to make integrated circuit testable (design for test).
- Synchronous clocking disciplines compared, clock skew, clock distribution, input/output timing.
- Synchronization and metastability.
- CMOS transistor-level circuits of gates, flip-flops and random access memories.
- Sinks of energy in CMOS circuits.
- Power estimation and low-power design.
- Current research in low-energy computing.
- Layout parasitics, interconnected delay, static timing analysis.
- Switching currents, ground bounce, IR-drop, power distribution.
- Floorplanning, chip assembly, packaging.
- Layout design at the mask level, physical design verification.
- Electromigration, electrostatic discharge, and latch-up.
- Models of industrial cooperation in microelectronics.
- The caveats of virtual components.
- The cost structures of ASIC development and manufacturing.
- Market requirements, decision criteria, and case studies.
- Yield models.
- Avenues to low-volume fabrication.
- Marketing considerations and case studies.
- Management of VLSI projects.

Exercises are concerned with back-end design (floorplanning, placement, routing, clock and power distribution, layout verification). Industrial CAD tools are being used.

Lecture notes

All written documents in English.

Literature

Highlight:
Students are offered the opportunity to design a circuit of their own which then gets actually fabricated as a microchip! Students who elect to participate in this program register for a term project at the Integrated Systems Laboratory in parallel to attending the VLSI II course.

Prerequisites:
"VLSI I: from Architectures to Very Large Scale Integration Circuits and FPGAs" or equivalent knowledge.

Further details:
http://www.iis.ee.ethz.ch/stud_area/vorlesungen/vlsi2.en.html
The course is an introduction to some basic topics in signal processing, detection/estimation theory, and machine learning.

Scanning probe and diffraction techniques allow studying activated atomic processes during early stages of epitaxial growth. For this seminar reviews the philosophical and phenomenological as well as the neurobiological aspects of consciousness. The subjective features of consciousness are explored, and modern research into its neural substrate, particularly in the visual domain, is explained. Emphasis is placed on students developing their own thinking through a discussion-centered course structure.

The course's goal is to give an overview of the contemporary state of consciousness research, with emphasis on the contributions brought by modern cognitive neuroscience. We aim to clarify concepts, explain their philosophical and scientific backgrounds, and to present experimental protocols that shed light on a variety of consciousness related issues.

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Part I - Linear Signal Representation and Approximation: Hilbert spaces, least squares and LMMSE estimation, projection and estimation


The atomic processes on surfaces are activated by the increase of the substrate temperature. They can be studied using scanning tunneling microscopy (STM) and atomic force microscopy (AFM). The combination with molecular beam epitaxy (MBE) allows determining the sizes of the critical nuclei and the other activated processes in a hierarchical fashion. The evolution of the surface morphology is characterized by the density and size distribution of the nanostructures that could be quantified by means of the rate equation analysis, the mean-field nucleation theory, as well as the scaling theory. The surface morphology is further characterized by defects and nanostructure's shapes, which are based on the strain relieving mechanisms and kinetic growth processes.

As the first step, real structures on clean surfaces including surface reconstructions and surface relaxations, defects in crystals are presented, before the preparation of clean metallic, semiconducting, oxidic and organic surfaces are introduced.

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High-resolution electron diffraction is complementary to scanning probe techniques and provides exact mean values. Some phenomena are quantitatively described by the kinematic theory and perfectly understood by means of the Ewald construction. Other phenomena need to be described by the more complex dynamical theory. Electron diffraction is not only associated with elastic scattering but also inelastic excitation mechanisms that reflect the electronic structure of the surfaces studied. Low-energy electrons lead to phonon and high-energy electrons to plasmon excitations. Both effects are perfectly described by dipole and impact scattering.

Thin-films of rather complex organic materials are often quantitatively characterized by photons with a broad range of wavelengths from ultra-violet to infra-red light. Asymmetries and preferential orientations of the (anisotropic) molecules are verified using the optical dichroism and second harmonic generation measurements. These characterization techniques are vital for optimizing the preparation of medical implants and the determination of tissue's anisotropies within the human body.

Cell-surface interactions are related to the cell adhesion and the contractile cellular forces. Physical means have been developed to quantify these interactions. Other physical techniques are introduced in cell biology, namely to count and sort cells, to study cell proliferation and metabolism and to determine the relation between cell morphology and function.

3D scaffolds are important for tissue augmentation and engineering. Design, preparation methods, and characterization of these highly porous 3D microstructures are also presented.

Visiting clinical research in a leading university hospital will show the usefulness of the lecture series.

227-0147-00L -consciousness from philosophy to neuroscience (University of Zurich)  W 3 credits 2V D. Kiper, A. Gamma

mind the enrollment deadlines at UZH: http://www.uzh.ch/studies/application/mobilitaet_en.html

objective

the course includes discussions of scientific as well as philosophical articles. We review current schools of thought, models of consciousness, and proposals for the neural correlate of consciousness (NCC).

content

lecture notes

literature

prerequisites / notice

Since we are all experts on consciousness, we expect active participation and discussions!

402-0674-00L -physics in medical research: from atoms to cells W 6 credits 2V+1U B. K. Müller

abstract

scanning probe and diffraction techniques allow studying activated atomic processes during early stages of epitaxial growth. For quantitative description, rate equation analysis, mean-field nucleation and scaling theories are applied on systems ranging from simple metallic to complex organic materials. The knowledge is expanded to optical and electronic properties as well as to proteins and cells.

objective

the lecture series is motivated by an overview covering the skin of the crystals, roughness analysis, contact angle measurements, protein absorption/ activity and monocyte behaviour.

content

lecture notes

literature

prerequisites / notice

we display articles pertaining to the issues we cover in the class on the course's webpage.

Since we are all experts on consciousness, we expect active participation and discussions!
Abstract
Machine learning algorithms provide analytical methods to search data sets for characteristic patterns. Typical tasks include the classification of data, function fitting and clustering, with applications in image and speech analysis, bioinformatics and exploratory data analysis. This course is accompanied by practical machine learning projects.

Objective
Students will be familiarized with the most important concepts and algorithms for supervised and unsupervised learning; reinforce the statistics knowledge which is indispensible to solve modeling problems under uncertainty. Key concepts are the generalization ability of algorithms and systematic approaches to modeling and regularization. A machine learning project will provide an opportunity to test the machine learning algorithms on real world data.

Content
The theory of fundamental machine learning concepts is presented in the lecture, and illustrated with relevant applications. Students can deepen their understanding by solving both pen-and-paper and programming exercises, where they implement and apply famous algorithms to real-world data.

Topics covered in the lecture include:
- Bayesian theory of optimal decisions
- Maximum likelihood and Bayesian parameter inference
- Classification with discriminant functions: Perceptrons, Fisher’s LDA and support vector machines (SVM)
- Ensemble methods: Bagging and Boosting
- Regression: least squares, ridge and LASSO penalization, non-linear regression and the bias-variance trade-off
- Non parametric density estimation: Parzen windows, nearest neighbour
- Dimension reduction: principal component analysis (PCA) and beyond

Lecture notes
No lecture notes, but slides will be made available on the course webpage.

Literature

Prerequisites / notice
The course requires solid basic knowledge in analysis, statistics and numerical methods for CSE as well as practical programming experience for solving assignments. Students should at least have followed one previous course offered by the Machine Learning Institute (e.g., CIL or LIS) or an equivalent course offered by another institution.

GESS Science in Perspective
see GESS Science in Perspective: Language Courses
ETH/UZH

Recommended GESS Science in Perspective (Type B) for D-ITET

see GESS Science in Perspective: Type A: Enhancement of Reflection Capability

Master’s Thesis and Semester Papers/Seminars
Option 1: Long Master’s Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-1041-01L</td>
<td>NSC Master's Theses (long) and Exam (University of Zurich)</td>
<td>W</td>
<td>45</td>
<td>96D</td>
<td>R. Hahnloser</td>
</tr>
</tbody>
</table>

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: INI503
Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html
Only students who fulfills the following criteria are allowed to begin with their master thesis:
- a. successful completion of the bachelor programme;
- b. fulfilling of any additional requirements necessary to gain admission to the master programme.

Abstract
The Master thesis concludes the study programme. Thesis work should prove the students' ability to independent, structured and scientific working.

Objective
see above

Option 2: Short Master’s Thesis and Semester Papers/Seminars

Short Master Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-1041-02L</td>
<td>NSC Master's Theses and Exam (University of Zurich)</td>
<td>W</td>
<td>29</td>
<td>62D</td>
<td>R. Hahnloser</td>
</tr>
</tbody>
</table>

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: INI504
Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html
Only students who fulfills the following criteria are allowed to begin with their master thesis:
- a. successful completion of the bachelor programme;
- b. fulfilling of any additional requirements necessary to gain admission to the master programme.
Abstract

The Master thesis concludes the study programme. Thesis work should prove the students' ability to independent, structured and scientific working.

Objective

see above

Semester Papers/Seminars

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-1036-01L</td>
<td>NSC Master Short Project I (University of Zurich)</td>
<td>W</td>
<td>8 credits</td>
<td>17A</td>
<td>R. Hahnloser</td>
</tr>
<tr>
<td></td>
<td><em>No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: INI505</em></td>
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<tr>
<td></td>
<td>Mind the enrolment deadlines at UZH:</td>
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<tr>
<td>Abstract</td>
<td>Usually a student selects the topic of a Master Short Project in consultation with his or her mentor.</td>
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<tr>
<td>Objective</td>
<td>see above</td>
<td></td>
<td></td>
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</tbody>
</table>

| 227-1036-02L | NSC Master Short Project II (University of Zurich)                    | W    | 8 credits| 17A   | R. Hahnloser |
|             | *No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: INI506* |      |          |       |           |
|             | Mind the enrolment deadlines at UZH:                                 |      |          |       |           |
| Abstract   | Usually a student selects the topic of a Master Short Project in consultation with his or her mentor. |      |          |       |           |
| Objective  | see above                                                             |      |          |       |           |

Neural Systems and Computation Master - Key for Type

| O | Compulsory                                                                 | E-  | Recommended, not eligible for credits |
| W+| Eligible for credits and recommended                                       | Z   | Courses outside the curriculum       |
| W | Eligible for credits                                                       | Dr  | Suitable for doctorate               |

Key for Hours

| V | lecture                                                                     | P   | practical/laboratory course          |
| G | lecture with exercise                                                      | A   | independent project                  |
| U | exercise                                                                    | D   | diploma thesis                       |
| S | seminar                                                                    | R   | revision course / private study      |
| K | colloquium                                                                |     |                                       |

ECTS

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Core Courses

1. Semester (EPFL)

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-2011-00L</td>
<td>Neutronics (EPFL)</td>
<td>O</td>
<td>4</td>
<td>3G</td>
<td>external organisers</td>
</tr>
<tr>
<td></td>
<td>No enrolment to this course at ETH Zurich. Book the corresponding module directly at EPFL.</td>
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<tr>
<td>Abstract</td>
<td>In this course, one acquires an understanding of the basic neutronics interactions occurring in a nuclear fission reactor and, as such, the conditions for establishing and controlling a nuclear chain reaction.</td>
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<tr>
<td>Objective</td>
<td>By the end of the course, the student must be able to:</td>
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<tr>
<td></td>
<td>- Elaborate on neutron diffusion equation</td>
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<td></td>
<td>- Systematize nuclear reaction cross sections</td>
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<td></td>
<td>- Formulate approximations to solving the diffusion equation for simple systems</td>
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<td>Content</td>
<td>Content:</td>
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</tr>
<tr>
<td></td>
<td>- Brief review of nuclear physics</td>
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<tr>
<td></td>
<td>- Historical: Constitution of the nucleus and discovery of the neutron - Nuclear reactions and radioactivity - Cross sections - Differences between fusion and fission.</td>
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<td>- Nuclear fission</td>
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<td>- Characteristics - Nuclear fuel - Introductory elements of neutronics.</td>
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<td>- Fissile and fertile materials - Breeding.</td>
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<td>- Neutron diffusion and slowing down</td>
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<td>- Monoenergetic neutrons - Angular and scalar flux</td>
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<td></td>
<td>- Diffusion theory as simplified case of transport theory - Neutron slowing down through elastic scattering.</td>
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<td>- Multiplying media (reactors)</td>
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<td>- Multiplication factors - Criticality condition in simple cases.</td>
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<td>- Reactor kinetics</td>
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<td>- Point reactor model: prompt and delayed transients - Practical applications.</td>
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<td>- Reactivity variations and control</td>
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<td>- Short, medium and long term reactivity changes ? Different means of control.</td>
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<tr>
<td>Literature</td>
<td>Distributed documents, recommended book chapters</td>
<td></td>
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<tr>
<td>Prerequisites / notice</td>
<td>Prerequisite for: Reactor Experiments</td>
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</tbody>
</table>

| 151-2013-00L | Reactor Experiments (EPFL) | O    | 4    | 5U    | external organisers  |
|             | No enrolment to this course at ETH Zurich. Book the corresponding module directly at EPFL. |      |      |       |                      |
| Abstract    | To gain hands-on experience in the conduction of nuclear radiation measurements, as also in the execution and analysis of reactor physics experiments using the CROCUS reactor. |      |      |       |                      |
| Objective   | To gain hands-on experience in the conduction of nuclear radiation measurements, as also in the execution and analysis of reactor physics experiments using the CROCUS reactor. |      |      |       |                      |
| Content     | - Radiation detector systems, alpha and beta particles |      |      |       |                      |
|             | - Radiation detector systems, gamma spectroscopy |      |      |       |                      |
|             | - Introduction to neutron detectors (He-3, BF3) |      |      |       |                      |
|             | - Slow-down area (Fermi age) of Pu-Be neutrons in H2O |      |      |       |                      |
|             | - Approach-to-critical experiments |      |      |       |                      |
|             | - Buckling measurements |      |      |       |                      |
|             | - Reactor power calibration |      |      |       |                      |
|             | - Control rod calibration |      |      |       |                      |
| Literature  | Distributed documents, recommended book chapters |      |      |       |                      |
| Prerequisites / notice | Prerequisite for: Special Topics in Reactor Physics (2nd sem.) |      |      |       |                      |

| 151-2015-00L | Reactor Technology (EPFL) | O    | 4    | 3G    | H.M. Prasser, external organisers  |
|             | No enrolment to this course at ETH Zurich. Book the corresponding module directly at EPFL. |      |      |       |                      |
| Abstract    | This course provides an overview of microfabrication processes used to produce micro-scale robots and will cover topics related to microactuators, microsensors, and modeling at these scales. The course will also investigate micromanipulation technologies, incl. the assembly of micron-sized parts, the manipulation of biological cells, and the types of robots used to perform these tasks. |      |      |       |                      |
| Objective   | To comprehend (particularly in the context of light water reactors) the basic heat removal phenomena in a reactor core, identify the technological limits for heat generation from the viewpoints of fuel, cladding and coolant, and be introduced to optimization principles in reactor thermal design. |      |      |       |                      |
### Content
- Fuel rod, LWR fuel elements
- Temperature field in fuel rod
- Reactor core, design
- Flux and heat source distribution, cooling channel
- Single-phase convective heat transfer, axial temperature profiles
- Boiling crisis and DNB ratio
- Pressurized water reactors, design
- Primary circuit design
- Steam generator heat transfer, steam generator types
- Boiling water reactors
- Reactor design
- LWR power plant technology
- Other types of reactors (overview)
- Generation IV systems

### Literature
Distributed documents, recommended book chapters

### Prerequisites / notice
Required prior knowledge: Neutronics
Prerequisite for: Nuclear Safety (2nd sem.)

### 151-2043-00L Radiation Protection and Radiation Applications (EPFL)

**Abstract**
An introductory course in the basic concepts of radiation detection and interactions and energy deposition by ionizing radiation in matter, radionuclide production and its applications in medicine, industry and research. The course includes presentations, lecture notes, problem sets and seminars.

**Objective**
By the end of the course, the student must be able to:
- Explain the basic physics principles that underpin radiotherapy, e.g. types of radiation, atomic structure, etc.
- Explain the interaction mechanisms of ionizing radiation at keV and MeV energies with matter.
- Explain the principles of radiation dosimetry.
- Explain the principles of therapeutic radiation physics including X-rays, electron beam physics, radioactive sources, use of unsealed sources and Brachytherapy.
- Describe how to use radiotherapy equipment both for tumour localisation, planning and treatment.
- Define quality assurance and quality control, in the context of radiotherapy and the legal requirements.
- Explain the principles and practice of radiation protection, dose limits, screening and protection mechanisms.

**Content**
Basics: radiation sources and interaction with matter, radionuclide production using reactors and accelerators, radiation protection and shielding.

Medical applications: diagnostic tools, radiopharmaceuticals, cancer treatment methodologies such as brachytherapy, neutron capture therapy and proton therapy.

Industrial applications: radiation gauges, radiochemistry, tracer techniques, radionuclide batteries, sterilisation, etc.

Applications in research: dating by nuclear methods, applications in environmental and life sciences, etc.


**Abstract**
To understand the basic principles governing the advanced energy conversion systems and the perspective for technological progress. To present the characteristics of the main fossil and renewable energy systems from a resource and production technology viewpoint. Learning to assess the globally and locally available resources of such energies and be able to dimension roughly the installations required.

**Objective**
To understand the basic principles governing the advanced energy conversion systems and the perspective for technological progress. To present the essential characteristics of the main fossil and renewable energy systems from a resource and production technology viewpoint. The students will learn to assess the globally and locally available resources of such fossil or renewable energies and be able to make a rough dimensioning of the installations that will use them.

**Content**
- Overview of fossil and renewable energy resource characteristics
- Reminder of Thermodynamic Laws and exergy theory
- Vapour and gas cycles, combined cycles. Natural gas, coal and nuclear power plants
- Fuel cell principles and technologies. Hybrid fuel cell - turbine cycles
- Technologies of heat pumps (compression, absorption, magnetic) and Organic Rankine Cycles (ORC). Co- and tri-generation
- Biomass technologies for both fuel (liquid or gas) or renewable energies and be able to make a rough dimensioning of the installations that will use them.
- Solar energy resources
- Solar-thermal and photovoltaic systems
- Hydraulic resources
- Hydraulic turbines and schemes
- Wind energy resources
- Wind turbines
- Other renewable technologies

**Literature**
Bibliographie:
Notes of the lectures;
Borel, Favrat Thermodynamique et énergétique PPUR 2005, Haldi et al. Systèmes énergétiques PPUR 2003 (distributed course notes and partial translation of chapters of books)

**Prerequisites / notice**
Required prior knowledge: Basic knowledge of physics and thermodynamics

### 151-2021-00L Hydraulic Turbomachines (EPFL)

**Abstract**
To understand the basic principles governing the hydraulic turbomachines and the perspective for technological progress. To present the essential characteristics of the main hydraulic turbomachines from a resource and production technology viewpoint. The students will learn to assess the globally and locally available resources of such hydraulic turbomachines and be able to dimension roughly the installations that will use them.

**Objective**
To understand the basic principles governing the hydraulic turbomachines and the perspective for technological progress. To present the essential characteristics of the main hydraulic turbomachines from a resource and production technology viewpoint. The students will learn to assess the globally and locally available resources of such hydraulic turbomachines and be able to dimension roughly the installations that will use them.

**Content**
- Overview of hydraulic turbomachines characteristics
- Reminder of Thermodynamic Laws and exergy theory
- Vapour and gas cycles, combined cycles. Natural gas, coal and nuclear power plants
- Fuel cell principles and technologies. Hybrid fuel cell - turbine cycles
- Technologies of heat pumps (compression, absorption, magnetic) and Organic Rankine Cycles (ORC). Co- and tri-generation
- Biomass technologies for both fuel (liquid or gas) or renewable energies and be able to make a rough dimensioning of the installations that will use them.
- Solar energy resources
- Solar-thermal and photovoltaic systems
- Hydraulic resources
- Hydraulic turbines and schemes
- Wind energy resources
- Wind turbines
- Other renewable technologies

**Literature**
Bibliographie:
Notes of the lectures;
Borel, Favrat Thermodynamique et énergétique PPUR 2005, Haldi et al. Systèmes énergétiques PPUR 2003 (distributed course notes and partial translation of chapters of books)

**Prerequisites / notice**
Required prior knowledge: Basic knowledge of physics and thermodynamics
Abstract
Mastering the scientific design of a hydraulic machine, pump and turbine, by using the most advanced engineering design tools. For each chapters the theoretical basis are first established and then practical solutions are discussed with the help of recent design examples.

Objective
Mastering the scientific design of a hydraulic machine, pump and turbine, by using the most advanced engineering design tools. For each chapters the theoretical basis are first established and then practical solutions are discussed with the help of recent design examples.

Content
- Turbomachine equations, mechanical power balance in a hydraulic machines, moment of momentum balance applied to the runner/impeller, generalized Euler equation.
- Hydraulic characteristic of a reaction turbine, a Pelton turbine and a pump, losses and efficiencies of a turbomachine, real hydraulic characteristics.
- Similarity laws, non dimensional coefficients, reduced scale model testing, scale effects.
- Cavitation, hydraulic machine setting, operating range, adaptation to the piping system, operating stability, runaway.
- Reaction turbine design: general procedure, general project layout, design of a Francis runner, design of the spiral casing and the distributor, draft tube role, CFD validation of the design, design fix, reduced scale model experimental validation.
- Pelton turbine design: general procedure, project layout, injector design, bucket design, mechanical problems.
- Centrifugal pump design: general architecture, energetic loss model in the diffuser and/or the volute, volute design, operating stability.

151-2023-00L Nuclear Fusion and Plasma Physics (EPFL)

Objective
Achieve basic understanding of plasma physics concepts for fusion energy, and of basic principles of fusion reactors.

Content
1) Basics of thermonuclear fusion
2) The plasma state and its collective effects
3) Charged particle motion and collisional effects
4) Fluid description of a plasma
5) Plasma equilibrium and stability
6) Magnetic confinement: Tokamak and Stellarator
7) Waves in plasma
8) Wave-particle interactions
9) Heating and non inductive current drive by radio frequency waves
10) Heating and non inductive current drive by neutral particle beams
11) Material science and technology: Low and high Temperature superconductor - Properties of material under irradiation
12) Some nuclear aspects of a fusion reactor: Tritium production
13) Licensing a fusion reactor: safety, nuclear waste
14) Inertial confinement

151-2025-00L Introduction to Particle Accelerators (EPFL)

Abstract
The course presents basic physics ideas underlying the workings of modern accelerators. We will examine key features and limitations of these machines as used in accelerator driven sciences like high energy physics, materials and life sciences.

Objective
By the end of the course, the student must be able to:
- Design basic linear and non-linear charged particles optics
- Elaborate basic ideas of physics of accelerators
- Use a computer code for optics design
- Optimize accelerator design for a given application
- Estimate main beam parameters of a given accelerator

Content
Overview, history and fundamentals
Transverse particle dynamics (linear and nonlinear)
Longitudinal particle dynamics
Linear accelerators
Circular accelerators
Acceleration and RF-technology
Beam diagnostics
Accelerator magnets
Injection and extraction systems
Synchrontron radiation

151-2041-00L Medical Radiation Physics (EPFL)

Prerequisites / notice
Prérequis: Notion de relativité restreinte et d'électrodynamique

Data: 06.03.2019 12:57
Autumn Semester 2016
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This course covers the physical principles underlying medical imaging using ionizing radiation (radiography, fluoroscopy, CT, SPECT, PET). The focus is not only on risk and close to the patient and staff, but also on an objective description of the image quality.

Physics of radiography: X-ray production, Radiation-patient interaction, Image detection and display

Image quality: Wagner's taxonomy, MTF, NPS, contrast, SNR, DQE, NEQ, CNR

Dose to the patient: External irradiation, Internal contamination, compartmental models

Physics of computer tomography (CT)

Risk and radiation: Rational risk and state of our knowledge, Psychological aspects, Ethics and communication

Physics of single-photon emission computed tomography (SPECT)

Physics of mammography

Receiver operating characteristics (ROC) and hypothesis testing: Link between medical diagnostic and statistical hypothesis testing, Sensitivity, specificity, prevalence, predictive values

Physics of radioscopy

Model observers in medical imaging: Human visual characteristics and their quantification, Bayesian cost and Ideal model observer, Anthropomorphic model observers, Detection experiments (rating, M-AFC, yes-no)

Physics of positron emission tomography (PET)

Physics of resonance magnetic imaging
The course will teach fundamental concepts of Uncertainty Quantification and Propagation (UQ+P) for computational models of systems in engineering and life sciences. Emphasis will be placed on practical and computational aspects of UQ+P including the implementation of relevant algorithms in multicores architecture.

Content
Topics will be covered including: Uncertainty quantification under parametric and non-parametric modeling uncertainty, Bayesian inference with model class assessment, Markov Chain Monte Carlo simulation, prior and posterior reliability analysis.

Lecture notes
The class will be largely based on the book: Data Analysis: A Bayesian Tutorial by Devinderjit Sivia as well as on class notes and related literature that will be distributed in class.

Literature
1. Data Analysis: A Bayesian Tutorial by Devinderjit Sivia
2. Probability Theory: The Logic of Science by E. T. Jaynes
3. Class Notes

Prerequisites / notice
Fundamentals of Probability, Fundamentals of Computational Modeling

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>151-0104-00L</td>
<td>Uncertainty Quantification for Engineering &amp; Life</td>
<td>4</td>
<td>3G</td>
<td>P. Koumoutsakos</td>
</tr>
</tbody>
</table>

Abstract
Quantification of uncertainties in computational models pertaining to applications in engineering and life sciences. Exploitation of massively available data to develop computational models with quantifiable predictive capabilities. Applications of Uncertainty Quantification and Propagation to problems in mechanics, control, systems and cell biology.

Objective
The course will teach fundamental concept of Uncertainty Quantification and Propagation (UQ+P) for computational models of systems in Engineering and Life Sciences. Emphasis will be placed on practical and computational aspects of UQ+P including the implementation of relevant algorithms in multicores architecture.

Content
Topics that will be covered include: Uncertainty quantification under parametric and non-parametric modelling uncertainty, Bayesian inference with model class assessment, Markov Chain Monte Carlo simulation, prior and posterior reliability analysis.

Lecture notes
Slides will be handed out.

Literature

Elecitives
Course from the catalogue of Master courses ETH Zurich and EPFL. At least 4 credit points must be collected from the offer of Science in Perspective (SiP) compulsory electives at ETH Zurich or Management of Technology and Entrepreneurship at EPFL.

Industrial Internship
Number | Title | Type | ECTS | Lecturers
---|---|---|---|---
151-1021-00L | Industrial Internship Nuclear Engineering Only for Nuclear Engineering MSc. | O | 8 | external organisers

Abstract
The main objective of the 12-week internship is to expose master's students to the industrial work environment within the field of nuclear energy. During this period, students have the opportunity to be involved in on-going projects at the host institution.

Objective
The main objective of the 12-week internship is to expose master's students to the industrial work environment within the field of nuclear energy.

Semester Project
Number | Title | Type | ECTS | Lecturers
---|---|---|---|---
151-1020-00L | Semester Project Nuclear Engineering Only for Nuclear Engineering MSc. | O | 8 | Professors

Abstract
The subject of the Semester Project and the choice of the supervisor (ETH or EPFL professor) are to be approved in advance by the tutor.

Objective
The semester project is designed to train the students in the solution of specific engineering problems. This makes use of the technical and social skills acquired during the master's program. Tutors propose the subject of the project, elaborate the project plan, and define the roadmap together with their students, as well as monitor the overall execution.

Master's Thesis
Number | Title | Type | ECTS | Lecturers
---|---|---|---|---
151-1009-00L | Master's Thesis Nuclear Engineering Students who fulfill the following criteria are allowed to | O | 30 | Supervisors

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>151-1021-00L</td>
<td>Industrial Internship Nuclear Engineering Only for Nuclear Engineering MSc.</td>
<td>O</td>
<td>8</td>
<td>external organisers</td>
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<tr>
<td>151-1020-00L</td>
<td>Semester Project Nuclear Engineering Only for Nuclear Engineering MSc.</td>
<td>O</td>
<td>8</td>
<td>Professors</td>
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<tr>
<td>151-1009-00L</td>
<td>Master's Thesis Nuclear Engineering Students who fulfill the following criteria are allowed to</td>
<td>O</td>
<td>30</td>
<td>Supervisors</td>
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</table>
begin with their Master's Thesis:

a. successful completion of the bachelor programme;
b. fulfilling of any additional requirements necessary to
gain admission to the master programme;
c. successful completion of the semester project.
d. completion of minimum 72 ECTS in the categories
"Core Courses" and "Electives" in the Master studies and
completion of 8 ECTS in the "Semester Project"

For the supervision of the Master's Thesis, the following professors can be chosen: H.-M. Prasser (ETHZ), M.Q. Tran (EPFL), A. Pautz (EPFL)

Abstract

Master's programs are concluded by the master's thesis. The thesis is aimed at enhancing the student's capability to work independently

Objective

The thesis is aimed at enhancing the student's capability to work independently toward the solution of a theoretical or applied problem.

Nuclear Engineering Master - Key for Type

<table>
<thead>
<tr>
<th>Key</th>
<th>Type Description</th>
<th>Recommended/Eligibility</th>
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<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
<td>E- Recommended, not eligible for credits</td>
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<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z Courses outside the curriculum</td>
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<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr Suitable for doctorate</td>
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Key for Hours

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<tr>
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<td>lecture with exercise</td>
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<td>U</td>
<td>exercise</td>
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<td>S</td>
<td>seminar</td>
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<td>K</td>
<td>colloquium</td>
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<td>P</td>
<td>practical/laboratory course</td>
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<td>A</td>
<td>independent project</td>
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<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
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ECTS

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
# First Year Examinations

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</table>

**Abstract**

First identification with Pharmaceutical Sciences; motivation for profiling in the Natural Sciences, which are focused on within the first two years as a preparation for the specialized studies; sensitization for the duties and the responsibilities of a person with a federal diploma in Pharmacy; information about job opportunities.

**Objective**

First identification with Pharmaceutical Sciences; motivation for profiling in the Natural Sciences as a preparation for the specialized studies; sensitization for the duties and the responsibilities of a person with a federal diploma in Pharmacy; information about job opportunities.

**Content**

Introduction to Pharmaceutical Sciences by selected milestones of research and development. Overview on research activities at the Institute of Pharmaceutical Sciences that is focussed on drug delivery and development (from concepts to prototypes). Sensitization for communication skills and information management. Demonstration of job opportunities in community pharmacies, in the hospital, in industry, and in the public sector by experts in the different fields.

**Lecture notes**

Handouts for individual lectures.

**Prerequisites / notice**

Interactive teaching

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<tr>
<th>Number</th>
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<tbody>
<tr>
<td>401-0291-00L</td>
<td>Mathematics I</td>
<td>O</td>
<td>6</td>
<td>4V+2U</td>
<td>E. W. Farkas</td>
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</tbody>
</table>

**Abstract**

Mathematics III is an introduction to one- and multidimensional calculus and linear algebra emphasizing on applications.

**Objective**

Students understand mathematics as a language for modeling and as a tool for solving practical problems in natural sciences. Students can analyze models, describe solutions qualitatively or calculate them explicitly if need be. They can solve examples as well as their practical applications manually and using computer algebra systems.

**Content**

Einführung in die Differentiell- und Integralrechnung von Funktionen einer Variablen und Anwendungen:


**Literature**

Siehe Lernmaterialien > Literatur

L. Papula, Mathematik für Ingenieure und Naturwissenschaftler, 11. Auflage, Vieweg und Teubner

Th. Wihler, Mathematik für Naturwissenschaften, 2 Bände: Einführung in die Analysis, Einführung in die Lineare Algebra; Haupt-Verlag Bern, UTB

Ch. Blatter, Lineare Algebra; VDF

H. H. Storrer: Einführung in die mathematische Behandlung der Naturwissenschaften I; Birkhäuser.

Prerequisities / notice


Der Zugang zu den Übungsserien erfolgt online. Vorlesungsverzeichnis > Lernmaterialien > Material zur Vorlesung

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>252-0852-00L</td>
<td>Foundations of Computer Science</td>
<td>O</td>
<td>4</td>
<td>2V+2U</td>
<td>L. E. Fässler, H.J. Böckenhauer, M. Dahinden, D. Komm, H. Lehner</td>
</tr>
</tbody>
</table>

**Abstract**

Students learn to apply selected concepts and tools from computer science for working on interdisciplinary projects. The following topics are covered: modeling and simulations, introduction to programming, visualizing multi-dimensional data, introduction matrices, managing data with lists and tables and with relational databases, universal methods for algorithm design.

**Objective**

The students learn to:

- understand the role of computer science in science,
- to control computer and automate processes of problem solving by programming,
- choose and apply appropriate tools from computer science,
- process and analyze real-world data from their subject of study,
- handle the complexity of real-world data,
- know universal methods for algorithm design.

**Content**

1. The role of computer science in science
2. Introduction to Programming with Python
3. Modeling and simulations
4. Introduction to Matrices with Matlab
5. Visualizing multidimensional data
6. Data management with lists and tables
7. Data management with a relational database
8. Universal methods for algorithm design

**Lecture notes**

All materials for the lecture are available at www.gdi.ethz.ch

**Prerequisites / notice**

This course is based on application-oriented learning. The students spend most of their time working through projects with data from natural science and discussing their results with teaching assistants. To learn the computer science basics there are electronic tutorials available.

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<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>529-1001-01L</td>
<td>General Chemistry (for Biology/Pharmacy/HST)</td>
<td>O</td>
<td>4</td>
<td>4V</td>
<td>W. Uhlig</td>
</tr>
</tbody>
</table>

**Abstract**

This course is based on application-oriented learning. The students spend most of their time working through projects with data from natural science and discussing their results with teaching assistants. To learn the computer science basics there are electronic tutorials available.
The lecture deals with a number of basic chemistry concepts. These include (amongst others) chemical reactions, energy transfer during chemical reactions, properties of ionic and covalent bonds, Lewis structures, properties of solutions, kinetics, thermodynamics, acid-base equilibria, electrochemistry and properties of metal complexes.

The course is designed to provide an understanding of the basic principles and concepts of general and inorganic chemistry.

These include (amongst others) chemical reactions, energy transfer during chemical reactions, properties of ionic and covalent bonds, Lewis structures, properties of solutions, kinetics, thermodynamics, acid-base equilibria, electrochemistry and properties of metal complexes.


Weiterführende Literatur:
Brown, LeMay, Bursten CHEMIE (deutsch)
Housecroft and Constable, CHEMISTRY (englisch)
Oxtoby, Gillis, Nachtrieb, MODERN CHEMISTRY (englisch)

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>529-1011-00L</td>
<td>Organic Chemistry I (for students of Biology, Pharmaceutical Sci., and Health Sci. &amp; Tech.)</td>
<td>O</td>
<td>4 credits</td>
<td>4G</td>
<td>C. Thilgen</td>
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</table>

**Abstract**
Fundamentals of Organic Chemistry: molecular structure. Bonding and functional groups; nomenclature; resonance and aromaticity; stereochemistry; conformation; bond strength; organic acids and bases; basic reaction thermodynamics and kinetics; reactive intermediates: carbanions, carbenium ions and radicals.

**Objective**
Understanding the basic concepts and definitions of organic chemistry. Knowledge of the functional groups and classes of compounds that are important in biological systems. Foundations for the understanding of the relationship between structure and reactivity.

**Content**

**Lecture notes**
Printed lecture notes are available. Exercises, answer keys and other handouts can be downloaded from the Moodle course "Organic Chemistry I" of the current semester (https://moodle-app2.let.ethz.ch).

**Literature**
Lecture notes are available.

As a supplement, a selection of textbooks is proposed:

**551-0105-00L**
**Fundamentals of Biology IA**

<table>
<thead>
<tr>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
<th>Abstract</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>5 credits</td>
<td>5G</td>
<td>M. Aebi, E. Hafen</td>
<td></td>
</tr>
</tbody>
</table>

**Abstract**
The course provides an introduction to the basics of molecular- and cell biology and genetics.

**Objective**
Introduction to modern biology and to principal biological concepts.

**Content**
The course is divided into several chapters:
1. Basic principles of Evolution.
2. Chemistry of Life: Water; Carbon and molecular diversity; biomolecules
3. The cell: structure; membrane structure and function, cell cycle
4. Metabolism: Respiration; Photosynthesis; Fermentation
5. Heredity: meiosis and sexual reproduction; Mendelian genetics, chromosomal basis of inheritance, molecular basis of inheritance, from gene to protein, regulation of gene expression; genomes and their evolution

**Lecture notes**
None.

**Literature**
The text-book "Biology" (Campbell, Reece) (10th edition) is the basis of the course.

The structure of the course is largely identical with that of the text-book.

**Prerequisites / notice**
Certain sections of the text-book must be studied by self-instruction.

**Additional First Year Courses**

**535-0567-00L**
**Communication and Social Competences**

<table>
<thead>
<tr>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>1 credit</td>
<td>1V</td>
<td>J. Stadelwieser</td>
</tr>
</tbody>
</table>

**Abstract**
Introduction into basic skills of rhetoric, presentation, communication. Introduction into learning and working techniques and writing protocols.

**Objective**
Students . . .

(1) recognize the importance of effective communication/presentation regarding objectives and audience;
(2) know the basics of rhetoric, communication, presentation, learning and working techniques;
(3) are enabled to prepare presentations (with slides/powerpoint);
(4) know four types of protocols;
(5) are enabled to write protocols;
(6) know possibilities to optimize their learning and working success;
(7) are enabled to scrutinize a scientifical text.

**Content**
- Communication: models
- Preparation of presentation
- Analysis of the audience; definition of goals
- Language, pronunciation, technique, space
- Stage fright
- Protocols: types, writing protocols
- Scientific text: scrutinize
- Learning effectively
- Working rules

**Literature**
- Stadelwieser Jürg, Kommunikation als Schlüssel zum Erfolg, Tobler, 2000 (vergriffen/Bibliothek).

**535-1001-00L**
**Laboratory Course General Chemistry (for Biology and Pharmacy)**

**Type**
O 6 credits 8P R. O. Kiasner, K.H. Altmann, J. Hall, D. Neri, G. Schneider, M. D. Wörle

**Abstract**
Information about the practical course will be given on the first day.
Abstract
Introduction to the practical work in a chemistry laboratory. The most important manipulations and techniques are treated, as well as the the most fundamental chemical reaction types.

Objective
- Knowledge of the basic chemical laboratory methods.
- Basic knowledge of the scientific approach in experimenting.
- Observation and interpretation of real-world chemical processes.
- Keeping of a reliable laboratory journal.

Content
- Simple chemical methods and calculations.
- Separation techniques.
- Physical measurements: mass, volume, pH, optical spectra.
- Ionic solids (salts).
- Acid/base chemistry, buffers.
- Redox reactions.
- Metal complexes.
- Titration methods and quantitative spectrometry.
- Introduction to qualitative analysis.

Lecture notes
Course manual in German (is handed out to the students at the begin of the lessons).
Language: German, English upon request.

PDF files available at
http://acac1.ethz.ch/praktikum/docs.html

Literature

is a suitable textbook.

Prerequisites / notice
This practical course causes costs for materials and chemicals. The costs are charged to the students at the end of semester.

► Second Year

★★ Second Year Core Subjects

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-1042-00L</td>
<td>Analytics</td>
<td>O</td>
<td>2 credits</td>
<td>1.5G</td>
<td>M. Badertscher</td>
</tr>
</tbody>
</table>

Abstract
Principles of the most important separation techniques and the interpretation of molecular spectra.

Objective
Knowledge of the necessary basics and the possibilities of application of the relevant spectroscopical and separation methods in analytical chemistry.

Content

Lecture notes
A comprehensive script is available in the HCI-Shop. A summary of the part "Spektroskopie" defines the relevant material for the exam.

Literature
- Pretsch E., Bühlpinnm P., Badertscher M., Spektroskopische Daten zur Strukturaufklärung organischer Verbindungen, fünte Auflage, Springer-Verlag, Berlin 2010;
- K. Cammann, Instrumentelle Analytische Chemie, Verfahren, Anwendungen, Qualitätssicherung, Spektrum Akademischer Verlag, Heidelberg, 2001;

Prerequisites / notice
Prerequisites:
- 529-1001-01 V "Allgemeine Chemie I (für Biol./Pharm.Wiss.)"
- 535-1011-00 P "Allgemeine Chemie I (für Biol./Pharm.Wiss.)"
- 529-1011-00 G "Organische Chemie I (für Biol./Pharm.Wiss.)"

353-0223-00L | Pharmaceutical Analytics I                  | O    | 1 credit | 1.5G  | C. Steuer         |

Abstract
Theoretical and practical comprehension of analytical chemistry in order to solve pharmaceutical problems.

Objective
Knowledge in Pharmaceutical Analytics in order to solve fundamental analytical problems. Handling of the most important pharmacopeial texts and monographs.

Content
Introduction in Pharmaceutical Analytics. Theoretical and practical considerations concerning a lot of methods in different Pharmacopeias. Identification, purity testing, stability testing, assays of drugs and drug formulations.

Lecture notes
The script can be downloaded from the IPW homepage, "course materials".

Literature

Prerequisites / notice
A passed exam of the annual course (Pharmaceutical Analytics I and II) is required for admission to the laboratory course in Pharmaceutical Analytics 535-0219-00.

551-0103-00L | Fundamentals of Biology II: Cell Biology   | O    | 5 credits | 5V    | E. Hafend, U. Kutay, J. Matos,
              |                                             |      |          |       | G. Schertler, U. Suter, S. Werner |

Abstract
The goal of this course is to provide students with a wide general understanding in cell biology. With this material as a foundation, students have enough of a cell biological basis to begin their specialization not only in cell biology but also in related fields such as biochemistry, microbiology, pharmacological sciences, molecular biology, and others.

Objective
The goal of this course is to provide students with a wide general understanding cell biology. With this material as a foundation, students have enough of a cell biological basis to begin their specialization not only in cell biology but also in related fields such as biochemistry, microbiology, pharmacological sciences, molecular biology, and others.

Content
The focus is animal cells and the development of multicellular organisms with a clear emphasis on the molecular basis of cellular structures and phenomena. The topics include biological membranes, the cytoskeleton, protein sorting, energy metabolism, cell cycle and division, viruses, extracellular matrix, cell signaling, embryonic development and cancer research.

Lecture notes
The lectures are presented in the Powerpoint format. These are available on the WEB for ETH students over the nethz (Moodle). Some lectures are available on the ETH WEB site in a live format (Livestream) at the above WEB site.

Literature

Prerequisites / notice
Some of the lectures are given in the English language. Certain sections of the text-book must be studied by self-instruction.

Data: 06.03.2019 12:57
Autumn Semester 2016
Analytical part: basic operations for the separation of mixtures of organic compounds (recrystallization, distillation, extraction, chromatography)

1) P. Wörfel, M. Bitzer, U. Claus, H. Felber, M. Hübel, B. Vollenweider, Laborpraxis (Bd. 1: Einführung, allgemeine Methoden; Bd. 2: Analytische Methoden; Bd. 3: Trennungsmethoden; Bd. 4: Analytische Methoden), Birckhäuser Verlag.

Lecture notes
none

Prerequisites / notice
Some of the lectures are given in the English language.
### Third Year

#### Third Year Core Subjects

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>535-0230-00L</td>
<td>Medicinal Chemistry I</td>
<td>O</td>
<td>2 credits</td>
<td>2V</td>
<td>J. Hall</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>The lectures give an overview of selected drugs and the molecular mechanisms underlying their therapeutic effects in disease. The historical and modern-day methods by which these drugs were discovered and developed are described. Structure-function relationships and the biophysical roles underlying ligand-target interactions will be discussed and illustrated with examples.</td>
<td></td>
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<tr>
<td><strong>Objective</strong></td>
<td>Basic understanding of therapeutic agents with respect to molecular, pharmacological and pharmaceutical properties.</td>
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</tr>
<tr>
<td><strong>Content</strong></td>
<td>Molecular mechanisms of action of drugs. Structure function and biophysical basis of ligand-target interactions</td>
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</tr>
<tr>
<td><strong>Lecture notes</strong></td>
<td>Will be provided in parts before each individual lecture.</td>
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<td></td>
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</tr>
<tr>
<td><strong>Prerequisites / notice</strong></td>
<td>Requirements: Knowledge of physical and organic chemistry, biochemistry and biology. Attendance of Medicinal Chemistry II in the spring semester.</td>
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</tbody>
</table>

| 535-0421-00L | Galenical Pharmacy I         | O    | 2 credits | 2G    | J.C. Leroux, B. A. Gander |
| **Abstract** | Principles and technologies for the manufacturing of dosage forms and drug delivery systems. Knowledge of pharm. excipients, materials, containers, liquid and semi-solid dosage forms, their production, function, quality and application. Comprehension of molecular interactions in solution and colloidal systems. Comprehension of interfacial phenomena and stabilization measures in dosage forms. |
| **Objective** | Knowledge of the most important pharmaceutical excipients, materials, containers, liquid and semi-solid dosage forms, of their production, function, quality, stability and application. Comprehension of the molecular interactions in solution and colloidal systems. Comprehension of interfacial phenomena and stabilization measures in dosage forms. |
| **Content** | Introduction and overview of important fundamentals, principles and technologies for the development and manufacturing of dosage forms and drug delivery systems. Overview of the most important pharmaceutical excipients and polymers, their structure, properties and processing; importance of materials properties for containers. Pharmaceutical solvents, fundamentals of solubility and solubilization of drugs. Water treatment processes, sterilization techniques and quality requirements of pharmaceutical water. Parenteral dosage forms and liquid ophthalmics. Surfactants, micelle formation and colloidal systems. Liquid suspensions and emulsions. Stabilization measures in dosage forms. |
| **Literature** | C.-D. Herzfeld und J. Kreuter (Hrsg.) Grundlagen der Arzneiformenlehre, Springer Verlag, Berlin 1999  
C. H. Leuenberger (Hrsg.) - Physikalische Pharmazie, Wissenschaftliche Verlagsgesellschaft, Stuttgart 2002  
R. Voigt, Pharmazeutische Technologie, 10. Auflage, Deutscher Apotheker Verlag, Stuttgart, 2006  
| **Prerequisites / notice** | Language: German and English |

| 535-0521-00L | Pharmacology and Toxicology I | O    | 2 credits | 2V    | U. Quitterer         |
| **Abstract** | The two-semester lecture course will provide a detailed understanding of the fundamentals of drug action and the mechanisms of action and therapeutic use of the important classes of drugs. The lectures are intended for students of pharmaceutical sciences. |
| **Objective** | Topics include disease-relevant macroscopic, microscopic, pathobiochemical and functional disturbances of specific organs and organ systems. The lectures integrate disease pathology with mechanisms of drug action, usage, metabolism, pharmacokinetics, side effects, toxicity, contraindications and dosage of relevant drug classes. Basic principles of clinical pharmacology and pharmacotherapy will be covered. |
| **Content** | The lectures will provide a comprehensive survey of pharmacology and toxicology. Special emphasis is placed on the interrelationship between pharmacological, pathophysiological and clinical aspects. |
| **Lecture notes** | Für jede Vorlesung wird ein Skript abgegeben, das eine Zusammenfassung mit den wichtigsten Stichpunkten beinhaltet. Die Skripte enthalten die Hauptpunkte der Vorlesung und definieren prüfungsrelevante Kenntnisse. Sie ersetzen die Vorlesung nicht! |

Data: 06.03.2019 12:57  Autumn Semester 2016  Page 1205 of 1571
Literature

Recommended reading:


or


Comprehensive overview:

The classic textbook in Pharmacology:

Prerequisites / notice

Voraussetzungen: Abschluss Grundstudium

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Lecturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>535-0333-00L</td>
<td>Pharmaceutical Biology</td>
<td>O 3 credits 3V</td>
<td>K.H. Altmann</td>
</tr>
<tr>
<td>535-0810-00L</td>
<td>Gene Technology</td>
<td>O 2 credits 2G</td>
<td>D. Neri</td>
</tr>
</tbody>
</table>

Abstract

The structure and biosynthesis of plant constituents and the pharmacological effects and therapeutic applications of biogenic drugs of plant origin (extract-based herbal medicines; isolated natural products) are discussed. Areas of focus are (a) major biosynthetic pathways for plant-derived natural products, (b) pharmacological effects of herbal extracts, and (c) molecular mechanisms of action.

Objective

The understanding of the biosynthesis of plant-derived natural products. Acquisition of fundamental knowledge on the medical applications of important herbal medicines and of isolated natural products (general disease areas, molecular constituents of medicinal plants and herbal medicines in general, molecular constituents responsible for pharmacological activity, possible mechanisms of action, available clinical data to support medical use).

Content

The lecture is centered around the discussion of medicinal plants and herbal medicines and their common medical applications. The main areas addressed in the lecture are (a) the structure and biosynthesis of plant constituents (i.e. plant-derived natural products) and (b) the pharmacological effects and therapeutic applications of biogenic drugs of plant origin (herbal medicines based on plant extracts as well as isolated natural products). The basic pathways for the biosynthesis of the most important classes of plant-derived natural products are discussed in detail. Likewise, the molecular basis of the pharmacological effects of medicinal plant extracts (and derived herbal medicines) and their individual constituent components (isolated natural products) is broadly addressed. As part of this discussion the availability of clinical data (or lack thereof) to support specific clinical applications of herbal medicines will be repeatedly highlighted. Potential risks associated with the use of herbal medicines are discussed for selected cases.

Lecture notes

Is provided in parts before each lecture (electronically as pdf) and also available on the Ilias platform via My Studies.

Literature

- There is no English translation of the above textbook (or any reasonably equivalent text). Students intending to take the exam for the course and are not sufficiently proficient in German should contact the lecturer before the start of the course.

Prerequisites / notice

Requirements: Lecture courses in basic organic chemistry, biochemistry, and biology

Abstract

The course will provide a solid overview of the science and issues in gene technology and its pharmaceutical applications. The aim of the lecture course is to provide a solid overview of gene technology, with a special focus on drug development. Topics: Antibody phage technology, DNA-encoded chemistry, protein modification technology, genome sequencing, transcriptomics, proteomics, functional genomics, principle of drug discovery. The course is suited for advanced undergraduate and early graduate students in pharmaceutical sciences or related fields.
1. Antibody phage technology
   The antibody molecule
   V genes, CDRs, basics of antibody engineering
   Principles of phage display
   Phagemid and phage vectors
   Antibody libraries
   Phage display selection methodologies
   Other phage libraries (peptides, globular proteins, enzymes)
   Alternative screening/selection methodologies
   DNA-encoded chemical libraries

2. Proteins: chemical modification and detection of biomolecular interactions
   Homo- and hetero-dimerization of proteins
   Chemical modifications of proteins
   Antibody-drug conjugates
   Radioactive labeling of proteins
   Kinetic association and dissociation constants
   Affinity constant: definition and its experimental measurement

3. Genomics: Applications to Human Biology
   Protein cloning and expression
   DNA sequencing
   Some foundations of genetic analysis
   Knock-out technologies
   Transcriptomics
   Proteomics
   Recombinant vaccines

4. Pharmaceuticals: Focus on Discovery
   Ligand Discovery
   Half-life extension
   Cancer therapy
   Gene therapy

Lecture notes
Skript "Gene Technology" by Prof. Dario Neri and slides of the lecture

535-0830-00L Pharmaceutical Immunology O 2 credits 2G D. Neri, C. Halin Winter
Abstract Get Students familiar with basic Immunological concepts of pharmaceutical relevance.
Objective Get Students familiar with basic Immunological concepts of pharmaceutical relevance.
Content Chapters 1 - 11 of the Janeway's ImmunoBiology, by Kenneth Murphy (9th Edition; Garland).
Literature Janeway's ImmunoBiology, by Kenneth Murphy (9th Edition).

535-0210-00L Radiopharmaceutical Chemistry O 2 credits 2V R. Schibli, S. M. Ametamey
Abstract Introduction of basic principles of radiation, structure and function of radiopharmaceuticals, examples of radiopharmaceuticals in nuclear medicine practice, discussion of functional radiopharmaceuticals, molecular imaging, targeted radionuclide therapy, radiopharmaceutical synthesis.
Objective Introduction of basic principle of radiation, structure and function of radiopharmaceuticals, examples of radiopharmaceuticals in nuclear medicine practice, discussion of functional radiopharmaceuticals, molecular imaging, targeted radionuclide therapy, radiopharmaceutical synthesis.
Content Introduction radioactivity, radiopharmaceuticals, PET- and SPET- nuclides, radionuclide generators, radiopharmaceuticals for imaging the heart, infection- and lungdiagnostics, groups of brain radiopharmaceuticals, PET-kinetik modelling, molecular imaging, application in nuclear medicine, tumor-affine radiopharmaceuticals, targeted radionuclide therapy, radiopharmaceutical synthesis.
Sprache: Englisch
ISBN-10: 1441958592
-available at the Polybuchhandlung

535-0165-00L Clinical Microbiology O 1 credit 1V K. Lucke
Abstract Thorough knowlegde of major pathogens involved in infectious diseases; principles of laboratory diagnosis of pathogenic bacteria and fungi.
Objective Thorough knowlegde of all major pathogens involved in infectious diseases; principles of laboratory diagnosis of pathogenic bacteria and fungi.
Content Basics and principles of clinical microbiology:
- host-pathogen interaction
- symptoms and diagnosis of major bacterial pathogens
- therapeutic regimens commonly used against bacterial disease
- major aspects of medical mycology, virology and parasitology
- epidemiology
- Brock, Mikrobiologie, Pearson, 13. aktualisierte Auflage
- Kayser F. et al., Medizinische Mikrobiologie, Thieme, Stuttgart, New York
- Aktuelles Auflage (derzeit 12. Auflage 2010)

Prerequisites / notice
Basic knowledge in biochemistry, general microbiology, immunology

Laboratory Courses 3rd Year

Data: 06.03.2019 12:57 Autumn Semester 2016 Page 1207 of 1571
The scriptum (in German) will be distributed at the beginning of the course. It contains all protocols necessary for the practical work.

This lecture focusses on basic concepts of ecotoxicology and their application to environmental chemicals and environmental pollution. The effects of various compounds will be regarded. Emphasis will be placed on hormonally active compounds and their effects to aquatic organisms. Furthermore, methods of environmental risk assessment of environmental pollutants will be discussed.

Content
- Simulation of clinical specimens representing ca. 50 realistically constructed cases are analysed. The students work in groups and gain insight into the procedures in a routine clinical microbiological laboratory. Using a scriptum, they learn how to identify pathogens and test them for antimicrobial susceptibility. As single groups can work only on a fraction of the cases, results and observations are shared by short presentations throughout all groups.

Lecture notes
- The scriptum in German will be distributed at the beginning of the course. It contains all protocols necessary for the practical work.

Lecturers
- J. Hall, M. Detmar, C. Halin Winter, D. Neri

Prerequisites / notice
- Registration for the course until 15 October
- Attendance of the lecture Medical Microbiology in the same semester or earlier
- Basic skills in careful laboratory work.

Compensatory Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-0297-00L</td>
<td>Applied Ecotoxicology</td>
<td>W</td>
<td>2 credits</td>
<td>2V</td>
<td>K. Fent</td>
</tr>
<tr>
<td>376-0021-00L</td>
<td>Introduction to Biomedical Engineering</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>P. Christen, R. Müller, J. G. Snedecker, M. Zenobi-Wong</td>
</tr>
<tr>
<td>376-1305-00L</td>
<td>Development of the Nervous System</td>
<td>W</td>
<td>3 credits</td>
<td>2V</td>
<td>E. Stoeckli, further lecturers</td>
</tr>
</tbody>
</table>

Respective lectures must be attended before/with the Laboratory Courses. Special schedule for the Laboratory Courses.

Data: 06.03.2019 12:57 Autumn Semester 2016 Page 1208 of 1571
The main focus is on the development of the NS: Early development of the NS, cellular processes, nerve fiber growth, building of synapses and neuronal networks.

Lecture notes
Must be downloaded from OLAT: https://www.olat.uzh.ch/olat/dmz/ as BIO344

Literature
The lecture requires reading of book chapters, handouts and original scientific papers. Further information will be given in the individual lectures and are mentioned on OLAT.

Prerequisites / notice
None. Bring something to write and your student ID

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Semester</th>
<th>Instructor(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-1305-01L</td>
<td>Structure, Plasticity and Repair of the Nervous System</td>
<td>W 3 credits 2V</td>
<td>M. E. Schwab, further lecturers</td>
<td></td>
</tr>
<tr>
<td>376-1714-00L</td>
<td>Biocompatible Materials</td>
<td>W 4 credits 3G</td>
<td>K. Maniura, J. Möller, M. Zenobi-Wong</td>
<td></td>
</tr>
<tr>
<td>551-0313-00L</td>
<td>Microbiology (Part I)</td>
<td>W 3 credits 2V</td>
<td>W.D. Hardt, L. Ebert, H.M. Fischer, J. Piel, M. Pilhofer</td>
<td></td>
</tr>
<tr>
<td>551-0319-00L</td>
<td>Cellular Biochemistry (Part I)</td>
<td>W 3 credits 2V</td>
<td>U. Kutay, R. I. Enchev, B. Kommann, M. Peter, I. Zemp, further lecturers</td>
<td></td>
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</tbody>
</table>

Abstract
The course covers the structure, plasticity and regeneration of the adult nervous system (NS) with focus on: sensory systems, cognitive functions, learning and memory, molecular and cellular mechanisms, animal models, and diseases of the NS.

Objective
The aim is to give a deepened insight into the structure, plasticity and regeneration of the nervous system based on molecular, cellular and biochemical approaches.

Content
The main focus is on the structure, plasticity and regeneration of the NS: biology of the adult nervous system; structural plasticity of the adult nervous system, regeneration and repair: networks and nerve fibers, regeneration, pathological loss of cells.

Lecture notes
ETH students: Lecture notes will be provided on Moodle https://moodle-app2.let.ethz.ch/course/view.php?id=694
Password will be provided at the beginning of the lecture.

Literature
UZH students: Lecture notes will be provided on OLAT: https://www.olat.uzh.ch/olat/dmz/

The lecture requires reading of book chapters, handouts and original scientific papers. Further information will be given in the individual lectures and are mentioned on Moodle / OLAT.

Abstract
Introduction to molecules used for biomaterials, molecular interactions between different materials and biological systems (molecules, cells, tissues). The concept of biocompatibility is discussed and important techniques from biomaterials research and development are introduced.

Objective
The class consists of three parts:
1. Introduction into molecular characteristics of molecules involved in the materials-to-biology interface. Molecular design of biomaterials.
2. The concept of biocompatibility.
3. Introduction into methodology used in biomaterials research and application.

Content
Introduction into native and polymeric biomaterials used for medical applications. The concepts of biocompatibility, biodegradation and the consequences of degradation products are discussed on the molecular level. Different classes of materials with respect to potential applications in tissue engineering and drug delivery are introduced. Strong focus lies on the molecular interactions between materials having very different bulk and/or surface chemistry with living cells, tissues and organs. In particular the interface between the materials surfaces and the eukaryotic cell surface and possible reactions of the cells with an implant material are elucidated. Techniques to design, produce and characterize materials in vitro as well as in vivo analysis of implanted and explanted materials are discussed.

In addition, a link between academic research and industrial entrepreneurship is established by guest speakers.

Lecture notes
Handouts can be accessed online.

Literature
(available online via ETH library)

Handouts provided during the classes and references therin.

Abstract
Advanced lecture class providing a broad overview on bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

Objective
This concept class will be based on common concepts and introduce to the enormous diversity among bacteria and archaea. It will cover the current research on bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

Content
Advanced class covering the state of the research in bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

Lecture notes
Updated handouts will be provided during the class.

Literature
Current literature references will be provided during the lectures.

Prerequisites / notice
English
The lecture "Grundlagen der Biologie II: Mikrobiologie" is the basis for this advanced lecture.

Abstract
Concepts and molecular mechanisms underlying the biochemistry of the cell, providing advanced insights into structure, function and regulation of individual cell components. Particular emphasis will be put on the spatial and temporal integration of different molecules and signaling pathways into global cellular processes such as intracellular transport, cell division & growth, and cell migration.

Objective
The full-year course (551-0319-00 & 551-0320-00) focuses on the molecular mechanisms and concepts underlying the biochemistry of cellular physiology, investigating how these processes are integrated to carry out highly coordinated cellular functions. The molecular characterisation of complex cellular functions requires a combination of approaches such as biochemistry, but also cell biology and genetics. This course is therefore the occasion to discuss these techniques and their integration in modern cellular biochemistry.

The students will be able to describe the structural and functional details of individual cell components, and the spatial and temporal regulation of their interactions. In particular, they will learn to explain the integration of different molecules and signaling pathways into complex and highly dynamic cellular processes such as intracellular transport, cytoskeletal rearrangements, cell motility, cell division and cell growth. In addition, they will be able to illustrate the relevance of particular signaling pathways for cellular pathologies such as cancer.

Content
Structural and functional details of individual cell components, regulation of their interactions, and various aspects of the regulation and compartmentalisation of biochemical processes.

Lecture notes
Scripts and additional material will be provided during the semester. Please contact Dr. Alicia Smith for assistance with the learning materials. (alicia.smith@bb.biol.ethz.ch)

Literature
Recommended supplementary literature (review articles and selected primary literature) will be provided during the course.

Prerequisites / notice
To attend this course the students must have a solid basic knowledge in chemistry, biochemistry and general biology. The course will be taught in English.
This lecture deals with the basic principles of injury mechanics and rehabilitation. Mechanisms that can result in injury are presented.

Handouts will be made available.

Lecture notes

The lectures are supplemented with handouts.

Literature


Molecular biology of infectious foodborne pathogens (Listeria, Vibrio, E. coli, Campylobacter, etc)

To familiarize with the structure, properties and reactivity of food constituents. To understand the relationship between the multiple chemical reactions and the quality of food.

Content

Descriptive chemistry of food constituents (proteins, lipids, carbohydrates, plant phenolics, flavour compounds).

Reactions which affect the colour, flavour, texture, and the nutritional value of food raw materials and food products during processing, storage and preparation in a positive or in a negative way (e.g. lipid oxidation, Maillard reaction, enzymatic browning).

Links to food analysis, food processing, and nutrition.

The lectures Food Chemistry I and Food Chemistry II constitute a unit.

Lecture notes

Electronic copies of the presentation slides (PDF) and additional material will be made available for download to registered students.

Literature


M. Schuppler

This lecture is the first part of a one-year course. It offers insights into the fundamentals and applications of Food Microbiology. Contents include basic microbiology of the different bacteria, yeasts and molds present in foods, as well as the occurrence and control of foodborne pathogens and spoilage organisms.

Objective

The lecture offers insights into the basics, practical consequences and applications of Food Microbiology. Contents include basic microbiology of the different bacteria, yeasts, molds and protozoa in foods, as well as the occurrence and control of foodborne pathogens and spoilage organisms.

Content

1. History of Food Microbiology
   1.1. Short synopsis of foodborne microorganisms
   1.2. Spillage of Foods
   1.3. Foodborne Disease
   1.4. Food Preservation
   1.5. VIP's of Food Microbiology
   2. Overview of Microorganisms in Foods
   2.1 Origin of foodborne Microorganisms
   2.2. Bacteria
   2.3 Yeasts
   2.4. Molds
   3. Microbial Spillage of Foods
   3.1. Intrinsic and Extrinsic Parameters
   3.2 Meats, Seafoods, Eggs
   3.3 Milk and Milk Products
   3.4. Vegetable and Fruit Products
   3.5. Miscellaneous (baked goods, nuts, spices, ready-to-eat products)
   3.6. Drinks and Canned Foods
   4. Foodborne Disease
   4.1. Significance and Transmission of Foodborne pathogens
   4.2. Staphylococcus aureus
   4.3. Gram-positive Sporeformers (Bacillus & Clostridium)
   4.4. Listeria monocytogenes
   4.5. Salmonella, Shigella, Escherichia coli
   4.6. Vibrio, Yersinia, Campylobacter
   4.7. Brucella, Mycobacterium
   4.8. Parasites
   4.9. Viruses and Bacteriophages
   4.10. Mycotoxins
   4.11. Bioactive Amines
   4.12. Miscellaneous (Antibiotic-resistant Bacteria, Biofilms)

Lecture notes

Electronic copies of the presentation slides (PDF) and additional material will be made available for download.

Literature

Recommendations will be given in the first lecture

Biomechanics of Sports Injuries and Rehabilitation

This lecture introduces the basic principles of injury mechanics and rehabilitation focussing on sports injuries.

Objective

Within the scope of this lecture you will learn the basic principles of trauma biomechanics. Based on examples from sports, you will get to know different mechanisms that can possibly result in injury. Investigating the background and cause of injury should allow you to assess the injury risk for sports activities. Furthermore you should be able to develop measures to prevent such injury.

Content

This lecture deals with the basic principles of injury mechanics and rehabilitation. Mechanisms that can result in injury are presented. Furthermore possibilities to prevent injuries are discussed. Thereby the lecture focuses on sports injuries.

Lecture notes

Handouts will be made available.

Literature


Prerequisites / notice

A course work is required. The mark of this course work contributes to the final credits for this lecture. Details will be given during the first lecture.

Molecular Biology of Foodborne Pathogens

The course offers detailed information on selected foodborne pathogens and toxin producing organisms; the focus lies on relevant molecular biological aspects of pathogenicity and virulence, as well as on the occurrence and survival of these organisms in foods.

Objective

Detailed and current status of research and insights into the molecular basis of foodborne diseases, with focus on interactions of the microorganism or the toxins they produce with the human system. Understanding the relationship between specific types of food and the associated pathogens and microbial risks. Another focus lies on the currently available methods and techniques useful for the various purposes, i.e., detection, differentiation (typing), and antimicrobial agents.

Content

Molecular biology of infectious foodborne pathogens (Listeria, Vibrio, E. coli, Campylobacter, etc) and toxin-producing organisms (Bacillus, Clostridium, Staphylococcus). How and under which conditions will toxins and virulence factors be produced, and how do they work? How is the interaction between the human host and the microbial pathogen? What are the roles of food and the environment? What can be done to interfere with the potential risks? Which methods are best suited for what approach? Last, but not least, the role of bacteriophages in microbial pathogenicity will be highlighted, in addition to various applications of bacteriophage for both diagnostics and antimicrobial intervention.

Lecture notes

Electronic copies of the presentation slides (PDF) and additional material will be made available for download to registered students.

Literature

Recommendations will be given in the first lecture
752-5103-00L

**Functional Microorganisms in Foods**

**W** 3 credits 2G C. Lacroix, T. de Wouters, L. Meile, C. Schwab

**Abstract**

This integrated course will discuss new applications of microorganisms with functional properties in food and functional food products. Selected topics will be used to illustrate the rapid development but also limits of basic knowledge for applications of functional microorganisms to produce food with high quality, safety and potential health benefits for consumers.

**Objective**

To understand the principles, roles and mechanism of microorganisms with metabolic activities of high potential for application in traditional and functional foods utilization with high quality, safety and potential health benefits for the consumers. This course will integrate basic knowledge in food microbiology, microbial physiology, biochemistry, and technology.

**Content**

This course will address selected and current topics on new applications of microorganisms with functional properties in food and functional food products and characterization of functionality and safety of food bacteria. Specialists from the Laboratory of Food Biotechnology, as well as invited speakers from the industry will contribute to the selected topics as follows:

- Probiotics and Prebiotics: Probiotics, functional foods and health, towards understanding molecular modes of probiotic action; Challenges for the production and addition of probiotics to foods; Prebiotics and other microbial substrates for gut functionality.
- Bioprotective Cultures and Antimicrobial Metabolites: Antifungal cultures and applications in foods; Antimicrobial peptide-producing cultures (bacteriocins) for enhancing food quality and safety; Development of new protective cultures, the long path from research to industry.
- Legal and Protection Issues Related Functional Foods
- Industrial Biotechnology of Flavor and Taste Development
- Safety of Food Starter Cultures and Probiotics

**Lecture notes**

Students will be required to complete a group project on food products and ingredients with or from functional bacteria. The project will involve information research and analysis followed by an oral presentation and a written report.

**Literature**

A list of references will be given at the beginning of the course for the different topics presented during this course.

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752-6101-00L

**Dietary Etiologies of Chronic Disease**

W 3 credits 2V M. B. Zimmermann

**Abstract**

To have the student gain understanding of the links between the diet and the etiology and progression of chronic diseases, including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

**Objective**

To examine and understand the protective effect of foods and food ingredients in the maintenance of health and the prevention of chronic disease, as well as the progression of complications of the chronic diseases.

**Content**

The course evaluates food and food ingredients in relation to primary and secondary prevention of chronic diseases including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

**Lecture notes**

There is no script. Powerpoint presentations will be made available on-line to students.

**Literature**

To be provided by the individual lecturers, at their discretion.

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752-6105-00L

**Epidemiology and Prevention**

W 3 credits 2V M. Puhan, R. Heusser

**Abstract**

Enrolment to this course unit only possible at ETH. No enrolment to module CS16_101 at UZH.

Please mind the ETH enrolment deadlines for UZH students: https://www.ethz.ch/en/studies/undergraduate-courses/special-students/special-students-university-of-zurich.html

**Objective**

The module Epidemiology and prevention describes the process of scientific discovery from the detection of a disease and its causes, to the development and evaluation of preventive and treatment interventions and to improving population health.

**Content**

The overall goal of the course is to introduce students to epidemiological thinking and methods, which are critical pillars for medical and public health research. Students will also become aware on how epidemiological facts are used in prevention, practice and politics.

The module Epidemiology and prevention follows an overall framework that describes the course of scientific discovery from the detection of a disease to the development of prevention and treatment interventions and their evaluation in clinical trials and real world settings. We will discuss study designs in the context of existing knowledge and the type of evidence needed to advance knowledge. Examples form nutrition, chronic and infectious diseases will be used in order to show the underlying concepts and methods.

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752-5001-00L

**Food Biotechnology**

W 4 credits 3V C. Lacroix, L. Meile, M. Stevens

**Abstract**

Basic information for understanding biotechnology applied to food processing will be presented. This will include a presentation of the physiology of important productive microorganisms used in food fermentations, closely related to applications in biotechnology; microbial kinetics, and design and operation of bioreactors; and application of modern molecular tools for food biotechnology.

**Objective**

The main goal for this course is to provide students with basic information for understanding biotechnology applied to food processing. For the students, the aim will be:

- To understand the important role of microbial physiology and molecular tools for food biotechnology;
- To understand basic principles of fermentation biotechnology, with particular emphasis on food applications.

**Content**

Biotechnology has been defined as any technique that uses living organisms, or substances from those organisms, to make or modify a product, to improve plants or animals, or to develop microorganisms for specific uses. In this course, basic knowledge for understanding biotechnology as applied to food processing will be presented. This course builds on the application of principles learned from other basic courses in the Bachelor program, especially microbiology and microbial metabolism, molecular biology, biochemistry, physics and engineering. Students will learn about the physiology of important productive microorganisms (lactic acid bacteria, bifidobacteria, propionibacteria and fungi) used in food fermentations, closely related to applications in biotechnology. Microbial kinetics, and design and operation of bioreactors used for both research and industrial scale production of traditional foods and modern food ingredients will be presented. This part will be illustrated by examples of food fermentation processes, representative of specific challenges. Finally, the application of modern molecular tools to food biotechnology will be discussed.

**Lecture notes**

A complete course document and/or a copy of the power point slides from each lecture will be provided.

**Literature**

A list of references will be given at the beginning of the course for the different topics presented during the course.

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**GESS Science in Perspective**
Recommended GESS Science in Perspective (Type B) for D-CHAB.

see GESS Science in Perspective: Type A: Enhancement of Reflection Capability

see GESS Science in Perspective: Language Courses ETH/UFZH

**Pharmaceutical Sciences Bachelor - Key for Type**

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
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<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
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<tr>
<td>W</td>
<td>Eligible for credits</td>
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<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
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<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
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<tr>
<td>O</td>
<td>Compulsory</td>
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**Key for Hours**

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
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<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
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</tbody>
</table>

**ECTS**

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Students know and understand:

Therapeutic Proteins

The course consists of two parts:

1. Drug Seminars I
   - Chapters 13-16 of the Immunobiology VIII book (Janeway et al.)
   - Handouts to the lectures will be available for downloading under http://www.pharma.ethz.ch/scripts/index
   - Lecture notes
   - Literature

2. Drug Seminars II
   - Workshop on the development of therapeutic proteins
   - Basic concepts in the GMP production of therapeutic proteins
   - The mechanism of action of selected therapeutic proteins and their application
   - Basic concepts in the GMP production of therapeutic proteins

Objective

Students know and understand:
- basic mechanisms and regulation of the immune response
- the pathogenic mechanisms of the most important immune-mediated disorders
- the most frequently used expression systems for the production of therapeutic proteins
- the use of protein engineering tools for modifying different features of therapeutic proteins
- the mechanism of action of selected therapeutic proteins and their application

Content

The course consists of two parts:
- In a first part, students will complete their training of pharmaceutical immunology (Chapter 13 - 16 Immunobiology VIII textbook). This part particularly focuses on the pathogenic mechanisms of immune-mediated diseases. Deepened knowledge of immunology will be relevant for understanding the mechanism of action of many therapeutic proteins, as well as for understanding one major concern related to the use of protein-based drugs, namely, immunogenicity.
- The second part focuses on topics related to the development and application of therapeutic proteins, such as protein expression, protein engineering, reducing immunogenicity, and GMP production of therapeutic proteins. Furthermore, selected examples of approved therapeutic proteins will be discussed.

Lecture notes

Handouts to the lectures will be available for downloading under http://www.pharma.ethz.ch/scripts/index

Literature

- Chapters 13-16 of the Immunobiology VIII book (Janeway et al.)
- Lecture Handouts
- Paper References provided in the Scripts
- EMEA Dossier for Humira

Pharmacology and Toxicology III

The course is divided into two parts.
- The first part provides a detailed understanding of drugs and pharmacotherapy of infectious diseases and cancer. The second part gives an overview of the field of pharmacogenomics with a special focus on the role of genetic polymorphisms in disease susceptibility, drug response and adverse effects.
- The course advances basic knowledge in pharmacology and toxicology. Special emphasis is placed on the interrelationship between pharmacological, pathophysiological and clinical aspects of drug therapy in the fields of infectious diseases and cancer. The course also provides an overview of the field of pharmacogenomics, with a special focus on the role of genetic polymorphisms in disease susceptibility, drug response and adverse effects.

Content

Topics include the pharmacology and pharmacotherapy of infectious diseases and cancer. In the field of pharmacogenomics, the course is focused on genetics, genome-wide association studies, genetic disease predisposition, examples of genetic variability of drug metabolism and drug responses, identification of new drug targets, relevance of pharmacogenomics for clinical drug development, and toxicogenomics.

Lecture notes

A script is provided for each lecture course. The scripts define important and exam-relevant contents of lectures. Scripts do not replace the lecture.

Literature

Recommended reading:
- The classic textbook in Pharmacology: Goodman and Gilman’s The Pharmacological Basis of Therapeutics
- Laurence Brunton, Bruce Chabner, Bjorn Knollman.
  12th edition - 1808 pages

or

Klaus Aktories, Ulrich Förstermann, Franz Hofmann, Klaus Starke. Allgemeine und spezielle Pharmakologie und Toxikologie. 11th edition - 1216 pages

Pharmacoepidemiology and Drug Safety

Introduction to the principles, methods and applications of pharmacoepidemiology and drug safety. Drug safety in the pharmaceutical industry and regulatory authorities, but also for hospital and office pharmacists. Another focus is the evaluation and interpretation of pharmacoepidemiological drug safety studies in the medical literature and the evaluation of benefits vs. risks.
Objective

Objectives:
- To familiarize participants with the principle methods and applications of pharmacoepidemiology and drug safety that is relevant for industry, regulatory affairs, but also for clinical pharmacists in hospitals and office pharmacies.
- Perform independently a causality assessment of suspected adverse drug reactions in patients
- Study designs and biostatistics used for the quantitative evaluation of drug safety
- Setup of programs that can effectively reduce medication errors and improve drug safety in clinical practice, particularly in hospitals

Content

- Historical landmarks of drug safety
- Pharmacovigilance and causality assessment
- Drug safety in premarketing clinical trials
- Descriptive, cohort and case-control drug safety study designs; Data analysis and control of confounding
- Pharmacokinetics and regulatory decision making in drug safety; Risk management plans (RMPs)
- Medication errors, clinical pharmacology / clinical pharmacy
- Clinical Decision Support Systems, Interventional Pharmacoepidemiology
- Pharmacoepidemiological databases, 'Big Data'

Interactive discussion of many real-life examples for each topic

Lecture notes

This course will be a combination of formal lectures, group discussions and self-directed studies. Course material will be taught through seminars, case studies in small groups.

Reading material and scripts will be provided for each week.

Literature

Recommended literature:
- Rothman: Introduction to Epidemiology
- Strom, Kimmel, Hennessy: Textbook of Pharmacoepidemiology

Compensatory Courses

Elective courses can be used as compensatory courses.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>535-0023-00L</td>
<td>Computer-Assisted Drug Design (Practical Course)</td>
<td>W Dr</td>
<td>4 credits</td>
<td>6P</td>
<td>G. Schneider, J. A. Hiss</td>
</tr>
</tbody>
</table>

Abstract
The practical course is open for master and graduate students to get an introduction into hands-on computer-assisted drug design. The class includes an introduction to computer-based screening of a virtual compound library, subsequent synthesis of candidate ligands, and biochemically testing for activity on pharmacologically important drug targets.

Objective
Participants become familiar with state-of-the-art methodologies in a real-life computer-aided medicinal chemistry project. Participants work as small teams, perform literature research and discuss recent research findings. A seminar talk is to be given presenting the molecular design strategy chosen and the results obtained during the course.

Content
The course offers the possibility for people with and without computational and or laboratory background to get an introduction into computer-assisted drug design, as well as practical training in a modern chemical laboratory. Using various software suites, the participants will computationally create and screen a virtual compound library for potential active small molecules. The process will involve an introduction to screening a virtual compound library, synthesizing candidate inhibitors, and biological testing against a pharmacologically important drug target.

Lecture notes
Detailed information will be handed out during the course.

Literature
Textbook:

Prerequisites / notice
The class is organized as a two-week block course.

The number of participants is limited.

Kick-off meeting and confirmation of registration (Vorbesprechung und Platzvergabe): During the last lecture of the class "Computer-Assisted Drug Design" (535-0022-00).

Ideally, students interested in the course participated and successfully passed the lecture "Computer-Assisted Drug Design" (535-0022-00).

535-0024-00L
Methods in Drug Design
Complementary to the practical course "Computer-Assisted Drug Design (Practical Course)" 535-0023-00L.

Abstract
The lecture is organized as a two-week block during the practical course "Computer-Assisted Drug Design" (535-0023-00P), totalling 10 two-hour lectures. It provides an introduction to advanced drug design techniques and approaches emphasizing computer-assisted molecular design.

Objective
Participants will learn about computational algorithms and advanced experimental approaches to drug discovery and design, including selected actual topics and practical applications. The contents of the lecture will allow for a deeper understanding of modern computer-assisted drug design methods and how they are linked to experimental applications. The main focus is on computational medicinal chemistry, so that participants will be able to use relevant computer-based methods in own research projects.

Literature

Prerequisites / notice
Additional selected literature will be provided during the lecture.

The lecture is mandatory for all participants of the course "Computer-Assisted Drug Design" (535-0023-00P).

Electives

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>535-0250-00L</td>
<td>Biotransformation of Drugs and Xenobiotics</td>
<td>W Dr</td>
<td>1 credit</td>
<td>1V</td>
<td>S.D. Krämer</td>
</tr>
</tbody>
</table>

Abstract
Knowledge of the major reactions of biotransformation in drug therapy, prediction of possible metabolites of drugs and xenobiotics, recognition of structure elements and reactions which can lead to toxic metabolites. Knowledge of inter- and intraindividual factors influencing metabolism.

Objective
Goals: knowledge of the major reactions of biotransformation in drug therapy, prediction of possible metabolites of drugs and xenobiotics, recognition of structure elements and reactions which can lead to toxic metabolites. Knowledge of inter- and intraindividual factors influencing metabolism.

Content
Major reactions of biotransformation. Major enzymes and reaction partners involved in the biotransformation of drugs and xenobiotics. Toxic reactions of metabolites. Factors which affect the biotransformation.

Lecture notes
Biotransformation of drugs and xenobiotics
The students dispose of an overview on current principles and systems for the controlled delivery and targeting of drugs. The focus of the course lies on developing a capacity to understand the involved technologies and methods, as well as an appreciation of the chances and limits of these efforts.


Number of participants limited to 24.

Further references will be provided in the course.

The website also displays additional information on peroral delivery systems, transdermal systems and systems for alternative routes (nasal, pulmonary) of delivery. These fields are covered in detail in the course Galenische Pharmazie II (Galenical Pharmacy II).

Literature

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Prerequisites / Notice</th>
<th>Literature</th>
</tr>
</thead>
<tbody>
<tr>
<td>535-0423-00L</td>
<td>Drug Delivery and Drug Targeting</td>
<td></td>
<td><a href="http://www.galenik.ethz.ch/teaching/drug_del_drug_targ">http://www.galenik.ethz.ch/teaching/drug_del_drug_targ</a></td>
</tr>
</tbody>
</table>

Prerequisites: Basic lectures in biology or biochemistry and pharmaceutical biology have been attended; not suitable for first semester students.

Handouts will be provided.

Handouts will be provided.

Selected lecture notes, documents and supporting material will be directly provided or may be downloaded using

http://www.galenik.ethz.ch/teaching/drug_del_drug_targ
In December 2006, Pfizer stopped a large phase III study on the use of Torcetrapib for the prevention of atherosclerosis and cardiovascular disease. 800 million $ in development costs and 21 billion $ in stocks were annihilated overnight. The failure of Torcetrapib has pinpointed the limitations of an extremely reductionist view of atherosclerosis and it's prevention by drug therapy. It has also highlighted what high expectations we have in a safe and wide applicability of drugs and of their economical success.

Torcetrapib is not a single case. In the last 10 years, on average one drug per year was withdrawn from the market due to lack of efficacy, unexpected side effects or toxicity. This clearly shows that the common investigations and the modern understanding of drug actions are often not sufficient to predict the effects a drug will have in large patient populations.

These are the topics of the present course. Using three particularly informative examples of drug failures, the problems encountered and the concepts and informative value of preclinical and clinical studies will be analyzed and discussed. Furthermore, the ethical, societal, economical and political expectations in new drugs shall be reflected.

1. Introduction into industrial property (patents, trademarks, industrial designs);
2. Tissue plasminogen activator (t-PA), glucocerebrosidase and the biosynthesis of N-glycans
3. PSGL-1 and the biosynthesis of O-glycans;
4. The glycoprotein hormones and the production and analysis of therapeutic glycoproteins
5. Monoclonal antibodies and the modification of their therapeutic profile through glycoengineering
6. EPO "the same but different"

In the field of intellectual property, especially of patents and trademarks, with particular emphasis on pharmaceutics.

Prerequisities / notice
Successful participation in this course is required for a research project ("Forschungspraktikum") in the CADD group.


Prerequisites / notice
Requirements: basic knowledge in Medicinal Chemistry and Pharmacology. Ability to read and understand scientific publications written in English.

Lecture notes
Printouts of the slides used for the lectures and literature for reading and discussions will be available online.

Literature
Recommended reading: John Abramson, Overdo$ed America, Harper Perennial, New York 2008

G. Schneider
W

Knowledge in the field of intellectual property, especially of patents and trademarks, with particular emphasis on pharmaceutics.

Computer-Assisted Drug Design
V. I. Otto, P. Pliska

The slides used for the lectures will be provided online


Requirements: Basic knowledge in immunology, molecular biology, protein chemistry and analytics. Basic knowledge in pharmacology.
The aim of this lecture is a critical examination of the students with the topic of "Vitamins in Health and Disease". The students will get an overview of vitamins, of their medical applications and the role of the pharmacist with "over-the-counter" products.

Deficiencies of particular vitamins result in specific diseases such as for example scurvy (vitamin C deficiency). Such disease patterns are usually easily recognized and facile to be treated. The clinical utility of supplementation concerns people with severe deficiencies and a risk of complications. Latent vitamin deficiencies might result in variable disorders and risks. As an example neurological disorders in elderly as a consequence of chronic lack of vitamin B12 should be mentioned. Subclinical deficiencies are often difficult to assess. However, these are exactly the cases where advice of a pharmacist is requested.

A large intake of vitamins by over-supplementation or food fortification might be dangerous (hypervitaminosis). This is in particular the case for fat-soluble vitamins or in the case of constant intake of high amounts of water-soluble vitamins over a long time period.

The lecture 'Vitamins in Health and Disease' will give an overview over the history and applications of vitamins and their functions to preserve good health. The utility of vitamin supplementation during conditions of deficiencies, potential consequences of a latent deficiency as well as risks of over-supplementation will be discussed.

Hand-outs will be distributed during the lecture (partly in English, partly in German).

- Handbuch Nährstoffe, Burgerstein, Trias Verlag ISBN 978-3-8304-6071-8

Requirements: Basic knowledge in biochemistry and pharmacology. Ability to read and understand scientific publications in English.

Evidence Based Phytotherapy

Based on epidemiology, economic importance and evidence-based medicine, basic principles of rational phytotherapy will be discussed: a) Identification of drug candidates, b) registration requirements, c) criteria to assess efficacy, d) biomarkers and pharmacokinetics, e) safety and f) principles of extract generation. Important prototypes will be discussed.

Students should learn the importance of rational (= evidence based) pharmacotherapy with herbal extracts:

- Identification of drug candidates are being identified? What are the strategies?
- What are the selection criteria?
- Assessment of efficacy (animal-/human studies, biomarker)
- Pharmacokinetics
- Safety (Toxicity, unwanted adverse effects, drug-drug interactions)
- Pharmaceutical quality
- Securing of herbal identity (collections, agriculture)
- Quality management
- selection of appropriate extraction procedures?

Important prototypes will be presented and critically discussed:

- Cannabis sativa
- Crataegus sp.
- Echinacea
- Ginkgo biloba
- Hypericum perforatum
- Iberogast®
- Kava kava
- Pelargonium
- Punica granatum
- Serenoa repens

Effekte Zeiten 14.45 - 15.30; 15.45-16.30)

Einführung: Qualität Arzneipflanzen-Fertigprodukte, Monographien (Kommission E, ESCOP, HMPC), Unterschiede hinsichtlich des Registrierungsstatus und -anforderungen: traditional use, well established use und new herbal entities, Methoden Produktentwicklung (Pflanzenauswahl, Anbau, Extraktentwicklung, präklinische und klinische Entwicklung) - KB
Grundlegende Begriffe der evidenzbasierten Medizin- JD

Hypericum perforatum (inklusive Pyrrolizidinalkaloid problematik)
Ginkgo

05.10.2016
Iberogast (Beispiel eines Multikomponentenproduktes)
Cannabis

12.10.2016
Pflanzliche Nahrungsergänzungsmittel versus Pflanzliche Arzneimittel

19.10.2016
Echinacea
Serenoa repens

26.10.2016
Petasites
Silybum marianum

02.11.2016
Pelargonium

B) MC-Prüfung

Die Skripten werden vor den jeweiligen Vorlesungen per Email an die Teilnehmer versandt
Abstract
This course will provide an up-to-date, comprehensive review of the industrial perspective at the interface of biomaterials and drugs. This covers regulatory, clinical, pre-clinical and manufacturing concepts. The presentations are provided in an effort to maximize the interaction of student and lecturer.

Objective
- The student will be able to categorize a drug-biomaterial as a "drug" or a "material" from a regulatory perspective and can summarize general regulatory pathways for material/drug development.
- The student will be able to summarize the current concepts and challenges for the industry at the material-drug interface.
- The student will actively develop innovative, industrial concepts at the drug-biomaterial interface.

Content
This course will provide an up-to-date comprehensive review of the industrial perspective at the interface of biomaterials and drugs. General concepts related to regulatory affairs or such as cost-conscious planning of manufacturing processes will be covered by interactive case-studies and in close interaction between students and lecturers. The course covers the future at the biomaterial - implant interface - as it is seen by the industry today - and will be reviewed by experienced and long-standing faculty from industry with the aim to provide a balanced, insightful perspective. From that, clinical development concepts, regulatory pathways and real-life case studies will be discussed with the students. Finally the students - working in small groups of 4-5 - will outline a development pathway for an industrial project and present it to the course and in presence of all faculty to receive maximum feedback to their approaches.

The student will become familiar with the major elements required for a successful development and which challenges have to be taken into account to translate an idea into a successful product.

Research Project

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>535-0650-00L</td>
<td>Research Project</td>
<td>O</td>
<td>10 credits</td>
<td>20A</td>
<td>Lecturers</td>
</tr>
<tr>
<td>Abstract</td>
<td>The Research Project accustoms students to scientific work.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>Students are accustomed to scientific work and they get to know one specific research field.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Content</td>
<td>Students work on a current field of research.</td>
<td></td>
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</tr>
</tbody>
</table>

Master's Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>535-0660-00L</td>
<td>Master's Thesis</td>
<td>O</td>
<td>30 credits</td>
<td>40D</td>
<td>Lecturers</td>
</tr>
<tr>
<td>Abstract</td>
<td>In the Master thesis students prove their ability to independent, structured and scientific working. The Master thesis is usually carried out in a subject area of Pharmaceutical Sciences as chosen by the student.</td>
<td></td>
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</tbody>
</table>

GESS Science in Perspective

- see GESS Science in Perspective: Type A: Enhancement of Reflection Capability
- see GESS Science in Perspective: Language Courses ETH/UZH
- Recommended GESS Science in Perspective (Type B) for D-CHAB.

Second Year

Compulsory and Compensatory Block Courses

Compulsory Block Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>535-5501-00L</td>
<td>Applied Pharmacology</td>
<td>O</td>
<td>6 credits</td>
<td>7G</td>
<td>P. Wiedemeier, S. Erni, B. Falch, K. Fünfschilling, A. Gutzeit, I. S. Vogel Kahmann</td>
</tr>
<tr>
<td>Abstract</td>
<td>Overview of the most important clinical pictures: symptoms, recognition, differentiation, pharmacotherapy for the most important general and special medical indications. Groups of pharmaceutical compounds, active pharmaceutical ingredients, proprietary medicinal products: mechanisms of action, contraindication, therapeutic patterns, side effects, interactions.</td>
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</tr>
<tr>
<td>Objective</td>
<td>Students have a thorough knowledge of all clinical pictures and their symptoms regarding outpatient treatment. They know the main groups of indications including active pharmaceutical self-medication and ingredients, mechanisms of action, pharmacokinetics, pharmacodynamics and dosage. They are also able to identify the relevant side effects and interactions.</td>
<td></td>
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</tr>
<tr>
<td>Content</td>
<td>Pathophysiology of selected clinical pictures and their main symptoms and clinical parameters. Recognition of alarm symptoms and distinction between pharmaceutical self-medication and the need for medical treatment. Detailed coverage of the pharmacotherapy of all fields of indication encountered in outpatient treatment. Outlining of therapeutic strategies and patterns with regard to suitable pharmaceutical compounds, active pharmaceutical ingredients and representative range of proprietary medicinal products. Discussion of the most important mechanisms of action, contraindications, side effects and interactions.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>535-5502-00L</td>
<td>Pharmaceutical Manufacturing in Small Quantities</td>
<td>O</td>
<td>3 credits</td>
<td>3G</td>
<td>J. Fröhlich, H. Hartenberg, C. Meier</td>
</tr>
<tr>
<td>Abstract</td>
<td>Hands-on course in pharmaceutical manufacturing in the pharmacy according to &quot;GMP regulations for small quantities&quot; defined in the pharmacopeia: Design and practical approach in compounding of formulas using the most important dosage forms including their risks and quality assurance.</td>
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<tr>
<td>Objective</td>
<td>Students are able to manufacture, to package, to quality-control and document pharmaceutical compounding on their own, &quot;best practice&quot; and according to GMP regulations, using the appropriate techniques. They know the most important properties of active ingredients and excipients frequently used. They achieve the necessary knowledge including the relevant literature and other sources of information, as well as the legal requirements regarding pharmaceutical compounding in small quantities.</td>
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<tr>
<td>Content</td>
<td>To impart knowledge about the principal techniques and processes in the manufacturing of pharmaceuticals in small quantities (formulas), focusing on the design, manufacturing, quality assurance and risk based self-appraisal including the patient specific dispensing. During the practical training periods: by means of pharmaceutical relevant examples the design, the planning, the manufacturing including the correct use of the equipment, the in-process control, the packaging and the quality assurance are practiced for various dosage forms and recipes. Quality assurance and control are mainly risk adapted considering as well hygiene regulations according to current pharmaceutical practice. The participants will thus improve their general GMP knowledge and skills.</td>
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</tbody>
</table>
Abstract
Students understand the concept of continuum of care and its practical implementation. They know the medication process within an institutional environment. They are able to find the necessary information and deal with problems in connection with pharmaceuticals, to evaluate them and to communicate and documentate their findings adequately. They know how a hospital is organised (procedures, possible problems), responsibilities of the different members of the staff and, most importantly, what the function of a hospital pharmacy is.

Content
Principals of the organisation of institutional environments (emergency hospitals), with special focus on medication processes and institutional pharmaceutical care (circulation of medication, continuum of care). Hygiene regulations, medical products, applications, drug formulations, patient files, SOAP notes, kardex study. Participation at interdisciplinary visits, internal trainings and doctors' reports as well as visitation of the emergency room. Drug interaction, generic substitution, quality management and pharmacovigilance.

Abstract
Introduction to managed care systems (Pharmaceutical Care und Public Health): problems with regard to therapy and approaches to solutions, service, first aid and medicinal products. Methods of illness prevention and health promotion. Important additional assortments including complementary medicine. Law and economy in everyday pharmacy, structures of the national health care system.

Objective
Students know the most important concepts and methods of pharmaceutical care of patients with regard to OTC and Rx-only drugs as well as the essential concepts and methods of public health, prevention and health care. They master the basic rules concerning the pharmaceutical triage and their implications. For the clinical pictures covered during the course, they are able to make therapeutic plans or accompany and optimize doctor's orders. Students show an adequate understanding of the rights and duties of pharmacists as medical personnel regarding medical care and service within the framework of the Swiss health care system. They are capable of handling important medical products and instructing patients about their use. Students have the necessary basic skills and applications of first aid and emergency medicine. They know the essence, chances and limits with reference to additional assortments, therapeutic options like phytotherapy, complementary medicine, veterinary pharmacy and non-medicinal methods of healing. Students have the essential knowledge of legal aspects and regulations concerning pharmacists and know the basics of business administration.

Content
Pharmaceutical Care: possibilities of pharmaceutical care of patients regarding OTC and Rx-only drugs in the officinal pharmacy. Good pharmaceutical triage in practice, introduction to the pharmacist's role in the validation of prescriptions, recognition of medicinal, patient related, therapeutic problems and the finding of solutions: Choice of therapy (OTC), accompanying and optimizing therapies (Rx), compliance, correct administration of drugs, cooperation with other medical professions in the field of outpatient treatment. Traditional and proactive pharmaceutical service: development of adequate means of documentation and consultation as well as pharmaceutical follow-up care. Public health: role and possibilities of official pharmacies as partners within the Swiss health care system: primary health care, prevention, campaigns, early detection, instruction and mediation, referral to doctors. Needs of customers, patients and employees, and social interaction. Significance of the medical profession (illness, suffering, promotion of health and well-being). Basic training in first aid, emergency medicine and wound care. Medical products: handling of important applications and instruction of patients. Important and additional forms of therapy and assortments: phytotherapy, complementary medicine, veterinary pharmacy, non-medicinal methods of healing. Students have the essential knowledge of the anatomy and physiology of tissues, the embryonal and postnatal development, the cardiovascular system, kidney, the intestines and the basics of pathology.

Objective
Basic Knowledge of human embryology, anatomy and histology with focus on vegetative Anatomy; understanding structure - function relationships. Foundations of human anatomy and physiology and basics of clinical pathophysiology.

Abstract
Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Objective
The goal of this course is to provide students with a wide general understanding in cell biology. With this material as a foundation, students have enough of a cell biological basis to begin their specialization not only in cell biology but also in related fields such as biochemistry, microbiology, pharmacological sciences, molecular biology, and others.

Content
The focus is animal cells and the development of multicellular organisms with a clear emphasis on the molecular basis of cellular structures and phenomena. The topics include biological membranes, the cytoskeleton, protein sorting, energy metabolism, cell cycle and division, viruses, extracellular matrix, cell signaling, embryonic development and cancer research.

Literature

Topic/Lecturer/Chapter/Pages:
- Analyzing cells & molecules / Gebhard Schertler/8/ 439-463;
- Membrane structure / Gebhard Schertler/10/ 565-595;
- Compartments and Sorting/ Ulrike Kutay/12+12/ 641-694/755-758/782-783/315-320/325 -333/Table 6-2/Figure6-20, 6-21, 6-32, 6-34;
- Intracellular Membrane Traffic/ Ulrike Kutay/13/695-752;
- The Cytoskeleton/ Ulrike Kutay/16/989 - 948 (only the essentials);
- Membrane Transport of Small Molecules and the Electrical Properties of Membranes /Sabine Werner/11/597 - 633;
- Mechanisms of Cell Communication / Sabine Werner/15/813-876;
- Cancer/ Sabine Werner/20/1091-1141;
- Cell Junctions and Extracellular Matrix/Ueli Suter /1035-1081;
- Stem Cells and Tissue Renewal/Ueli Suter /1217-1262;
- Development of Multicellular organisms/ Ernst Hafen/21/ 1145-1179 /1184-1198/1198-1213;
- Cell Migration/Joao Matos/951-960;
- Cell Death/Joao Matos/1021-1032;

Prerequisites / notice
none

535-0135-AAL Clinical Chemistry I E- 1 credit 2R M. Hersberger

Abstract
Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Objective
Introduction into fundamentals of laboratory diagnostics and overview of the laboratory parameters concerning inflammation, lipid metabolism, myocardial infarction, diabetes, kidney function, urinary diagnostics, liver function, blood coagulation, blood count, therapeutic drug monitoring and drugs of abuse screening.

Content
Introduction into medical laboratory diagnostics: immunochemical methods, diagnostics of inflammation, acute myocardial infarction, lipid metabolism, diabetes, kidney function and urinary diagnostics, blood coagulation, blood count, therapeutic drug monitoring, drugs of abuse screening, common diagnostics of liver diseases, point-of-care diagnostics.

535-0222-AAL Pharmaceutical Analytics E- 4 credits 9R C. Steuer

Abstract
Theoretical and practical comprehension of analytical chemistry in order to solve pharmaceutical problems.
### Objective
Knowledge in Pharmaceutical Analytics in order to solve fundamental analytical problems. Handling of the most important pharmacopeial texts and monographs.

### Content
Introduction in Pharmaceutical Analytics. Theoretical and practical considerations concerning a lot of methods in different Pharmacopeias. Identification, purity testing, stability testing, assays of drugs and drug formulations.

### Lecture notes
A script can be purchased at the HCI-Shop, HCI-Building, D floor.

### Literature
David G. Watson, Pharmaceutical Analysis, Elsevier.

### 535-0241-AAL Biopharmacy
- **Enrolment:** ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.
- **Objective:** Introduction to the Basics in Biopharmacy. Pharmacokinetic processes (absorption, distribution, metabolism and excretion, ADME), which determine the fate of a drug in the body. Knowledge of the most important pharmacokinetic parameters. Interpretation of concentration-time-profiles of drugs. Pharmacokinetic profiling of drugs in view of therapy optimization and analysis of interaction potential.
- **Abstract:** Introduction to pharmacokinetics; definition of the most important pharmacokinetic parameters and their calculation from clinical data (compartment model, statistical model); kinetics of absorption (absorption profiles); distribution of drugs and role of protein binding; kinetics of elimination: excretion and biotransformation (physiological model); pharmacokinetic profiling of drugs for therapy optimization and for the analysis of the interaction potential; dosage regimen design.
- **Literature:**
  - K. Locher, Fundamentals of Biology II: Plant Biology, 2010

### 535-0440-AAL Quality Management in Pharmaceutical Business
- **Enrolment:** ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.
- **Objective:** Quality Management in Pharmaceutical Business. The students know the relevance and the role of quality assurance measures to assure quality, efficacy and safety of drugs. The students know the most important Swiss regulations, including the associated European regulations, which are relevant from a quality assurance point of view and they are able to interpret the content of this regulations.
- **Abstract:** The students know the relevance and the role of quality assurance measures to assure quality, efficacy and safety of drugs. The students know the most important Swiss regulations, including the associated European regulations, which are relevant from a quality assurance point of view and they are able to interpret the content of this regulations.
- **Literature:**

### 551-0110-AAL Fundamentals of Biology II: Microbiology
- **Enrolment:** ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.
- **Literature:**

### 551-0108-AAL Fundamentals of Biology II: Plant Biology
- **Enrolment:** ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.
- **Objective:** Water balance, assimilation, transport in plants; developmental biology, stress physiology.
- **Abstract:** Water balance, assimilation, transport in plants; developmental biology, stress physiology.
- **Literature:**

### 551-1323-AAL Fundamentals of Biology II: Biochemistry and Molecular Biology
- **Enrolment:** ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.
- **Objective:** Topics include the structure-function relationship of proteins / nucleic acids, protein folding, enzymatic catalysis, cellular pathways involved in bioenergetics and the biosynthesis and breakdown of amino acids, glycans, nucleotides, fatty acids and phospholipids, and steroids. There will also be a discussion of DNA replication and repair, transcription, and translation.
- **Abstract:** The course provides an introduction to Biochemistry / Molecular Biology with some emphasis on chemical and biophysical aspects.
- **Literature:**

### Pharmacological Sciences Master - Key for Type

<table>
<thead>
<tr>
<th>Code</th>
<th>Type</th>
<th>Credits</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q</td>
<td>Compulsory</td>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
</tbody>
</table>
### Key for Hours

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

**ECTS**

- European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
## Physics (General Courses) - Generally Accessible Seminars and Colloquia

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
</table>

**Abstract**
Research colloquium

**Prerequisites / notice**
Occasionally, talks may be delivered in German.

### Physics (General Courses) - Key for Type

<table>
<thead>
<tr>
<th>Letter</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Suitable for doctorate</td>
</tr>
</tbody>
</table>

### Key for Hours

<table>
<thead>
<tr>
<th>Letter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
</tr>
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<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

**ECTS**
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Physics Bachelor

Bachelor Studies (Programme Regulations 2016)

First Year

GESS Science in Perspective

Minor Courses

First Year Compulsory Courses

First Year Examination Block 1

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-1151-00L</td>
<td>Linear Algebra I</td>
<td>O</td>
<td>7 credits</td>
<td>4V+2U</td>
<td>M. Akveld</td>
</tr>
<tr>
<td>Objective</td>
<td>- Mastering basic concepts of Linear Algebra</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Introduction to mathematical methods</td>
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</tr>
<tr>
<td>Content</td>
<td>- Basics</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>- Vector spaces and linear maps</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Systems of linear equations and matrices</td>
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</tr>
<tr>
<td></td>
<td>- Determinants</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>- Endomorphisms and eigenvalues</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>402-1701-00L</td>
<td>Physics I</td>
<td>O</td>
<td>7 credits</td>
<td>4V+2U</td>
<td>A. Wallraff</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course gives a first introduction to Physics. The emphasis is on classical mechanics, together with an introduction to thermodynamics.</td>
<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>Acquire knowledge of the basic principles regarding the physics of classical mechanics and thermodynamics. Skills in solving physics problems.</td>
<td></td>
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</tr>
<tr>
<td>252-0847-00L</td>
<td>Computer Science</td>
<td>O</td>
<td>5 credits</td>
<td>2V+2U</td>
<td>B. Gärtner</td>
</tr>
<tr>
<td>Abstract</td>
<td>This lecture is an introduction to programming based on the language C++. We cover fundamental types, control statements, functions, arrays, and classes. The concepts will be motivated and illustrated through algorithms and applications.</td>
<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>The goal of this lecture is an algorithmically oriented introduction to programming.</td>
<td></td>
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</tr>
<tr>
<td>Content</td>
<td>This lecture is an introduction to programming based on the language C++. We cover fundamental types, control statements, functions, arrays, and classes. The concepts will be motivated and illustrated through algorithms and applications.</td>
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</tbody>
</table>

First Year Examination Block 2

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-1261-07L</td>
<td>Analysis I</td>
<td>O</td>
<td>10 credits</td>
<td>6V+3U</td>
<td>M. Einsiedler</td>
</tr>
<tr>
<td>Abstract</td>
<td>Introduction to the differential and integral calculus in one real variable: fundamentals of mathematical thinking, numbers, sequences, basic point set topology, continuity, differentiable functions, ordinary differential equations, Riemann integration.</td>
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<tr>
<td>Objective</td>
<td>The ability to work with the basics of calculus in a mathematically rigorous way.</td>
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</tbody>
</table>
Bachelor Studies (Programme Regulations 2010)

Course Units of the first year can be found in section Bachelor Studies (Programme Regulations 2016) - First Year.

Compulsory Courses

Second Year Compulsory Courses

Examination Block I

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-2303-00L</td>
<td>Complex Analysis</td>
<td>O</td>
<td>6</td>
<td>3V+2U</td>
<td>R. Pandharipande</td>
</tr>
<tr>
<td>Abstract</td>
<td>Complex functions of one variable, Cauchy-Riemann equations, Cauchy theorem and integral formula, singularities, residue theorem, index of closed curves, analytic continuation, special functions, conformal mappings, Riemann mapping theorem.</td>
<td></td>
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<tr>
<td>Objective</td>
<td>Working Knowledge with functions of one complex variables; in particular applications of the residue theorem</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Literature</td>
<td>Th. Gamelin: Complex Analysis. Springer 2001</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>D. Salamon: &quot;Funktionentheorie&quot;. Birkhauser, 2011. (In German)</td>
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<tr>
<td></td>
<td>R. Remmert: Theory of Complex Functions. Springer Verlag</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Number</th>
<th>Methods of Mathematical Physics I</th>
<th>O</th>
<th>6</th>
<th>3V+2U</th>
<th>C. A. Keller</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prerequisites / notice</td>
<td>Die Einschreibung in die Übungsgruppen erfolgt online. Melden Sie sich im Laufe der ersten Semesterwoche unter echo.ethz.ch mit Ihrem ETH Account an. Der Übungsbetrieb beginnt in der zweiten Semesterwoche.</td>
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</table>

<table>
<thead>
<tr>
<th>Number</th>
<th>Physics III</th>
<th>O</th>
<th>7</th>
<th>4V+2U</th>
<th>J. Home</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>Introductory course on quantum and atomic physics including optics and statistical physics. A basic introduction to quantum and atomic physics, including basics of optics and equilibrium statistical physics. The course will focus on the relation of these topics to experimental methods and observations.</td>
<td></td>
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</tr>
<tr>
<td>Content</td>
<td>Optics: Fermat's principle, lenses, imaging systems, diffraction, interference, relation between geometrical and wave descriptions, interferometers, spectrometers. Statistical mechanics: probability distributions, micro and macrostates, Boltzmann distribution, ensembles, equipartition theorem, blackbody spectrum, including Planck distribution.</td>
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<tr>
<td>Lecture notes</td>
<td>Lecture notes will be provided electronically during the course.</td>
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<tr>
<td></td>
<td>Statistical mechanics: &quot;Statistical Physics&quot;, F. Mandl 0-471-91532-7</td>
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</table>
### Third Year Compulsory Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0255-00L</td>
<td>Introduction to Solid State Physics</td>
<td>W</td>
<td>10 credits</td>
<td>3V+2U</td>
<td>K. Ensslin</td>
</tr>
<tr>
<td></td>
<td>Objective</td>
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<tr>
<td></td>
<td>Introduction to solid state physics, covering several topics that are later discussed in more detail in other more specialized lectures. The central topics are: solids and their lattice structures; interatomic bindings; lattice dynamics, electronic properties of insulators, metals, semiconductors, transport properties, magnetism, superconductivity.</td>
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<tr>
<td></td>
<td>Content</td>
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</tr>
<tr>
<td></td>
<td>Keywords: Schrödinger equation, basic formalism of quantum mechanics (states, operators, commutators, measuring process), symmetries (translations, rotations), quantum mechanics in one dimension, spherically symmetric problems in three dimensions, scattering theory, perturbation theory, variational techniques, spin, addition of angular momenta, relation between QM and classical physics.</td>
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<tr>
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</tr>
<tr>
<td></td>
<td>F. Schwabl: Quantum mechanics</td>
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<tr>
<td></td>
<td>J.J. Sakurai: Modern Quantum Mechanics</td>
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<tr>
<td></td>
<td>C. Cohen-Tannoudji: Quantum mechanics I</td>
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</tbody>
</table>

### Core Courses

#### Core Courses in Experimental Physics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0263-00L</td>
<td>Astrophysics I</td>
<td>W</td>
<td>10 credits</td>
<td>3V+2U</td>
<td>A. Refregier</td>
</tr>
<tr>
<td></td>
<td>Objective</td>
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<tr>
<td></td>
<td>This introductory course will develop basic concepts in astrophysics as applied to the understanding of the physics of planets, stars, galaxies, and the Universe.</td>
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<tr>
<td></td>
<td>Content</td>
<td></td>
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<tr>
<td></td>
<td>A Manuscript is distributed.</td>
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<td>Literature</td>
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</tr>
<tr>
<td></td>
<td>Ibach &amp; Lüth, Festkörperphysik</td>
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<tr>
<td></td>
<td>C. Kittel, Festkörperphysik</td>
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<tr>
<td></td>
<td>Ashcroft &amp; Mermin, Festkörperphysik</td>
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<td></td>
<td>W. Känzig, Kondensierte Materie</td>
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<tr>
<td></td>
<td>Prerequisites / notice</td>
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</tr>
<tr>
<td></td>
<td>Voraussetzungen: Physik I, II, III wünschenswert</td>
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</table>

#### Core Courses in Theoretical Physics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
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<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>402-0205-00L</td>
<td>Quantum Mechanics I</td>
<td>W</td>
<td>10 credits</td>
<td>3V+2U</td>
<td>T. K. Gehrmann</td>
</tr>
<tr>
<td></td>
<td>Objective</td>
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</tr>
<tr>
<td></td>
<td>Introduction to non-relativistic single-particle quantum mechanics. In particular, the basic concepts of quantum mechanics, such as the quantisation of classical systems, wave functions and the description of observables as operators on a Hilbert space, and the formulation of symmetries will be discussed. Basic phenomena will be analysed and illustrated by generic examples.</td>
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<tr>
<td></td>
<td>Content</td>
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</tr>
<tr>
<td></td>
<td>Keywords: Schrödinger equation, basic formalism of quantum mechanics (states, operators, commutators, measuring process), symmetries (translations, rotations), quantum mechanics in one dimension, spherically symmetric problems in three dimensions, scattering theory, perturbation theory, variational techniques, spin, addition of angular momenta, relation between QM and classical physics.</td>
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<tr>
<td></td>
<td>F. Schwabl: Quantum mechanics</td>
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<tr>
<td></td>
<td>J.J. Sakurai: Modern Quantum Mechanics</td>
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<tr>
<td></td>
<td>C. Cohen-Tannoudji: Quantum mechanics I</td>
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</tbody>
</table>

### Practical Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>402-0000-01L</td>
<td>Physics Lab I</td>
<td>O</td>
<td>4 credits</td>
<td>1V+4P</td>
<td>A. Biland, M. Doebeli, M. Kroner, S. P. Quanz</td>
</tr>
<tr>
<td></td>
<td>Objective</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Introductory lab course in experimental physics with accompanying lecture</td>
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</tbody>
</table>

Data: 06.03.2019 12:57  Autumn Semester 2016  Page 1226 of 1571
Objective

- Motivation und Herangehensweise in der Experimentalphysik
- Praktischer Aufbau von Experimenten und grundlegende Kenntnisse von Messmethoden und Instrumenten
- Einführung in relevante statistische Methoden der Datenauswertung und Fehleranalyse
- Kritische Beurteilung und Interpretation der Beobachtungen und Ergebnisse
- Darstellen und Kommunizieren der Ergebnisse mit Graphiken und Text
- Ethische Aspekte der experimentellen Forschung und wissenschaftlicher Kommunikation

Content

Versuche zu Themen aus den Bereichen der Mechanik, Optik, Wärme, Elektrizität und Kernphysik mit begleitender Vorlesung zur Vertiefung des Verständnisses der Datenanalyse und Interpretation

Lecture notes

Anleitung zum Physikalischen Praktikum; Vorlesungsskript

Prerequisites / notice

Aus einer Liste von 33 Versuchen müssen 9 Versuche in Zweiergruppen durchgeführt werden.

Am ersten Termin findet nur eine dreistündige Einführungsveranstaltung im Hörsaal statt und es werden noch keine Experimente durchgeführt.

402-0241-00L Advanced Physics Laboratory I

9 credits

C. Grab, T. M. Ihn

IMPORTANT: You may not enrol repeatedly in the course of the Bachelor programme.

Abstract

This laboratory course provides basic training of experimental skills. These are experimental design, implementation, measurement, data analysis and interpretation, as well as error analysis. Written manuals for the individual experiments are available.

402-0240-00L Advanced Physics Laboratory II

9 credits

C. Grab, T. M. Ihn

Prerequisite: "Advanced Physics Laboratory I" completed. Before enrolling in "Advanced Physics Laboratory II", please enrol in "Advanced Physics Laboratory I".

Enrol at most once in the course of the Bachelor programme!

Abstract

This laboratory course provides basic experimental skill training for performing physics experiments, including: Implementation of physics experiments using an instruction manual. Planning, designing, realizing, analyzing, and interpreting experiments. Estimating measurement precision.

Objective

Students should learn how to perform a bit more complex experiments, analyze the data and interpret the results.

Proseminars, Experimental and Theoretical Semester Papers

To organise a semester project take contact with one of the instructors.

Not all lecturers are directly eligible in myStudies if "Professors" is the required type of lecturers. In such cases please take contact with the Study Administration (www.phys.ethz.ch/studies/study-administration.html).

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0210-96L</td>
<td>Proseminar Theoretical Physics: Solitons and Instantons in Condensed Matter Number of participants limited to 24.</td>
<td>W</td>
<td>9</td>
<td>4S</td>
<td>V. Geshkenbein</td>
</tr>
<tr>
<td>402-0217-BSL</td>
<td>Theoretical Semester Project in a Group of the Physics Department Number of participants limited to 24.</td>
<td>W</td>
<td>9</td>
<td>18A</td>
<td>Supervisors</td>
</tr>
<tr>
<td>402-0215-BSL</td>
<td>Experimental Semester Project in a Group of the Physics Department</td>
<td>W</td>
<td>9</td>
<td>18A</td>
<td>Professors</td>
</tr>
<tr>
<td>402-0510-BSL</td>
<td>Advanced Solid State Physics Experiments</td>
<td>W</td>
<td>9</td>
<td>18P</td>
<td>Supervisors</td>
</tr>
</tbody>
</table>

Abstract

This course unit is an alternative if no suitable "Proseminar Theoretical Physics" is available if the proseminar is already overbooked.

Prerequisites / notice

Die Leistungskontrolle erfolgt aufgrund eines oder mehrerer schriftlicher Berichte bzw. einer schriftlichen Arbeit. Vorträge können ein zusätzlicher Bestandteil der Leistungskontrolle sein.

This course unit is an alternative if no suitable "Proseminar Theoretical Physics" is available if the proseminar is already overbooked.

Prerequisites / notice

Die Leistungskontrolle erfolgt aufgrund eines oder mehrerer schriftlicher Berichte bzw. einer schriftlichen Arbeit.

Abstract

Experiments in condensed matter physics. The work includes the planning, build-up, data taking and analysis, and interpretation of the experimental results.

Objective


Content

Arbeiten in einer Forschungsgruppe sind besonders gut geeignet, die Studierenden mit aktuellen Forschungsthemen und mit moderner Instrumentierung bekannt zu machen.

**402-0400-BSL** Advanced Quantum Electronics Experiments  ■  W  9 credits  18P  Supervisors

**Advisors for this experimental semester paper:**
- Prof. Tilman Esslinger
- Prof. Jérôme Faist
- Prof. Rachel Grange
- Prof. Jonathan Home
- Prof. Atac Imamoglu
- Prof. Steven Johnson
- Prof. Ursula Keller

**Abstract**
Implementation of experiments in quantum electronics. Planning, design, realisation, evaluation, and interpretation of the experiments.

**Content**

**402-0719-BSL** Particle Physics at PSI (Paul Scherrer Institute) ■  W  9 credits  18P  C. Grab

**Abstract**
During semester breaks 6-12 students stay for 3 weeks at PSI and participate in a hands-on course on experimental particle physics. A small real experiment is performed in common, including apparatus design, construction, running and data analysis. The course includes some lectures, but the focus lies on the practical aspects of experimenting.

**Objective**
Students learn all the different steps it takes to perform a complete particle physics experiment in a small team. They acquire skills to do this themselves in the team, including design, construction, data taking and data analysis.

**402-0717-BSL** Particle Physics at CERN ■  W  9 credits  18P  F. Nessi-Tedaldi, W. Lustermann

**Abstract**
During the semester break participating students stay for 4 weeks at CERN and perform experimental work relevant to our particle physics projects. Dates to be agreed upon.

**Objective**
Students learn, by doing, the needed skills to perform a small particle physics experiment: setup, problem solving, data taking, analysis, interpretation and presentation in a written report of publication quality.

**Content**
Detailed information in: http://www@cmsdoc.cern.ch/~nessif/ETHTeilchenpraktikumCERN.html

**Prerequisites / notice**
Language of instruction: English or German

**402-0340-BSL** Medical Physics ■  W  9 credits  18P  A. J. Lomax, K. P. Prüssmann, M. Rudin

**Abstract**
In agreement with the lecturers a semester paper in the context of the topics discussed in the lectures can be written.

**402-0240-00L** Advanced Physics Laboratory II  ■  W  9 credits  18P  C. Grab, T. M. Ihn

**Prerequisite:** "Advanced Physics Laboratory I" completed.
Before enrolling in "Advanced Physics Laboratory II", please enrol in "Advanced Physics Laboratory I".

Enrol at most once in the course of the Bachelor programme!

**Abstract**
This laboratory course provides basic experimental skill training for performing physics experiments, including: Implementation of physics experiments using an instruction manual. Planning, designing, realizing, analyzing, and interpreting experiments. Estimating measurement precision.

**Objective**
Students should learn how to perform a bit more complex experiments, analyze the data and interpret the results.

**GESS Science in Perspective**

**GESS Science in Perspective**

see Science in Perspective: Type A: Enhancement of Reflection Capability

Recommended Science in Perspective (Type B) for D-PHY.

**Language Courses**

see Science in Perspective: Language Courses ETH/UZH

**Additional Courses, Seminars and Colloquia**

**First or Second Year Additional Courses**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0351-00L</td>
<td>Astronomy</td>
<td>Z</td>
<td>2 credits</td>
<td>2V</td>
<td>H. M. Schmid, W. Schmutz</td>
</tr>
</tbody>
</table>

**Abstract**
An overview on the important topics in modern astronomy: planets, sun, stars, milky way, galaxies, and cosmology

**Objective**
This lecture gives a general introduction to main topics in modern astronomy. The lecture provide a basis for the more advanced lectures in astrophysics.

**Content**
Planeten, Sonne, Sterne, Milchstrasse, Galaxien und Kosmologie

**Lecture notes**
Kopien der Präsentationen werde zur Verfügung gestellt.

**Literature**
Astronomie. Harry Nussbaumer, Hans Martin Schmid
vdf Vorlesungsskripte (8. Auflage)

Der Neue Kosmos. A. Unsöld, B. Baschek, Springer

| 401-1511-00L | Geometry       | Z    | 3 credits | 2V+1U | T. Ilmanen |

**Abstract**
We will study the topology and geometry of 2 and 3 dimensional spaces (manifolds) from an informal point of view.

-what is it like to live in a non-Euclidean space (for example, in a surface)?
-orientation, genus, curvature
-classification of closed orientable surfaces
-spherical, Euclidean, and hyperbolic geometry
-3-manifolds a la Thurston

**Literature**
Jeffrey R. Weeks. The Shape of Space.

Edwin A. Abbott. Flatland. 1884.
Additional Courses

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>402-0247-00L</td>
<td>Electronics for Physicists I (Analogue)</td>
<td>Z</td>
<td>4 credits</td>
<td>2V+2P</td>
<td>R. Horisberger</td>
</tr>
</tbody>
</table>

Abstract
Passive elements, linear complex networks, transmission lines, simulation of analog circuits, semiconductor elements: diodes, bipolar and field-effect transistors, basic amplifier circuits, small signal analysis, differential amplifiers, noise in analog circuits, operational amplifiers, OTAs, gyror circuits, feedback and stability in amplifiers, oscillators, ADCs and DACs, introduction in CMOS technology. Practical exercises in small groups to the above themes complement the lectures.

Prerequisites / notice

Additional Courses (from Second Year Mathematics Bachelor)

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>401-2003-00L</td>
<td>Algebra I</td>
<td>Z</td>
<td>7 credits</td>
<td>4V+2U</td>
<td>L. Halbeisen</td>
</tr>
</tbody>
</table>

Abstract
Introduction and development of some basic algebraic structures - groups, rings, fields.

Objective
Introduction to basic notions and results of group, ring and field theory.

Content
Group Theory: basic notions and examples of groups; Subgroups, Quotient groups and Homomorphisms, Sylow Theorems, Group actions and applications

Ring Theory: basic notions and examples of rings; Ring Homomorphisms, ideals and quotient rings, applications

At the end we prove Mordell's Theorem for special elliptic curves.

Literature
J.F. Humphreys: A Course in Group Theory (Oxford University Press)
G. Smith and O. Tabachnikova: Topics in Group Theory (Springer-Verlag)
M. Artin: Algebra (Birkhäuser Verlag)
B.L. van der Waerden: Algebra I & II (Springer Verlag)

Seminars and Colloquia

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</table>

Abstract
Research colloquium

Prerequisites / notice
Occasionally, talks may be delivered in German.

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</table>

Abstract
Research colloquium

Objective
The Zurich Theoretical Physics Colloquium is jointly organized by the University of Zurich and ETH Zurich. Its mission is to bring both students and faculty with diverse interests in theoretical physics together. Leading experts explain the basic questions in their field of research and communicate the fascination for their work.

401-5330-00L  | Talks in Mathematical Physics        | E-   | 0 credits | 1K   | A. Cattaneo, G. Felder, M. Gaberdiel, G. M. Graf, H. Knörrer, T. H. Willwacher, University lecturers |

Abstract
Research colloquium

402-0501-00L  | Solid State Physics                  | E-   | 0 credits | 1S   | A. Zheludev, G. Blatter, C. Degen, K. Ensslin, D. Pescia, M. Sigrist, A. Wallraff |

Abstract
Research colloquium


Abstract
Research colloquium

402-0600-00L  | Nuclear and Particle Physics with Applications | E-   | 0 credits | 2S   | A. Rubbia, G. Dissertori, C. Grab, K. S. Kirch, R. Wallny |

Abstract
Research colloquium
### Selection of Higher Semester Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<tbody>
<tr>
<td>402-0811-00L</td>
<td>Programming Techniques for Scientific Simulations I</td>
<td>W</td>
<td>5</td>
<td>4G</td>
<td>M. Troyer</td>
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<tr>
<td>402-0893-00L</td>
<td>Particle Physics Seminar</td>
<td>E-</td>
<td>0</td>
<td>1S</td>
<td>T. K. Gehrmann</td>
</tr>
<tr>
<td>402-0700-00L</td>
<td>Seminar in Elementary Particle Physics</td>
<td>E-</td>
<td>0</td>
<td>1S</td>
<td>M. Spira</td>
</tr>
<tr>
<td>402-0369-00L</td>
<td>Research Colloquium in Astrophysics</td>
<td>E-</td>
<td>0</td>
<td>1K</td>
<td>S. Cantalupo, M. Carollo, S. Lilly, A. Refregier, K. Schawinski, H. M. Schmid</td>
</tr>
<tr>
<td>402-0356-00L</td>
<td>Astrophysics Seminar</td>
<td>E-</td>
<td>0</td>
<td>2S</td>
<td>S. Cantalupo, M. Carollo, S. Lilly, A. Refregier, K. Schawinski, H. M. Schmid</td>
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<tr>
<td>402-0530-00L</td>
<td>Mesoscopic Systems</td>
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<td>0</td>
<td>1S</td>
<td>T. M. Ihn</td>
</tr>
<tr>
<td>227-0980-00L</td>
<td>Seminar on Biomedical Magnetic Resonance</td>
<td>E-</td>
<td>0</td>
<td>2K</td>
<td>K. P. Prüssmann, S. Kozerke, M. Rudin</td>
</tr>
<tr>
<td>227-1043-00L</td>
<td>Neuroinformatics - Colloquia (University of Zurich)</td>
<td>E-</td>
<td>0</td>
<td>1K</td>
<td>S.C. Liu, R. Hahnloser, V. Mante, K. A. Martin</td>
</tr>
<tr>
<td>227-1044-00L</td>
<td>Auditory Informatics (University of Zurich)</td>
<td>E-</td>
<td>2</td>
<td>1S</td>
<td>R. Stoop</td>
</tr>
<tr>
<td>402-0396-00L</td>
<td>Recent Research Highlights in Astrophysics (University of Zurich)</td>
<td>E-</td>
<td>0</td>
<td>1S</td>
<td>University lecturers</td>
</tr>
<tr>
<td>Course Code</td>
<td>Course Title</td>
<td>Credits</td>
<td>Lecture Hours</td>
<td>Prerequisites / Notice</td>
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<tr>
<td>402-0713-00L</td>
<td>Astro-Particle Physics I</td>
<td>6</td>
<td>2V+1U</td>
<td>A. Biland</td>
<td></td>
</tr>
<tr>
<td>Abstract</td>
<td>This lecture gives an overview of the present research in the field of Astro-Particle Physics, including the different experimental techniques. In the first semester, main topics are the charged cosmic rays including the antimatter problem. The second semester focuses on neutral components of the cosmic rays as well as on some aspects of Dark Matter.</td>
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<tr>
<td>Objective</td>
<td>Successful students know:</td>
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<tr>
<td></td>
<td>- experimental methods to measure cosmic ray particles over full energy range</td>
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<td></td>
<td>- current knowledge about the composition of cosmic ray</td>
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<td></td>
<td>- possible cosmic acceleration mechanisms</td>
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<td></td>
<td>- correlation between astronomical object classes and cosmic accelerators</td>
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<td></td>
<td>- information about our galaxy and cosmology gained from observations of cosmic ray</td>
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<tr>
<td>Content</td>
<td>First semester (Astro-Particle Physics I):</td>
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<tr>
<td></td>
<td>- definition of 'Astro-Particle Physics'</td>
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<td></td>
<td>- important historical experiments</td>
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<td></td>
<td>- chemical composition of the cosmic rays</td>
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<td></td>
<td>- direct observations of cosmic rays</td>
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<tr>
<td></td>
<td>- indirect observations of cosmic rays</td>
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<tr>
<td></td>
<td>- 'extended air showers' and 'cosmic muons'</td>
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<tr>
<td></td>
<td>- 'knee' and 'ankle' in the energy spectrum</td>
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<td></td>
<td>- the 'anti-matter problem' and the Big Bang</td>
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<td></td>
<td>- 'cosmic accelerators'</td>
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<tr>
<td>Literature</td>
<td>See lecture home page: <a href="http://ihp-lx2.ethz.ch/AstroTeilchen/">http://ihp-lx2.ethz.ch/AstroTeilchen/</a></td>
<td></td>
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<tr>
<td>Lecture notes</td>
<td>many more details (in english and german) here:</td>
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<td></td>
<td><a href="http://ihp-lx2.ethz.ch/energy21/">http://ihp-lx2.ethz.ch/energy21/</a></td>
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<tr>
<td>402-0737-00L</td>
<td>Energy and Environment in the 21st Century (Part I)</td>
<td>6</td>
<td>2V+1U</td>
<td>M. Dittmar</td>
<td></td>
</tr>
<tr>
<td>Abstract</td>
<td>The energy and related environmental problems, the physics principles of using energy and the various real and hypothetical options are discussed from a physicist point of view. The lecture is intended for students of all ages with an interest in a rational approach to the energy problem of the 21st century.</td>
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<tr>
<td>Objective</td>
<td>Scientists and especially physicists are often confronted with questions related to the problems of energy and the environment. The lecture tries to address the physical principles of today’s and tomorrow energy use and the resulting global consequences for the world climate.</td>
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<tr>
<td>Content</td>
<td>Introduction: energy types, energy carriers, energy density and energy usage. How much energy does a human needs/uses?</td>
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<td></td>
<td>Energy conservation and the first and second law of thermodynamics</td>
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<td>Fossil fuels (our stored energy resources) and their use.</td>
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<td></td>
<td>Burning fossil fuels and the physics of the greenhouse effect.</td>
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<td>physics basics of nuclear fission and fusion energy</td>
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<td>controlled nuclear fission energy today, the different types of nuclear power plants, uranium requirements and resources, natural and artificial radioactivity and the related waste problems from the nuclear fuel cycle.</td>
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<td></td>
<td>Nuclear reactor accidents and the consequences, a comparison with risks from other energy using methods.</td>
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<td>The problems with nuclear fusion and the ITER project.</td>
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<td></td>
<td>Nuclear fusion and fission: `exotic’ ideas.</td>
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<td></td>
<td>Hydrogen as an energy carrier: ideas and limits of a hydrogen economy.</td>
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<td></td>
<td>new clean renewable energy sources and their physical limits (wind, solar, geothermal etc)</td>
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<td></td>
<td>Energy perspectives for the next 100 years and some final remarks</td>
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<tr>
<td></td>
<td>Environmental Physics: Boeker and Egbert New York Wiley 1999</td>
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<tr>
<td>Prerequisites / Notice</td>
<td>Science promised us truth, or at least a knowledge of such relations as our intelligence can seize: It never promised us peace or happiness Gustave Le Bon</td>
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</table>
|             | Physicists learned to realize that whether they like a theory or they don't like a theory is not the essential question. Rather, it's whether or not the theory gives predictions that agree with experiment. Richard Feynman, 1985
The goal of this course is to introduce the foundations of quantum information theory. It starts with a brief introduction to the mathematical theory of information and then discusses the basic information-theoretic aspects of quantum mechanics. Further topics include applications such as quantum cryptography and quantum computing.

Objective

The course gives an insight into the notion of information and its relevance to physics and, in particular, quantum mechanics. It also serves as a preparation for further courses in the area of quantum information sciences.

402-0580-00L Superconductivity

Abstract

Superconductivity; thermodynamics, London and Pippard theory; Ginzburg-Landau theory; spontaneous symmetry breaking, flux quantization, type I and II superconductors; microscopic BCS theory; electron-phonon mechanism, Cooper pairing, quasiparticle spectrum and tunneling, Josephson effect, superconducting quantum interference devices (SQUID), brief introduction to unconventional superconductivity.

Objective

Introduction to the most important concepts of superconductivity both on phenomenological and microscopic level, including experimental and theoretical aspects.

Content

This lecture course provides an introduction to superconductivity, covering both experimental as well as theoretical aspects. The following topics are covered:

- Basic phenomena of superconductivity: thermodynamics, electrodynamics, London and Pippard theory; Ginzburg-Landau theory;
- Spontaneous symmetry breaking, flux quantization, properties of type I and II superconductors; microscopic BCS theory; electron-phonon mechanism. Cooper pairing, coherent state, quasiparticle spectrum, quasiparticle tunnel, Josephson effects, superconducting quantum interference devices (SQUID), brief extension to unconventional superconductivity.

Lecture notes

Lecture notes and additional materials are available.

Literature

M. Tinkham "Introduction to Superconductivity"
H. Stolz: "Supraleitung"
W. Kinkel & G. "Superconductivity"
P. G. de Gennes "Superconductivity Of Metals And Alloys"
A. A. Abrikosov "Fundamentals of the Theory of Metals"

Prerequisites / notice

The preceding attendance of the scheduled lecture courses "Introduction to Solid State Physics" and "Quantum Mechanics I" are mandatory. The courses "Quantum Mechanics II" and "Solid State Theory" provide the most optimal conditions to follow the course.
Differential Geometry I

This course counts as a core course in the Bachelor's degree programme in Mathematics. Holders of an ETH Zurich Bachelor's degree in Mathematics who didn't use credits from neither 401-3531-00L Differential Geometry I nor 401-3532-00L Differential Geometry II for their Bachelor's degree still can have recognised this course for the Master's degree.

Furthermore, at most one of the three course units 401-3461-00L Functional Analysis I 401-3531-00L Differential Geometry I 401-3601-00L Probability Theory can be recognised for the Master's degree in Mathematics or Applied Mathematics.

Abstract
Curves in R^n, inner geometry of hypersurfaces in R^n, curvature, Theorema Egregium, special classes of surfaces, Theorem of Gauss-Bonnet. Hyperbolic space. Differentiable manifolds, tangent bundle, immersions and embeddings, Sard's Theorem, mapping degree and intersection number, vector bundles, vector fields and flows, differential forms, Stokes' Theorem.

Objective
Introduction to elementary differential geometry and differential topology.

Content
- Differential geometry in R^n: theory of curves, submanifolds and immersions, inner geometry of hypersurfaces, Gauss map and curvature, Theorema Egregium, special classes of surfaces, Theorem of Gauss-Bonnet, Poincaré Index Theorem.
- The hyperbolic space.
- Differential topology: differentiable manifolds, tangent bundle, immersions and embeddings in R^n, Sard's Theorem, transversality, mapping degree and intersection number, vector bundles, vector fields and flows, differential forms, Stokes' Theorem.

Functional Analysis I

This course counts as a core course in the Bachelor's degree programme in Mathematics. Holders of an ETH Zurich Bachelor's degree in Mathematics who didn't use credits from neither 401-3461-00L Functional Analysis I nor 401-3462-00L Functional Analysis II for their Bachelor's degree still can have recognised this course for the Master's degree.

Furthermore, at most one of the three course units 401-3461-00L Functional Analysis I 401-3531-00L Differential Geometry I 401-3601-00L Probability Theory can be recognised for the Master's degree in Mathematics or Applied Mathematics.

Abstract
Baire category; Banach and Hilbert spaces, bounded linear operators; three fundamental principles: Uniform boundedness, open mapping/closed graph theorem, Hahn-Banach; convexity; dual spaces; weak and weak* topologies; Banach-Alaoglu; reflexive spaces; compact operators and Fredholm theory; closed range theorem; spectral theory of self-adjoint operators in Hilbert spaces.

Probability Theory

This course counts as a core course in the Bachelor's degree programme in Mathematics. Holders of an ETH Zurich Bachelor's degree in Mathematics who didn't use credits from none of the three course units 401-3601-00L Probability Theory, 401-3642-00L Brownian Motion and Stochastic Calculus resp. 401-3622-00L Applied Stochastic Processes for their Bachelor's degree still can have recognised this course for the Master's degree.

Furthermore, at most one of the three course units 401-3461-00L Functional Analysis I 401-3531-00L Differential Geometry I 401-3601-00L Probability Theory can be recognised for the Master's degree in Mathematics or Applied Mathematics.

Abstract
Basics of probability theory and the theory of stochastic processes in discrete time.

Objective
This course presents the basics of probability theory and the theory of stochastic processes in discrete time. The following topics are planned: Basics in measure theory, random series, law of large numbers, weak convergence, characteristic functions, central limit theorem, conditional expectation, martingales, convergence theorems for martingales, Galton Watson chain, transition probability, Theorem of Ionescu Tulcea, Markov chains.

Content
This course presents the basics of probability theory and the theory of stochastic processes in discrete time. The following topics are planned: Basics in measure theory, random series, law of large numbers, weak convergence, characteristic functions, central limit theorem, conditional expectation, martingales, convergence theorems for martingales, Galton Watson chain, transition probability, Theorem of Ionescu Tulcea, Markov chains.

Fundamentals of Mathematical Statistics

The course covers the basics of inferential statistics.

Electives (Physics Master)
### Physics Bachelor - Key for Type

<table>
<thead>
<tr>
<th>Key</th>
<th>Meaning</th>
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</thead>
<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
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<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
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<tr>
<td>O</td>
<td>Compulsory</td>
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</tbody>
</table>

### Key for Hours

<table>
<thead>
<tr>
<th>Key</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

ECTS  European Credit Transfer and Accumulation System
- Special students and auditors need special permission from the lecturers.
<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0240-00L</td>
<td>Human Learning (EW1)</td>
<td>O</td>
<td>2 credits</td>
<td>2G</td>
<td>E. Stern</td>
</tr>
</tbody>
</table>

**Abstract:**
This course looks into scientific theories and also empirical studies on human learning and relates them to the school.

**Objective:**
Anyone wishing to be a successful teacher must first of all understand the learning process. Against this background, theories and findings on the way humans process information and on human behaviour are prepared in such a manner that they can be used for planning and conducting lessons. Students additionally gain an understanding of what is going on in learning and behavioural research so that teachers are put in a position where they can further educate themselves in the field of research into teaching and learning.

**Content:**
- Lernen als Verhaltensänderung und als Informationsverarbeitung: Das menschliche Gedächtnis unter besonderer Berücksichtigung der Verarbeitung symbolischer Information; Lernen als Wissenskonstruktion und Kompetenzentwicklung unter besonderer Berücksichtigung des Wissenstransfers; Lernen durch Instruktion und Erklärungen; Die Rolle von Emotion und Motivation beim Lernen; Interindividuelle Unterschiede in der Lernfähigkeit und ihre Ursachen: Intelligenztheorien, Geschlechtsunterschiede beim Lernen

**Lecture notes:**
Folien werden zur Verfügung gestellt.

**Literature:**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0240-03L</td>
<td>Introduction to Test Theory and Test Construction in Educational Contexts (University of Zurich)</td>
<td>W</td>
<td>4 credits</td>
<td>2S</td>
<td>University lecturers</td>
</tr>
</tbody>
</table>

**Abstract:**
In this seminar, students establish the scientific fundamentals of performance measurement and educational diagnostics and study them on the basis of different current issues.

**Objective:**
At the end of the seminar, participants will be in a position to
- describe the scientific fundamentals of test theory and test structure,
- evaluate examples of scientifically-developed tests in their application context,
- if necessary, critically question the performance assessment that they employ in practice and professionalise it still further.

**Content:**
Die konkreten Inhalte des Seminars ergeben sich aufgrund der Präferenzen der Teilnehmenden und der daraus abgeleiteten Themenübersicht für Vorträge und Seminararbeiten. Im Rahmen der Startveranstaltung wird eine Liste mit möglichen Themen abgegeben und erläutert. Schwerpunkte der Themenvorschläge sind:
- Testentwicklung
- Gütekriterien von Tests
- Aufgabenkonstruktion
- Datenauswertung
- Rasch-Modell
- Internationale Vergleichstests
- Zulassungsstu

**Lecture notes:**
Im Verlaufe des Semesters werden einzelne Unterlagen in den Veranstaltungen abgegeben. Dazu gehören auch die Handouts der verschiedenen, studentischen Vorträge.

**Literature:**
- Als Grundlagenliteratur werden folgende Werke empfohlen:
- Weitere Literatur wird in der Lehrveranstaltung genannt.

**Prerequisites / notice:**
This lecture is only apt for students who intend to enrol in the programs “Lehrdiplom” or “Didaktisches Zertifikat”. It is about learning in childhood and adolescence.

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**Physics TC**

**Educational Science**

General course offerings in the category Educational Science are listed under "Programme: Educational Science for Teaching Diploma and TC".

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>851-0240-15L</td>
<td>Colloquium on the Science of Learning and Instruction</td>
<td>W</td>
<td>1 credit</td>
<td>1K</td>
<td>E. Stern, P. Greutmann, further lecturers</td>
</tr>
</tbody>
</table>

**Abstract:**
In the colloquium we discuss scientific projects concerning the teaching in mathematics, computer science, natural sciences and technology (STEM). The colloquium is conducted by the professorships participating in the Competence Center EduETH (ETH) and in the Institute for Educational Sciences (UZH).

**Objective:**
Participants are exemplarily introduced to different research methods used in research on learning and instruction and learn to weigh advantages and disadvantages of these approaches.

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>851-0240-22L</td>
<td>Coping with Psychosocial Demands of Teaching (EW4)</td>
<td>W</td>
<td>2 credits</td>
<td>3S</td>
<td>A. Deiglmayr, P. Greutmann</td>
</tr>
</tbody>
</table>

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Data: 06.03.2019 12:57  Autumn Semester 2016  Page 1235 of 1571
In this class, students will learn concepts and skills for coping with psychosocial demands of teaching. Students possess theoretical knowledge and practical competences to be able to cope with the psychosocial demands of teaching.

(1) They know the basic rules of negotiation and conflict management (e.g., mediation) and can apply them in the school context (e.g., in conversations with parents).
(2) They can apply diverse techniques of classroom management (e.g., prevention of disciplinary problems in the classroom) and know relevant authorities for further information (e.g., legal conditions).

**851-0242-05L Cognitively Activating Instructions in MINT Subjects**

**Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).**

This course unit can only be enrolled after successful participation in, or during enrollment in the course "Human Learning (EW 1)".

**Objective**
- Get to know cognitively activating instructions in MINT subjects
- Get information about recent literature on learning and instruction

**Prerequisites / notice**
Für eine reibungslose Semesterplanung wird um frühe Anmeldung und persönliches Erscheinen zum ersten Lehrveranstaltungstermin ersucht.

**851-0242-07L Human Intelligence**

Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).

This course unit can only be enrolled after successful participation in, or during enrollment in the course "Human Learning (EW 1)".

**Objective**
- Understanding of research methods used in the empirical human sciences
- Understanding  findings relevant for education

**851-0242-08L Research Methods in Educational Science**

Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).

This course unit can only be enrolled after successful participation in, or during enrollment in the course "Human Learning (EW 1)".

**Objective**
- Understanding of research methods used in the empirical educational sciences
- Understanding findings relevant from scientific journals and media
- Understanding pedagogically relevant findings from the empirical educational sciences

**Subject Didactics and Professional Training**

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>402-0910-00L</td>
<td>Physics Didactics I: Special Didactics of Physics Teaching</td>
<td>O</td>
<td>4 credits</td>
<td>3G</td>
<td>M. Mohr</td>
</tr>
</tbody>
</table>

Simultaneous enrolment in Introductory Internship Physics - course 402-0920-00L - is compulsory for Teaching Diploma Physic

Information for UZH students:
Enrolment to this course unit only possible at ETH. No enrolment to module 090Phy1 at UZH.
Please mind the ETH enrolment deadlines for UZH students: https://www.ethz.ch/en/studies/non-degree-courses/special-students/special-students-university-of-zurich.html

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<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>3S</td>
<td>in this class, students will learn concepts and skills for coping with psychosocial demands of teaching. Students possess theoretical knowledge and practical competences to be able to cope with the psychosocial demands of teaching. (1) They know the basic rules of negotiation and conflict management (e.g., mediation) and can apply them in the school context (e.g., in conversations with parents). (2) They can apply diverse techniques of classroom management (e.g., prevention of disciplinary problems in the classroom) and know relevant authorities for further information (e.g., legal conditions).</td>
<td>W</td>
<td>2 credits</td>
<td>2S</td>
<td>R. Schumacher</td>
</tr>
</tbody>
</table>

Data: 06.03.2019 12:57 Autumn Semester 2016 Page 1236 of 1571
Students use their specialist-subject, educational-science and subject-didactics training to draw up concepts for teaching.

Teaching Internship Including Examination Lessons

The energy and related environmental problems, the physics principles of using energy and the various real and hypothetical options are discussed from a physicist point of view. The lecture is intended for students of all ages with an interest in a rational approach to the energy problem of the 21st century.

The lecture tries to address the physical principles of todays and tomorrow energy use and the resulting global consequences for the world climate.

The topics of the mentored work are mostly chosen from the high school curriculum.

Methods

With the help of the mentor the students individually work on a topic and write a thesis about it.

Specialized Courses in Respective Subject with Educational Focus

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0737-00L</td>
<td>Energy and Environment in the 21st Century (Part I)</td>
<td>W</td>
<td>6</td>
<td>2V+1U</td>
<td>M. Ditmar</td>
</tr>
</tbody>
</table>

The energy and related environmental problems, the physics principles of using energy and the various real and hypothetical options are discussed from a physicist point of view. The lecture is intended for students of all ages with an interest in a rational approach to the energy problem of the 21st century.

The lecture tries to address the physical principles of todays and tomorrow energy use and the resulting global consequences for the world climate.

The lecture is for students which are interested participate in a rational and responsible debate about the energyproblem of the 21. century.
Content

Introduction: energy types, energy carriers, energy density and energy usage. How much energy does a human need/uses?

Energy conservation and the first and second law of thermodynamics

Fossil fuels (our stored energy resources) and their use.

Burning fossil fuels and the physics of the greenhouse effect.

Physics basics of nuclear fission and fusion energy

Controlled nuclear fission energy today, the different types of nuclear power plants, uranium requirements and resources, natural and artificial radioactivity and the related waste problems from the nuclear fuel cycle.

Nuclear reactor accidents and the consequences, a comparison with risks from other energy using methods.

The problems with nuclear fusion and the ITER project.

Nuclear fusion and fission: "exotic" ideas.

Hydrogen as an energy carrier: ideas and limits of a hydrogen economy.

New clean renewable energy sources and their physical limits (wind, solar, geothermal etc)

Energy perspectives for the next 100 years and some final remarks

Lecture notes

Many more details (in English and German) here:

http://ihp-lx2.ethz.ch/energy21/

Literature


Environmental Physics: Boeker and Egbert New York Wiley 1999

Prerequisites / notice

Science promised us truth, or at least a knowledge of such relations as our intelligence can seize: it never promised us peace or happiness

Gustave Le Bon

Physicists learned to realize that whether they like a theory or they don't like a theory is not the essential question. Rather, it's whether or not the theory gives predictions that agree with experiment.

Richard Feynman, 1985

402-0922-00L Mentored Work Specialised Courses in Physics with an Educational Focus A

Mentored Work Specialised Courses in the Respective Subject with an Educational Focus in Physics for TC and Teaching Diploma.

Abstract

In the mentored work on their subject specialisation, students link high-school and university aspects of the subject, thus strengthening their teaching competence with regard to curriculum decisions and the future development of the tuition. They compile texts under supervision that are directly comprehensible to the targeted readers - generally specialist-subject teachers at high-school level.

Objective

Practice in the explanation of complex topics in physics as the core competence of the teaching profession

Content

Improvement of the physics education by providing attractive recent topics with regard to future curricular decisions and the public view of physics

Choice of topic by individual arrangement

402-0944-00L Science in School (Current Topics for the Classroom)

Enrolment in Physics Didactics I (402-0910-00L) and Physics Didactics II (402-0910-00L) is mandatory.

Content

Kennenlernen und erarbeiten (Übungen) von Unterrichtssequenzen zu modernen Themen der Physik.

Lecture notes

Unterlagen werden verteilt.

Literature

Wird angegeben.

Prerequisites / notice


Physics TC - Key for Type

O Compulsory
W+ Eligible for credits and recommended
W Eligible for credits

E- Recommended, not eligible for credits
Z Courses outside the curriculum
Dr Suitable for doctorate
### Key for Hours

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
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<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

### ECTS
- European Credit Transfer and Accumulation System
- Special students and auditors need special permission from the lecturers.
## Educational Science

Course offerings in the category Educational Science are listed under “Programme: Educational Science for Teaching Diploma and TC”.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>851-0242-06L</td>
<td>Cognitively Activating Instructions in MINT Subjects (W)</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>R. Schumacher</td>
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<tr>
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<td>Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).</td>
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<tr>
<td></td>
<td>This course unit can only be enrolled after successful participation in, or during enrollment in the course “Human Learning (EW 1)”.</td>
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<tr>
<td>Abstract</td>
<td>This seminar focuses on teaching units in chemistry, physics and mathematics that have been developed at the MINT Learning Center of the ETH Zurich. In the first meeting, the mission of the MINT Learning Center will be communicated. Furthermore, in groups of two, the students will intensively work on, refine and optimize a teaching unit following a goal set in advance.</td>
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<tr>
<td>Objective</td>
<td>- Get to know cognitively activating instructions in MINT subjects</td>
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<td></td>
<td>- Get information about recent literature on learning and instruction</td>
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<tr>
<td>Prerequisites</td>
<td>Für eine reibungslose Semesterplanung wird um frühe Anmeldung und persönliches Erscheinen zum ersten Lehrveranstaltungstermin ersucht.</td>
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<td></td>
<td>Number of participants limited to 20.</td>
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<tr>
<td>851-0242-07L</td>
<td>Human Intelligence (W)</td>
<td>W</td>
<td>1</td>
<td>1S</td>
<td>E. Stern, P. Edelsbrunner,</td>
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<td></td>
<td>Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).</td>
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<td></td>
<td></td>
<td>B. Rütsche</td>
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<td></td>
<td>Number of participants limited to 30.</td>
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<td></td>
<td>This course unit can only be enrolled after successful participation in, or during enrollment in the course “Human Learning (EW 1)”.</td>
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<tr>
<td>Abstract</td>
<td>The focus will be on the book “Intelligenz: Grosse Unterschiede und ihre Folgen” by Stern and Neubauer. Participation at the first meeting is obligatory. It is required that all participants read the complete book. Furthermore, in two meetings of 90 minutes, concept papers developed in small groups (5 - 10 students) will be discussed.</td>
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<tr>
<td>Objective</td>
<td>- Understanding research methods used in the empirical human sciences</td>
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<td></td>
<td>- Getting to know intelligence tests</td>
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<tr>
<td></td>
<td>- Understanding findings relevant for education</td>
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<td></td>
<td>At the third meeting, we will discuss the essays and develop research questions in group work.</td>
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<td>Prerequisites</td>
<td>This course unit can only be enrolled after successful participation in, or during enrollment in the course “Human Learning (EW 1)”.</td>
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<tr>
<td>851-0242-08L</td>
<td>Research Methods in Educational Science (W)</td>
<td>W</td>
<td>1</td>
<td>1S</td>
<td>P. Edelsbrunner, B. Rütsche,</td>
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<td></td>
<td>Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).</td>
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<td></td>
<td>E. Stern, E. Ziegler</td>
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<td></td>
<td>Number of participants limited to 30.</td>
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<tr>
<td>Abstract</td>
<td>Literature from the learning sciences is critically discussed with a focus on research methods.</td>
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<tr>
<td>Objective</td>
<td>- Understand research methods used in the empirical educational sciences</td>
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<td></td>
<td>- Understand and critically examine information from scientific journals and media</td>
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<td></td>
<td>In the small groups students will write critical essays about the read literature. At the third meeting, we will discuss the essays and develop research questions in group work.</td>
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<tr>
<td>Prerequisites</td>
<td>Literature from the learning sciences is critically discussed with a focus on research methods.</td>
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<tr>
<td>851-0242-09L</td>
<td>Student Research Projects: Practical Research on Learning and Instruction (W)</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>A. Deiglmayr, P. Edelsbrunner,</td>
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<tr>
<td></td>
<td>Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).</td>
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<td></td>
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<td>S. Hofer, B. Rütsche, L. Schalk,</td>
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<tr>
<td></td>
<td>Number of participants limited to 20.</td>
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<td></td>
<td></td>
<td>E. Stern, E. Ziegler</td>
</tr>
<tr>
<td>Abstract</td>
<td>The successful completion of both course no. 851-0240-00L “Menschliches Lernen (EW 1)&quot; and course no. 851-0238-01L “Unterstützung und Diagnose von Wissenserwerbsprozessen (EW 3)&quot; is a necessary prerequisite for this course.</td>
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<tr>
<td>Objective</td>
<td>In teams of two, participants in this seminar conduct their own research project. Each team is advised by one of the researchers serving as lecturers in this course. Basic conceptual and methodological issues are the topic of a series of plenary meetings; however, the major part of the work is done in small-group meetings with the advising researcher, and in self-directed research projects.</td>
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<tr>
<td>Learning goals</td>
<td>The course is targeted at advanced students who have taken an interest in gathering practical research experience in the fields of Learning &amp; Instruction. In teams of two, students conduct their own research projects (planning, conducting, analyzing, interpreting, and presenting research); thus, the course requires a high amount of self-directed working. Students are personally advised, and supported in their research project, by one of the researchers serving as lecturers in this course. During the first half the semester, relevant methodological knowledge and skills are practiced during plenary meetings and in students’ independent reading (e.g. generating and testing research questions, designing experiments, and analyzing data in the field of Learning and Instruction)</td>
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<tr>
<td>Learning goals</td>
<td>Learning goals include:</td>
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<tr>
<td></td>
<td>- Participants can illustrate and explain basic methods and concepts for research in the fields of Learning and Instruction, e.g. with the help of practical examples.</td>
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<td></td>
<td>- Participants can design and conduct a study that is relevant for answering their research question.</td>
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<td></td>
<td>- Participants can summarize and evaluate the main results from a study in the field of learning and Instruction, with regard to the research question being asked.</td>
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</tbody>
</table>

## Subject Didactics in Physics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0910-00L</td>
<td>Physics Didactics I: Special Didactics of Physics Teaching (O)</td>
<td>O</td>
<td>4</td>
<td>3G</td>
<td>M. Mohr</td>
</tr>
<tr>
<td></td>
<td>Limited number of participants.</td>
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<tr>
<td></td>
<td>Further information is available from the lecturer via email.</td>
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</tbody>
</table>
Objective

Die Studierenden verfügen über fachdidaktisches Grundwissen für den Physikunterricht an einer Mittelschule. Sie können eigene Lektionen unter Berücksichtigung der vielfältigen Rahmenbedingungen planen, durchführen und evaluieren. Sie reflektieren ihren Unterricht und sind bestrebt, ihn didaktisch und pädagogisch weiter zu entwickeln.

Die Studierenden kennen die Einsatzmöglichkeiten verschiedener Unterrichtsmethoden und Hilfsmittel. Sie können die Eignung von Unterrichtsformen im Hinblick auf eine Lernsituation beurteilen. Sie bemühen sich in ihrem Unterricht, geeignete Methoden und Medien angepasst an die Klasse und das Thema einzusetzen.


Content

Thematische Schwerpunkte


Fachspezifisches: Sachstrukturen der gängigen Unterrichtsthemen, Alltagsbezüge, Fehlvorstellungen, Demonstrations- und Schülerexperimente, Arbeitsmittel zu physikalischen Themen des Grundlagen- und Schwerpunktsunterrichts

Einsatz verschiedener Unterrichtsmaterialien: Experimente, Computer, Taschenrechner, Video, Simulation

Unterrichtsformen: Lernaufgabe, Werkstatt, Puzzle, Projekt, Gruppenarbeit, Praktikum

Lernformen

Interaktive Lehr-Lernveranstaltung mit Vorträgen und Demonstrationen des Dozenten, studentischer Einzel- und Kleingruppenarbeit, kurzen Präsentationen der Studierenden, Verleihung der Inhalte durch Bearbeitung von Aufträgen ausserhalb der Kontaktstunden

Lecture notes

Folien und weitere Unterlagen werden zur Verfügung gestellt

Literature

wird während der Veranstaltung mitgeteilt

Prerequisites / notice

Die Veranstaltung ist zusammen mit dem Einführungspraktikum zu belegen
Objective

Right at the start of their training, students acquire initial experience with the observation of teaching, the establishment of concepts for teaching and the implementation of teaching. This early confrontation with the complexity of everything that teaching involves helps students decide whether they wish to and, indeed, ought to, continue with the training. It forms a basis for the subsequent pedagogical and subject-didactics training.

Content

- The teaching practice takes in 50 lessons: 30 are taught by the students, and the students sit in on 20 lessons. The teaching practice lasts 4-6 weeks. It gives students the opportunity to implement the contents of their specialist-subject, educational science and subject-didactics training in the classroom. Students also conduct work assignments in parallel to their teaching practice.
- Students use their specialist-subject, educational-science and subject-didactics training to draw up concepts for teaching.
- They are able to assess the significance of tuition topics in their subject from different angles (including interdisciplinary angles) and impart these to their pupils.
- They acquire the skills of the teaching trade.
- They practise finding the balance between instruction and openness so that pupils can and, indeed, must make their own cognitive contribution.
- They learn to assess pupils' work.
- Together with the teacher in charge of their teacher training, the students constantly evaluate their own performance.

Content


Literature

Wird von der Praktikumslehrperson bestimmt.

402-0911-00L Teaching Internship Physics O 8 credits 17P M. Mohr

Objective

Teaching Internship Physics for Teaching Diploma

Physics as Major Subject

Abstract

The teaching practice takes in 50 lessons: 30 are taught by the students, and the students sit in on 20 lessons. The teaching practice lasts 4-6 weeks. It gives students the opportunity to implement the contents of their specialist-subject, educational science and subject-didactics training in the classroom. Students also conduct work assignments in parallel to their teaching practice.

Objective

- Students use their specialist-subject, educational-science and subject-didactics training to draw up concepts for teaching.
- They are able to assess the significance of tuition topics in their subject from different angles (including interdisciplinary angles) and impart these to their pupils.
- They acquire the skills of the teaching trade.
- They practise finding the balance between instruction and openness so that pupils can and, indeed, must make their own cognitive contribution.
- They learn to assess pupils' work.
- Together with the teacher in charge of their teacher training, the students constantly evaluate their own performance.

Content


Literature

Wird von der Praktikumslehrperson bestimmt.

402-0913-00L Teaching Internship Physics II W 4 credits 9P M. Mohr

Objective

Teaching Internship for students upgrading TC to Teaching Diploma.

Abstract

This is a supplement to the Teaching Internship required to obtain a Master of Advanced Studies in Secondary and Higher Education in the corresponding subject. It is aimed at enlarging the already acquired teaching experience. Students observe 10 lessons and teach 15 lessons independently.

Objective

- Die Studierenden können die Bedeutung von Unterrichtsthemen in ihrem Fach unter verschiedenen Blickwinkeln einschätzen. Sie kennen und beherrschen das unterrichtliche Handwerk. Sie können ein gegebenes Unterrichtsthema für eine Gruppe von Lernenden fachlich und didaktisch korrekt strukturieren und in eine adequate Lernumgebung umsetzen. Es gelingt ihnen, die Balance zwischen Anleitung und Offenheit zu finden, sodass die Lernenden sowohl über den nötigen Freiraum wie über ausreichend Orientierung verfügen, um aktiv und effektiv flexibel nutzbare (Fach-)Wissen zu erwerben.

Content


402-0921-01L Examination Lesson I Physics O 1 credit 2P M. Mohr

Abstract

Simultaneous enrolment in "Examination Lesson II Physics" (402-0921-02L) is compulsory.

Objective

- On the basis of a specified topic, the candidate shows that they are in a position
- to develop and conduct teaching that is conducive to learning at high school level, substantiating it in terms of the subject-matter and from the didactic angle
- to analyze the tuition they have given with regard to its strengths and weaknesses, and outline improvements.

Content


Lecture notes

Dokument: Schriftliche Vorbereitung für Prüfungsdokumentationen.

Prerequisites / notice

Nach Abschluss der übrigen Ausbildung.

402-0921-02L Examination Lesson II Physics O 1 credit 2P M. Mohr

Abstract

Simultaneous enrolment in "Examination Lesson I Physics" (402-0921-01L) is compulsory.

Objective

- On the basis of a specified topic, the candidate shows that they are in a position
- to develop and conduct teaching that is conducive to learning at high school level, substantiating it in terms of the subject-matter and from the didactic angle
- to analyze the tuition they have given with regard to its strengths and weaknesses, and outline improvements.

Data: 06.03.2019 12:57 Autumn Semester 2016 Page 1242 of 1571

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<tr>
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<td>W</td>
<td>6</td>
<td>2V+1U</td>
<td>M. Dittmar</td>
</tr>
<tr>
<td>Abstract</td>
<td>The energy and related environmental problems, the physics principles of using energy and the various real and hypothetical options are discussed from a physicist point of view. The lecture is intended for students of all ages with an interest in a rational approach to the energy problem of the 21st century.</td>
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<tr>
<td>Objective</td>
<td>Scientists and espially physicists are often confronted with questions related to the problems of energy and the environment. The lecture tries to address the physical principles of todays and tomorrow energy use and the resulting global consequences for the world climate.</td>
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<tr>
<td>Content</td>
<td>The lecture is for students which are interested participate in a rational and responsible debate about the energyproblem of the 21. century.</td>
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<td></td>
<td>Energy conservation and the first and second law of thermodynamics</td>
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<td>Fossil fuels (our stored energy resources) and their use.</td>
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<td>Burning fossil fuels and the physics of the greenhouse effect.</td>
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<td>physics basics of nuclear fission and fusion energy</td>
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<td>controlled nuclear fission energy today, the different types of nuclear power plants, uranium requirements and resources, natural and artificial radioactivity and the related waste problems from the nuclear fuel cycle.</td>
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<td>Nuclear reactor accidents and the consequences, a comparison with risks from other energy using methods.</td>
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<td>new clean renewable energy sources and their physical limits (wind, solar, geothermal etc)</td>
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<td></td>
<td>Energy perspectives for the next 100 years and some final remarks</td>
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<tr>
<td>Lecture notes</td>
<td>many more details (in english and german) here:</td>
<td></td>
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</tr>
<tr>
<td>Literature</td>
<td><a href="http://hp-lx2.ethz.ch/energy21/">http://hp-lx2.ethz.ch/energy21/</a></td>
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<td></td>
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<td>Science promised us truth, or at least a knowledge of such relations as our intelligence can seize: it never promised us peace or happiness</td>
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<td></td>
<td>Gustave Le Bon</td>
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<td></td>
<td>Physicists learned to realize that whether they like a theory or they don't like a theory is not the essential question.</td>
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<tr>
<td></td>
<td>Rather, it's whether or not the theory gives predictions that agree with experiment.</td>
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<td></td>
<td>Richard Feynman, 1985</td>
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<tr>
<td>402-0944-00L</td>
<td>Science in School (Current Topics for the Classroom)</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>C. Wagner, A. Vaterlaus</td>
</tr>
<tr>
<td>Content</td>
<td>Enrolment in Physics Didactics I (402-0910-00L) and Physics Didactics II (402-0910-00L) is mandatory.</td>
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<tr>
<td>Lecture notes</td>
<td>Kennenlernen und erarbeiten (Übungen) von Unterrichtssequenzen zu modernen Themen der Physik.</td>
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<tr>
<td>Literature</td>
<td>Unterrlagen werden verteilt.</td>
<td></td>
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</tr>
<tr>
<td>Prerequisites / notice</td>
<td>Wird angegeben.</td>
<td></td>
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</tbody>
</table>
Abstract
In the mentored work on their subject specialisation, students link high-school and university aspects of the subject, thus strengthening their teaching competence with regard to curriculum decisions and the future development of the tuition. They compile texts under supervision that are directly comprehensible to the targeted readers - generally specialist-subject teachers at high-school level.

Objective
Practice in the explanation of complex topics in physics as the core competence of the teaching profession

Content
Choice of topic by individual arrangement

402-0923-00L
Mentored Work Specialised Courses in Physics with an Educational Focus B
Mentored Work Specialised Courses in the Respective Subject with an Educational Focus in Physics for Teaching Diploma and for students upgrading TC to Teaching Diploma.

Abstract
In the mentored work on their subject specialisation, students link high-school and university aspects of the subject, thus strengthening their teaching competence with regard to curriculum decisions and the future development of the tuition. They compile texts under supervision that are directly comprehensible to the targeted readers - generally specialist-subject teachers at high-school level.

Objective
Practice in the explanation of complex topics in physics as the core competence of the teaching profession

Content
Choice of topic by individual arrangement

402-0924-00L
Internship Physics Didactics
Internship Physics Didactics for Teaching Diploma with Physics as First Subject.

Abstract
During the Internship Physics Didactics students teach 8 lessons in the classes of an internship teaching person. Students develop, test and analyze teaching arrangement under the guidance of a mentor (one of the lecturers).

Objective
Basic knowledge for the design of teaching arrangements is the topic of the Physics Didactics I and II courses. In the subsequent Internship Physics Didactics students combine the theoretical knowledge acquired in the didactics courses with practical aspects of teaching. During the internship students learn to transform their teaching goals into a real live class room setting considering subject specific, didactical and pedagogical aspects.

Content

Lecture notes
Wird vom Mentor bestimmt.

Prerequisites / notice
Das Fachdidaktikpraktikum kann erst nach dem Besuch der FD1 und frühestens mit der FD2 durchgeführt werden (eine gleichzeitige Belegung von Fachdidaktik 2 und Fachdidaktikpraktikum ist möglich).

Compulsory Elective Courses
Further course offerings from the category Educational Science are listed under "Programme: Educational Science for Teaching Diploma and TC".

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0737-00L</td>
<td>Energy and Environment in the 21st Century (Part I)</td>
<td>W</td>
<td>6 credits</td>
<td>2V+1U</td>
<td>M. Dittmar</td>
</tr>
</tbody>
</table>

Abstract
The energy and related environmental problems, the physics principles of using energy and the various real and hypothetical options are discussed from a physicist point of view. The lecture is intended for students of all ages with an interest in a rational approach to the energy problem of the 21st century.

Objective
Scientists and especially physicists are often confronted with questions related to the problems of energy and the environment. The lecture tries to address the physical principles of todays and tomorrow energy use and the resulting global consequences for the world climate.

The lecture is for students which are interested participate in a rational and responsible debate about the energyproblem of the 21. century.
Content

Introduction: energy types, energy carriers, energy density and energy usage. How much energy does a human needs/uses?

Energy conservation and the first and second law of thermodynamics

Fossil fuels (our stored energy resources) and their use.

Burning fossil fuels and the physics of the greenhouse effect.

Physics basics of nuclear fission and fusion energy

Controlled nuclear fission energy today, the different types of nuclear power plants, uranium requirements and resources, natural and artificial radioactivity and the related waste problems from the nuclear fuel cycle.

Nuclear reactor accidents and the consequences, a comparison with risks from other energy using methods.

The problems with nuclear fusion and the ITER project.

Nuclear fusion and fission: "exotic" ideas.

Hydrogen as an energy carrier: ideas and limits of a hydrogen economy.

New clean renewable energy sources and their physical limits (wind, solar, geothermal etc)

Energy perspectives for the next 100 years and some final remarks

Lecture notes

Many more details (in English and German) here:

http://hph-lx2.ethz.ch/energy21/

Literature


Environmental Physics: Boeker and Egbert New York Wiley 1999

Prerequisites / notice

Science promised us truth, or at least a knowledge of such relations as our intelligence can seize: it never promised us peace or happiness

Gustave Le Bon

Physicists learned to realize that whether they like a theory or they don't like a theory is not the essential question. Rather, it's whether or not the theory gives predictions that agree with experiment.

Richard Feynman, 1985

402-0944-00L Science in School (Current Topics for the Classroom) W 2 credits 2G C. Wagner, A. Vaterlaus

Abstract

The unit "Computer Science in Secondary School Mathematics" addresses key contributions of computer science to general education, the tight relations between the algorithmic and the mathematical way of thinking, and the thoughtful choice of computer science topics for high school mathematics classes.

Objective

The general goal of the course consists in presenting ways to teach fundamentals of computer science, which are closely related to contents and methods of mathematics. After attending the course unit, a mathematics teacher is able to teach selected fundamentals of computer science in mathematics classes.

The students understand the fundamental concepts of computer science in the context of a broad and deep knowledge. Through this understanding, they manage to prepare teaching materials for a successful knowledge transfer and to pass their passion for the subject on to their pupils.

The students know various teaching methods as well as their advantages and disadvantages. They can handle inhomogeneous prior knowledge of the learners inside a class. Besides holding classes, the students do care about the individual pupil support.

They encourage the autonomy of the learners, manage to work with diverse target groups and to establish a positive learning environment.

The students are able to express themselves using a comprehensible and refined professional language, both in a spoken and a written way, and they master the basic terminology of computer science. Besides the English terms, they are familiar with the corresponding German expressions. The students are able to produce detailed, matured, linguistically correct and design-wise appealing teaching materials.
The main topics of the course unit "Computer Science in Secondary School Mathematics" represent a scientific and didactic added value for mathematics classes.

The course covers the didactics of logic, of cryptology, of finite state automata, of computability and of the introduction to programming. The students develop the understanding of fundamental scientific concepts such as algorithm, program, complexity, determinism, computation, automata, verification, testing, security of a cryptosystem and secure communication. They reflect on ways to embed them into a scientifically sound and didactically sustainable mathematics course.

In a semester exercise, the students develop and document an adaptive teaching unit for computer science. They learn to employ the didactics methods and techniques that are introduced at the beginning of the semester.

Lecture notes

Literature


see Compulsory Elective Courses Teaching Diploma

### Physics Teaching Diploma - Key for Type

<table>
<thead>
<tr>
<th>O</th>
<th>Compulsory</th>
<th>E-</th>
<th>Recommended, not eligible for credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
<td>Suitable for doctorate</td>
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</tbody>
</table>

### Key for Hours

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
<th>P</th>
<th>practical/laboratory course</th>
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</thead>
<tbody>
<tr>
<td>G</td>
<td>lecture with exercise</td>
<td>A</td>
<td>independent project</td>
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<tr>
<td>U</td>
<td>exercise</td>
<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>S</td>
<td>seminar</td>
<td>R</td>
<td>revision course / private study</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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</table>

### ECTS

Special students and auditors need special permission from the lecturers.
Physics Master

Core Courses

One Core Course in Experimental or Theoretical Physics from Physics Bachelor is eligible; however, this Core Course from Physics Bachelor cannot be used to compensate for the mandatory Core Course in Experimental or Theoretical Physics.

For the category assignment keep the choice “no category” and take contact with the Study Administration (www.phys.ethz.ch/studies/study-administration.html) after having received the credits.

Core Courses in Theoretical Physics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0861-00L</td>
<td>Statistical Physics</td>
<td>W</td>
<td>10 credits</td>
<td>4V+2U</td>
<td>G. Blatter</td>
</tr>
<tr>
<td>Abstract</td>
<td>This lecture covers the concepts of classical and quantum statistical physics, and some aspects of kinetic gas theory and hydrodynamics. In a more advanced part degenerate Fermions, Bose-Einstein condensation, real Bose gases, magnetism, general mean field theory and critical phenomena will be addressed.</td>
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<tr>
<td>Objective</td>
<td>This lecture gives an introduction in the basic concepts and applications of statistical physics for the general use in physics and, in particular, as a preparation for the theoretical solid state physics education.</td>
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<tr>
<td>Lecture notes</td>
<td>Lecture notes available in german.</td>
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<tr>
<td>Literature</td>
<td>No specific book is used for the course. Relevant literature will be given in the course.</td>
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</table>

402-0843-00L Quantum Field Theory I

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>402-0830-00L</td>
<td>General Relativity</td>
<td>W</td>
<td>10 credits</td>
<td>4V+2U</td>
<td>P. Jetzer</td>
</tr>
<tr>
<td>Abstract</td>
<td>Manifold, Riemannian metric, connection, curvature; Special Relativity; Lorentzian metric; Equivalence principle; Tidal force and spacetime curvature; Energy-momentum tensor, field equations, Newtonian limit; Post-Newtonian approximation; Schwarzschild solution; Mercury's perihelion precession, light deflection.</td>
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<tr>
<td>Objective</td>
<td>The goal of this course is to provide a solid introduction to the formalism, the techniques, and important physical applications of quantum field theory. Furthermore it prepares students for the advanced course in quantum field theory (Quantum Field Theory II), and for work on research projects in theoretical physics, particle physics, and condensed-matter physics.</td>
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Core Courses: Experimental Physics

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>402-0257-00L</td>
<td>Advanced Solid State Physics</td>
<td>W</td>
<td>10 credits</td>
<td>3V+2U</td>
<td>A. Zheludev</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course is an extension of the introductory course on solid state physics.</td>
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<tr>
<td>Objective</td>
<td>The purpose of this course is to learn to navigate the complex collective quantum phases, excitations and phase transitions that are the dominant theme in modern solid state physics. The emphasis is on the main concepts and on specific experimental examples, both classic ones and those from recent research.</td>
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<tr>
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<td>The goal is to study how novel phenomena emerge in the solid state.</td>
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</table>
Content

Today's challenges and opportunities in Solid State Physics

- Phase transitions and critical phenomena
  - Main concepts: coherence length, symmetry, order parameter, correlation functions, generalized susceptibility
  - Bragg-Williams mean field theory
  - Landau theory of phase transitions
  - Fluctuations in Landau theory
  - Critical exponents: significance, measurement, inequalities, equalities
  - Scaling and hyperscaling
  - Universality
  - Critical dynamics
  - Quantum phase transitions and quantum criticality

- Fermi surface instabilities
  - The concept of the Landau Fermi liquid in metals
  - Kohn anomalies
  - Charge density waves
  - Metallic ferromagnets and half-metals
  - Spin density waves

- Magnetism of insulators
  - Magnetic interactions in solids and the spin Hamiltonian
  - Magnetic structures and phase transitions
  - Spin waves
  - Quantum magnetism

- Electron correlations in solids
  - Mott insulating state
  - Phases of the Hubbard model
  - Layered cuprates (non-superconducting properties)

Lecture notes

The printed material for this course involves: (1) a self-contained script, distributed electronically at semester start. (2) experimental examples (Power Point slide-style) selected from original publications, distributed at the start of every lecture.

Literature

A list of books will be distributed. Numerous references to useful published scientific papers will be provided.

Prerequisites / notice

This course is for students who like to be engaged in active learning. The "exercise classes" are organized in a non-traditional way: following the idea of "less is more", we will work on only about half a dozen topics, and this gives students a chance to take a look at original literature (provided), and to get the grasp of a topic from a broader perspective.

Students report back that this mode of "exercise class" is more satisfying than traditional modes, even if it does not mean less effort.

402-0442-00L Quantum Optics W 10 credits 3V+2U J. Faist

Abstract

This course gives an introduction to the fundamental concepts of Quantum Optics and will highlight state-of-the-art developments in this rapidly-evolving discipline. The topics covered include the quantum nature of light, semi-classical and quantum mechanical description of light-matter interaction, laser manipulation of atoms and ions, optomechanics and quantum computation.

Objective

The course aims to provide the knowledge necessary for pursuing research in the field of Quantum Optics. Fundamental concepts and techniques of Quantum Optics will be linked to modern experimental research. During the course the students should acquire the capability to understand currently published research in the field.

Content

This course gives an introduction to the fundamental concepts of Quantum Optics and will highlight state-of-the-art developments in this rapidly evolving discipline. The topics that are covered include:

- coherence properties of light
- quantum nature of light: statistics and non-classical states of light
- light matter interaction: density matrix formalism and Bloch equations
- quantum description of light matter interaction: the Jaynes-Cummings model, photon blockade
- laser manipulation of atoms and ions: laser cooling and trapping, atom interferometry,
- further topics: Rydberg atoms, optomechanics, quantum computing, complex quantum systems.

Lecture notes

Selected book chapters will be distributed.

Literature

Text-books:

G. Grynberg, A. Aspect and C. Fabre, Introduction to Quantum Optics
R. Loudon, The Quantum Theory of Light
Atomic Physics, Christopher J. Foot
Advances in Atomic Physics, Claude Cohen-Tannoudji and David Guéry-Odelin
C. Cohen-Tannoudji et al., Atom-Photon-Interactions
M. Scully and M.S. Zubairy, Quantum Optics
Y. Yamamoto and A. Imamoglu, Mesoscopic Quantum Optics

402-0402-00L Ultrafast Laser Physics W 10 credits 3V+2U J. P. Gallmann, S. Johnson, U. Keller

Abstract

Introduction to ultrafast laser physics with an outlook into cutting edge research topics such as attosecond science and coherent ultrafast sources from THz to X-rays.

Objective

Understanding of basic physics and technology for pursuing research in ultrafast laser science. How are ultrashort laser pulses generated, how do they interact with matter, how can we measure these shortest man-made events and how can we use them to time-resolve ultrafast processes in nature? Fundamental concepts and techniques will be linked to a selection of hot topics in current research and applications.
The lecture covers the following topics:

a) Linear pulse propagation: mathematical description of pulses and their propagation in linear optical systems, effect of dispersion on ultrashort pulses, concepts of pulse carrier and envelope, time-bandwidth product

b) Dispersion compensation: technologies for controlling dispersion, pulse shaping, measurement of dispersion

c) Nonlinear pulse propagation: intensity-dependent refractive index (Kerr effect), self-phase modulation, nonlinear pulse compression, self-focusing, filamentation, nonlinear Schrödinger equation, solitons, non-instantaneous nonlinear effects (Raman/Brillouin), self-steepening, saturable gain and absorption

d) Second-order nonlinearities with ultrashort pulses: phase-matching with short pulses and real beams, quasi-phase matching, second-harmonic and sum-frequency generation, parametric amplification and generation

e) Relaxation oscillations: dynamical behavior of rate equations after perturbation

f) Q-switching: active Q-switching and its theory based on rate equations, active Q-switching technologies, passive Q-switching and theory

g) Active modelocking: introduction to modelocking, frequency comb versus axial modes, theory for various regimes of laser operation, Haus master equation formalism

h) Passive modelocking: slow, fast and ideally fast saturable absorbers, semiconductor saturable absorber mirror (SESAM), designs of and materials for SESAMs, modelocking with slow absorber and dynamic gain saturation, modelocking with ideally fast saturable absorber, Kerr-lens modelocking, soliton modelocking, Q-switching instabilities in modelocked lasers, inverse saturable absorption

i) Pulse duration measurements: rf cables and electronics, fast photodiodes, linear system theory for microwave test systems, intensity and interferometric autocorrelations and their limitations, frequency-resolved optical gating, spectral phase interferometry for direct electric-field reconstruction and more

j) Noise: microwave spectrum analyzer as laser diagnostics, amplitude noise and timing jitter of ultrafast lasers, lock-in detection

k) Ultrafast measurements: pump-probe scheme, transient absorption/differential transmission spectroscopy, four-wave mixing, optical gating and more

l) Frequency combs and carrier-envelope offset phase: measurement and stabilization of carrier-envelope offset phase (CEP), time and frequency domain applications of CEP-stabilized sources

m) High-harmonic generation and attosecond science: non-perturbative nonlinear optics / strong-field phenomena, high-harmonic generation (HHG), phase-matching in HHG, attosecond pulse generation, attosecond technology: detectors and diagnostics, attosecond metrology (streaking, RABBITT, transient absorption, attoclock), example experiments

n) Ultrafast THz science: generation and detection, physics in THz domain, weak-field and strong-field applications

o) Brief introduction to other hot topics: relativistic and ultra-high intensity ultrafast science, ultrafast electron sources, free-electron lasers, etc.

Prerequisites:

Phenomenology of Particle Physics I: Relativistic kinematics, Decay rates and cross sections, The Dirac equation, From the S-matrix to the Feynman rules of QED, Scattering processes in QED, Experimental tests of QED, Hadron spectroscopy, Unitary symmetries and QCD, QCD and alpha_s running, QCD in e^+-e^- annihilation, Experimental tests of QCD in e^+-e^- annihilation

Phenomenology of Particle Physics II: Introduction to modern particle physics, Topics to be covered in Phenomenology of Particle Physics II: Relativistic kinematics, Decay rates and cross sections, The Dirac equation, From the S-matrix to the Feynman rules of QED, Scattering processes in QED, Experimental tests of QED, Hadron spectroscopy, Unitary symmetries and QCD, QCD and alpha_s running, QCD in e^+-e^- annihilation, Experimental tests of QCD in e^+-e^- annihilation

Literature:

As described in the entity: Lernmaterialien

Electives:

Electives: Physics and Mathematics

Selection: Solid State Physics

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<tbody>
<tr>
<td>402-0521-66L</td>
<td>Modern Aspects in Surface Science Research: Techniques and Applications</td>
<td>W</td>
<td>6 credits</td>
<td>2V+1U</td>
<td>O. Gürü</td>
</tr>
</tbody>
</table>

Lecture notes

Class notes will be made available.

Prerequisites: Basic knowledge of quantum electronics (e.g., 402-0275-00L Quantenelektronik).
Abstract
The Course will treat the subjects of the crystal structure of bulk and surfaces, imaging surfaces with electrons and ions, general scanning probe microscopy methods, Scanning Tunnelling Microscopy, Atomic force microscopy, Electronic structure of the bulk and surfaces, and STM and AFM spectroscopy. The various techniques will be illustrated with examples from modern research.

Objective
It is the aim of this course to provide a review of modern aspects in surface science research.

Content
Course description
The course will start with an overview of the fundamentals of bulk crystals and a reminder on the x-ray diffraction from crystals. We will continue with the extension of the alphabet of bulk crystal structure to surfaces and the nomenclature of surface reconstructions and interesting structures like moiré patterns will be introduced. Following the two introductory weeks, we will dwell in to the realm of imaging the surfaces. We will start with electron beam based imaging and analysis techniques of surfaces. Scanning Electron Microscopy (SEM), Low Energy Electron Diffraction (LEED) and Low Energy Electron Microscopy (LEEM) will be discussed. Imaging with ion beam based techniques like Low Energy Ion Scattering (LEIS) and He-ion microscopy will be touched upon. Following these, probe microscopy techniques will be explored starting with the topographer and continuing with Scanning Tunnelling Microscopy (STM). Basics of Atomic Force Microscopy (AFM) will follow. Imaging is a fundamental part of efforts on understanding surfaces. Yet, a through understanding and capability of generating and manipulating novel surface and interface systems can only be achieved by studying the electronic structure of surfaces. In order to investigate the electronic structure of surface and interface systems, a basic knowledge of the bulk electronic structure is necessary. So, introductory concepts on the electronic structure of the bulk and low dimensional systems will be discussed. Then, the basics of photoelectron emission form surfaces will be given. In the final two weeks of the course an overview of the spectroscopic modes of scanning probes and atomic scale electron spectroscopy will be introduced.

Literature
6) Charles Kittel, Introduction to Solid State Physics (8th Ed.)
7) Neil W. Ashcroft and N. David Mermin, Solid State Physics
8) Harald Ibach and Hans Lüth, Solid-State Physics: An Introduction to Principles of Materials Science
9) Further reading material will be supplied.

Prerequisites / notice
At least, 4 homework will be assigned.

402-0526-00L Ultrafast Processes in Solids

Abstract
Ultrafast processes in solids are of fundamental interest as well as relevant for modern technological applications. The dynamics of the lattice, the electron gas as well as the spin system of a solid are discussed. The focus is on time resolved experiments which provide insight into pico- and femtosecond dynamics.

Objective
After attending this course you understand the dynamics of essential excitation processes which occur in solids and you have an overview over state of the art experimental techniques used to study fast processes.
1. Introduction and overview

Semiconductor Nanostructures

2. Dynamics of the electron gas
   2.1 First experiments on electron dynamics and lattice heating
   2.2 The finite lifetime of excited states
   2.3 Detection of lifetime effects
   2.4 Dynamical properties of reactions and adsorbents

3. Dynamics of the lattice
   3.1 Phonons
   3.2 Non-thermal melting

4. Dynamics of the spin system
   4.1 Laser induced ultrafast demagnetization
   4.2 Ultrafast spin currents generated by lasers
   4.3 Landau-Lifschitz-Dynamics
   4.4 Laser induced switching

5. Correlated materials

Lecture notes will be distributed

Literature

The lecture notes will be made available during the course, through the Moodle portal.

Prerequisites / notice

The course gives an introduction to the use of synchrotron radiation in materials science. It treats the generation of intense x-ray beams at synchrotron radiation sources and their use for the characterisation of materials properties at different length scales. As part of the course, experiments will be carried out at the Swiss Light Source, Paul Scherrer Institut.


This lecture is complementary to the lecture on "ultrafast methods for solid state physics" of the spring semester. Both lectures can be attended independently. The focus of this lecture is on the physical processes whereas the focus of the "ultrafast methods for solid state physics" lecture is on the experimental techniques.
Objective

A comprehensive understanding of the interaction of x-rays with condensed matter and their use in materials analysis; acquiring hands-on experience with the use of synchrotron radiation.

Content

Interaction of x-rays with matter:
Elastic scattering from bound electron, atom and assemblies of atoms; Compton scattering; principles of diffraction from crystals and scattering from disordered systems; thermal diffuse scattering, small-angle scattering from nanometre-sized objects; X-ray absorption spectroscopy; microscopy; comparison with neutron scattering, where appropriate.

The generation of high-brilliance x-ray beams at synchrotron radiation sources:
Undulators, wigglers and bending magnets; comparison with conventional lab sources; the future x-ray free electron laser.

Instrumentation:
Monochromator; diffractometer; detector.

Determination of materials properties:
Crystal structure; defects and strain fields; structure of surfaces and interfaces; chemical bonding properties.

New methods:
Coherent x-ray scattering and diffractive imaging.

Lecture notes

A reader and a guide through the experiments at the Swiss Light Source will be made available on the web.

Literature


Prerequisites / notice

Part of the course is in the form of practical work at the Swiss Light Source. During two days (dates to be agreed), the following experiments will be performed: (1) elastic and Compton scattering, (2) liquid scattering and powder diffraction, and (4) X-ray absorption spectroscopy.

Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
402-0317-00L | Semiconductor Materials: Fundamentals and Fabrication | W | 6 credits | 2V+1U | S. Schön, W. Wegscheider

Abstract

This course gives an introduction into the fundamentals of semiconductor materials. The main focus is on state-of-the-art fabrication and characterization methods. The course will be continued in the spring term with a focus on applications.

Objective

Basic knowledge of semiconductor physics and technology. Application of this knowledge for state-of-the-art semiconductor device processing.

Content

Fundamentals of Solid State Physics: Semiconductor materials, band structures, carrier statistics in intrinsic and doped semiconductors, p-n junctions, low-dimensional structures; Bulk Material growth of Semiconductors: Czochralski method, floating zone method, high pressure synthesis; Semiconductor Epitaxy: Fundamentals, MBE, MOCVD, LPE; In situ characterization: RHEED, LEED, AES, XPS, process control (temperature, thickness)

Prerequisites / notice

Part of the course is in the form of practical work at the Swiss Light Source. During two days (dates to be agreed), the following experiments will be performed: (1) elastic and Compton scattering, (2) liquid scattering and powder diffraction, and (4) X-ray absorption spectroscopy.

Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
402-0464-00L | Optical Properties of Semiconductors | W | 8 credits | 2V+2U | A. Imamoglu, G. Scalari

Abstract

This course presents a comprehensive discussion of optical processes in semiconductors.

Objective

The rich physics of the optical properties of semiconductors, as well as the advanced processing available on these material, enabled numerous applications (lasers, LEDs and solar cells) as well as the realization of new physical concepts. Systems that will be covered include quantum dots, exciton-polaritons, quantum Hall fluids and graphene-like materials.

Content

Electronic states in III-V materials and quantum structures, optical transitions, excitons and polaritons, novel two dimensional semiconductors, spin-orbit interaction and magneto-optics.

Prerequisites / notice

Prerequisites: Quantum Mechanics I, Introduction to Solid State Physics

Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
402-0865-66L | Physics of Cold Atomic Gases | W | 6 credits | 2V+1U | W. Zwergen

Abstract

This course presents a comprehensive discussion of optical processes in semiconductors.

Objective

The rich physics of the optical properties of semiconductors, as well as the advanced processing available on these material, enabled numerous applications (lasers, LEDs and solar cells) as well as the realization of new physical concepts. Systems that will be covered include quantum dots, exciton-polaritons, quantum Hall fluids and graphene-like materials.

Content

Electronic states in III-V materials and quantum structures, optical transitions, excitons and polaritons, novel two dimensional semiconductors, spin-orbit interaction and magneto-optics.

Prerequisites / notice

Prerequisites: Quantum Mechanics I, Introduction to Solid State Physics

Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
402-0415-62L | Modern Topics in Terahertz Science | W | 6 credits | 2V+1U | S. Johnson

Abstract

This course reviews current research topics in Terahertz Science with a strong focus on scientific applications in physics, chemistry and biology, as well as the emerging field of nonlinear THz optics.

Objective

Terahertz frequency electromagnetic radiation lies at the border between electronics and optics, and as such has many unique properties that make it well-suited to study the electronic, magnetic and structural properties of many materials. The course objective is to give students the ability to identify problems of current interest in physics, chemistry, materials science and biology that can be potentially addressed using terahertz photonics and to design potential experimental solutions.

Content

The course will focus predominantly on understanding research conducted over the last 4-5 years at the forefront of this developing field, with a strong emphasis on nonlinear THz science which has only recently become possible. This in particular has generated excitement as it offers potential new ways to control chemical reactions and/or phase transitions in materials.

Lecture notes

Scripts will be distributed via moodle.

Literature

The readings for the course will draw mostly on current journal articles that will be distributed in class/via moodle. There is also a general textbook listed below available electronically via the ETH library system. You can also order a black-and-white paperback via an "on-demand" system for a pretty reasonable price.

Prerequisites / notice

Prerequisites: Quantum electronics.

Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---

Selection: Particle Physics, Nuclear Physics

Prerequisites

Selection: Particle Physics, Nuclear Physics

Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---

Type

This course will review current research topics in Terahertz Science with a strong focus on scientific applications in physics, chemistry and biology, as well as the emerging field of nonlinear THz optics.

Objective

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Literature

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Prerequisites / notice

The former course title of this course is "Terahertz Technology and Applications".

Selection: Particle Physics, Nuclear Physics

Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---

Type

This course will review current research topics in Terahertz Science with a strong focus on scientific applications in physics, chemistry and biology, as well as the emerging field of nonlinear THz optics.

Objective

The course will focus predominantly on understanding research conducted over the last 4-5 years at the forefront of this developing field, with a strong emphasis on nonlinear THz science which has only recently become possible. This in particular has generated excitement as it offers potential new ways to control chemical reactions and/or phase transitions in materials.

Lecture notes

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Literature

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Prerequisites / notice

The former course title of this course is "Terahertz Technology and Applications".

Selection: Particle Physics, Nuclear Physics

Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---

Type

This course will review current research topics in Terahertz Science with a strong focus on scientific applications in physics, chemistry and biology, as well as the emerging field of nonlinear THz optics.

Objective

The course will focus predominantly on understanding research conducted over the last 4-5 years at the forefront of this developing field, with a strong emphasis on nonlinear THz science which has only recently become possible. This in particular has generated excitement as it offers potential new ways to control chemical reactions and/or phase transitions in materials.

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Literature

The readings for the course will draw mostly on current journal articles that will be distributed in class/via moodle. There is also a general textbook listed below available electronically via the ETH library system. You can also order a black-and-white paperback via an "on-demand" system for a pretty reasonable price.

Prerequisites / notice

The former course title of this course is "Terahertz Technology and Applications".

Selection: Particle Physics, Nuclear Physics

Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
**Experimental Methods and Instruments of Particle Physics**

**Abstract**


**Objective**

Acquire an in-depth understanding and overview of the essential elements of experimental methods in particle physics, including accelerators and experiments.

**Content**

1. Examples of modern experiments
2. Basics: Bethe-Bloch, radiation length, nuclear interaction length, fixed-target vs. collider, principles of measurements: energy- and momentum-conservation, etc.
3. Physics and layout of accelerators
4. Charged particle tracking and vertexing
5. calorimetry
6. Particle identification
7. Analysis methods: invariant and missing mass, jet algorithms, b-tagging
8. Special detectors: extended air shower detectors and cryogenic detectors
9. MC simulations (GEANT), trigger, readout, electronics

**Lecture notes**

Slides are handed out regularly, see http://www.physik.uzh.ch/en/teaching/PHY461/HS2016.html

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**Astro-Particle Physics I**

**Abstract**

This lecture gives an overview of the present research in the field of Astro-Particle Physics, including the different experimental techniques. In the first semester, main topics are the charged cosmic rays including the antimatter problem. The second semester focuses on the neutral components of the cosmic rays as well as on some aspects of Dark Matter.

**Objective**

Successful students know:
- experimental methods to measure cosmic ray particles over full energy range
- current knowledge about the composition of cosmic ray
- possible cosmic acceleration mechanisms
- correlation between astronomical objects and cosmic accelerators
- information about our galaxy and cosmology gained from observations of cosmic rays

**Content**

First semester (Astro-Particle Physics II):
- definition of ‘Astro-Particle Physics’
- important historical experiments
- chemical composition of the cosmic rays
- direct observations of cosmic rays
- indirect observations of cosmic rays
- ‘extended air showers’ and ‘cosmic muons’
- ‘knee’ and ‘ankle’ in the energy spectrum
- the ‘anti-matter problem’ and the Big Bang
- ‘cosmic accelerators’

**Lecture notes**

See lecture home page: http://ihp-lx2.ethz.ch/AstroTeilchen/

**Literature**

See lecture home page: http://ihp-lx2.ethz.ch/AstroTeilchen/

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**Particle Physics in the Early Universe**

*Does not take place this semester.*

**Abstract**

An introduction to key concepts on the interface of Particle Physics and Early Universe cosmology. Topics include inflation and inflationary models, the Electroweak phase transition and vacuum stability, matter-antimatter asymmetry, recombination and the Cosmic Microwave Background, relic abundances and primordial nucleosynthesis, baryogenesis, dark matter and more.

**Prerequisites / notice**

Recommended: Quantum Field Theory 1 or Quantum Field Theory 2

**Low Energy Particle Physics**

**Abstract**

Low energy particle physics provides complementary information to high energy physics with colliders. In this lecture, we will concentrate on selected experiments, using mainly neutrons and muons, which have significantly improved our understanding of particle physics today.

The course aims to provide an introduction to selected advanced topics in low energy particle physics with neutrons and muons.

Low energy particle physics provides complementary information to high energy physics with colliders. At the Large Hadron Collider one directly searches for new particles at energies up to the TeV range. In a complementary way, low energy particle physics indirectly probes the existence of such particles and provides constraints for “new physics”, making use of precision and high intensities.

Besides the sensitivity to effects related with new physics (e.g. lepton flavor violation, symmetry violations, CPT tests, search for electric dipole moments, new low mass exchange bosons etc.), low energy physics provides the best test of QED (electron g-2), the best tests of bound-state QED (atomic physics and exotic atoms), precise determinations of fundamental constants, information about the CKM matrix, precise information on the weak and strong force even in the non-perturbative regime etc.

In this lecture, we will concentrate on selected experiments, using mainly neutrons and muons, which have significantly improved our understanding of particle physics today. Starting from a general introduction on high intensity/high precision particle physics and the main characteristics of muons and neutrons and their production, we will then focus on the discussion of fundamental problems and groundbreaking experiments:

- Production and characteristics of muon and neutron beams
- Ultracold neutron production
- Measurement of the neutron lifetime and electric dipole moment
- The neutron in the gravitational field and its electric charge
- Muon and neutron decay correlations
- Lepton flavour violations with muons to search for new physics
- What atomic physics can do for particle physics and vice versa
- Laser experiments at accelerators
- From myonic hydrogen to the proton structure and bound-state QED
- From pionic hydrogen to the strong interaction and effective field theories
- etc.
**Literature**

- Golub, Richardson & Lamoreaux: "Ultra-Cold Neutrons"
- Rauch & Werner: "Neutron Interferometry"
- Carlile & Willis: "Experimental Neutron Scattering"
- Byrne: "Neutrons, Nuclei and Matter"
- Klapdor-Kleingrothaus: "Non Accelerator Particle Physics"

**402-0767-00L** Neutrino Physics  
**W 6 credits 2V+1U  A. Rubbia**

**Abstract**

Theoretical basis and selected experiments to determine the properties of neutrinos and their interactions (mass, spin, helicity, chirality, oscillations, interactions with leptons and quarks).

**Objective**

Introduction to the physics of neutrinos with special consideration of phenomena connected with neutrino masses.

**Lecture notes**

Script

**Literature**


D.O. Caldwell, Current Aspects of Neutrino Physics, Springer.


**402-0777-00L** Particle Accelerator Physics and Modeling I  
**W 6 credits 2V+1U  A. Adelmann**

**Abstract**

This is the first of two courses, introducing particle accelerators from a theoretical point of view and covers state-of-the-art modeling techniques. It emphasizes the multidisciplinary aspect of the field, both in methodology (numerical and computational methods) and with regard to applications such as medical, industrial, material research and particle physics.

**Objective**

You understand the building blocks of particle accelerators. Modern analysis tools allows you to model state-of-the-art particle accelerators. In some of the exercises you will be confronted with next generation machines. We will develop a Python simulation tool (AcceLEGOrator) that reflects the theory from the lecture.

**Content**

- Particle Accelerators an Overview
- Relativity for Accelerator Physicists
- Building Blocks of Particle Accelerators
- Lie Algebraic Structure of Classical Mechanics and Applications to Particle Accelerators
- Symplectic Maps & Analysis of Maps
- Particle Tracking
- Linear & Circular Machines
- Cyclotrons
- Free Electron Lasers
- Collective effects in linear approximation
- Preview of Particle Accelerator Physics and Modeling II

**Literature**

Particle Accelerator Physics, H. Wiedemann, ISBN-13 978-3-540-49043-2, Springer


**Prerequisites / notice**

Physics, Computational Science (RW) at BSc. Level

This lecture is also suited for PhD. students

**402-0851-00L** QCD: Theory and Experiment  
**W 3 credits 3G  G. Dissertori, University lecturers**

**Abstract**

An introduction to the theoretical aspects and experimental tests of QCD, with emphasis on perturbative QCD and related experiments at colliders.

**Objective**

Knowledge acquired on basics of perturbative QCD, both of theoretical and experimental nature. Ability to perform simple calculations of perturbative QCD, as well as to understand modern publications on theoretical and experimental aspects of perturbative QCD.

**Content**

QCD Lagrangian and Feynman Rules
QCD running coupling
Parton model
Altarelli-Parisi equations
Basic processes
Experimental tests at lepton and hadron colliders
Measurements of the strong coupling constant

**Literature**

2) R. K. Ellis, W. J. Stirling, B. R. Webber : "QCD and Collider Physics" (Cambridge Monographs on Particle Physics, Nuclear Physics & Cosmology)

**Prerequisites / notice**

Will be given as block course, language: English.
For students of both ETH and University of Zurich.

**402-0737-00L** Energy and Environment in the 21st Century (Part I)  
**W 6 credits 2V+1U  M. Dittmar**

**Abstract**

The energy and related environmental problems, the physics principles of using energy and the various real and hypothetical options are discussed from a physicist point of view. The lecture is intended for students of all ages with an interest in a rational approach to the energy problem of the 21st century.

**Objective**

Scientists and espially physicists are often confronted with questions related to the problems of energy and the environment. The lecture tries to address the physical principles of todays and tomorrow energy use and the resulting global consequences for the world climate.

The lecture is for students which are interested participate in a rational and responsible debate about the energyproblem of the 21. century.
Content
Introduction: energy types, energy carriers, energy density and energy usage. How much energy does a human need/uses?

Energy conservation and the first and second law of thermodynamics

Fossil fuels (our stored energy resources) and their use.

Burning fossil fuels and the physics of the greenhouse effect.

Physics basics of nuclear fission and fusion energy

Controlled nuclear fission energy today, the different types of nuclear power plants, uranium requirements and resources, natural and artificial radioactivity and the related waste problems from the nuclear fuel cycle.

Nuclear reactor accidents and the consequences, a comparison with risks from other energy using methods.

The problems with nuclear fusion and the ITER project.

Nuclear fusion and fission: "exotic" ideas.

Hydrogen as an energy carrier: ideas and limits of a hydrogen economy.

New clean renewable energy sources and their physical limits (wind, solar, geothermal etc)

Energy perspectives for the next 100 years and some final remarks

Lecture notes
many more details (in English and German) here:

http://ihp-lx2.ethz.ch/energy21/

Literature

Environmental Physics: Boeker and Egbert New York Wiley 1999

Prerequisites / notice

Science promised us truth, or at least a knowledge of such relations as our intelligence can seize: it never promised us peace or happiness

Gustave Le Bon

Physicists learned to realize that whether they like a theory or they don't like a theory is not the essential question. Rather, it's whether or not the theory gives predictions that agree with experiment.

Richard Feynman, 1985

Selection: Theoretical Physics

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>402-0822-13L</td>
<td>Introduction to Integrability</td>
<td>W</td>
<td>6</td>
<td>2V+1U</td>
<td>N. Beisert</td>
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<tr>
<td>Abstract</td>
<td>This course gives an introduction to the theory of integrable systems, related symmetry algebras and efficient calculational methods.</td>
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<td>Objective</td>
<td>Integrable systems are a special class of physical models that can be solved exactly due to an exceptionally large number of symmetries. Examples of integrable models appear in many different areas of physics, including classical mechanics, condensed matter, 2d quantum field theories and lately in string- and gauge theories. They offer a unique opportunity to gain a deeper understanding of generic phenomena in a simplified, exactly solvable setting. In this course we introduce the various notions of integrability in classical mechanics, quantum mechanics and quantum field theory. We discuss efficient methods for solving such models as well as the underlying enhanced symmetries.</td>
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<tr>
<td>Content</td>
<td>- Classical Integrability</td>
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<td>* Integrable Field Theory</td>
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<td>* Integrable Spin Chains</td>
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<td>* Quantum Integrability</td>
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<td>* Integrable Statistical Mechanics</td>
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<td>* Quantum Algebra</td>
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<td>* Bethe Ansatz and Related Methods</td>
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<td>* AdS/CFT Integrability</td>
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<tr>
<th>Number</th>
<th>Symmetries in Physics</th>
<th>W</th>
<th>6</th>
<th>2V+1U</th>
<th>M. Gaberdiel</th>
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<tbody>
<tr>
<td>Abstract</td>
<td>The course gives an introduction to symmetry groups in physics. It explains the relevant mathematical background (finite groups, Lie groups and algebras as well as their representations), and illustrates their important role in modern physics.</td>
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<td>Objective</td>
<td>The aim of the course is to give a self-contained introduction into finite group theory as well as Lie theory from a physicists point of view. Abstract mathematical constructions will be illustrated with examples from physics.</td>
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<tr>
<th>Number</th>
<th>The Physics of Electroweak Symmetry Breaking</th>
<th>W</th>
<th>6</th>
<th>2V+1U</th>
<th>not available</th>
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<tbody>
<tr>
<td>Abstract</td>
<td>The aim is to understand the need of physics beyond the Standard Model, the basic techniques of model building in theories BSM and the elements of collider physics required to analyze their phenomenological implications. After an introduction to the SM and alternative theories of electroweak symmetry breaking, we will investigate these issues in the context of models with warped extra dimensions.</td>
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Does not take place this semester.
The course introduces the theory and phenomenology of the recently discovered Higgs boson. With this course the students will receive a detailed introduction to the physics of the Higgs boson in the Standard Model. They will acquire the necessary theoretical background to understand the main production and decay channels of the Higgs boson at high-energy colliders, and the corresponding experimental signatures.

**Experimental part:**
- Introductory material:
  - reminders of detectors/accelerators
  - reminders of statistics: likelihoods, hypothesis testing
  - reminders of multivariate techniques: Neural Networks, Decision Trees
- Main topics:
  - pre-history (pre-LEP)
    - LEP1: measurements at the Z-pole
    - LEP2: towards the limit mH<114 GeV
    - TeVatron searches
  - LHC:
    -- main channels overview
    -- dissect on analysis
    -- combine information from all channels
    -- differential measurements
    -- off-shell measurements
  - Future:
    -- pseudo-observables / EFT
    -- Beyond Standard Model

**Literature**
- Higgs Hunter's Guide
  (by S.Dawson, J. Gunion, H. Haber and G. Kane)
- P. De Forcrand, Quantum Field Theory I, Phenomenology of Particle Physics I

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**402-0845-60L**

**Quantum Field Theory III: EFT and SUSY**

**W** 6 credits 2V+1U G. Isidori

**Abstract**
This course provides a comprehensive introduction to two advanced topics in Quantum Field Theory: Effective Field Theories (EFTs) and Supersymmetry (SUSY).

**Content**
In the first part we will discuss the basic concepts of EFTs, with particular attention to the concepts of decoupling of heavy degrees of freedom, matching and renormalization, chiral Lagrangians. The Standard Model viewed as an EFT will also be discussed as a specific application. The second part of the course is devoted to Supersymmetry, starting from the discussion of the SUSY algebra and its representations, to arrive, after the presentation of the superfield formalism, to the construction of the supersymmetric version of gauge field theories. A phenomenological discussion of the mechanisms of SUSY breaking and the construction of viable supersymmetric extensions of the Standard Model will also be presented.

**Topics:**
- Introduction to Effective Field Theories
- The Appelquist-Carrara zone theorem
- The matching procedure
- Chiral Lagrangians
- The SM as an EFTs
- The SUSY algebra
- Superspace and superfields
- Supersymmetric field theories
- Supersymmetric gauge theories
- Supersymmetry breaking
- The Minimal supersymmetric Standard Model

**Literature**
- J. Wess and J. Bagger, "Supersymmetry and supergravity".
- Mueller-Kirsten & Wiedemann, "Introduction to supersymmetry".

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**402-0899-65L**

**Higgs Physics**

**W** 6 credits 2V+1U M. Grazzini

*Does not take place this semester.*

**Abstract**
The course introduces the theory and phenomenology of the recently discovered Higgs boson. With this course the students will receive a detailed introduction to the physics of the Higgs boson in the Standard Model. They will acquire the necessary theoretical background to understand the main production and decay channels of the Higgs boson at high-energy colliders, and the corresponding experimental signatures.

**Objective**
With this course the students will receive a detailed introduction to the physics of the Higgs boson in the Standard Model. They will acquire the necessary theoretical background to understand the main production and decay channels of the Higgs boson at high-energy colliders, and the corresponding experimental signatures.

**Content**
Theory part:
- the Standard Model and the mass problem: WW scattering and the no-lose theorem
- the Higgs mechanism and its implementation in the Standard Model
- radiative corrections and the screening theorem
- theoretical constraints on the Higgs mass; the hierarchy problem
- Higgs production in e+e- collisions
- Higgs production at hadron colliders
- Higgs decays to fermions and vector bosons
- Higgs differential distributions, rapidity distribution, pt spectrum and jet vetoes
- Higgs properties and beyond the Standard Model perspective
- Outlook: The Higgs sector in weakly coupled and strongly coupled new physics scenarios.

Experimental part:
- Introductory material:
  - reminders of detectors/accelerators
  - reminders of statistics: likelihoods, hypothesis testing
  - reminders of multivariate techniques: Neural Networks, Decision Trees
- Main topics:
  - pre-history (pre-LEP)
    - LEP1: measurements at the Z-pole
    - LEP2: towards the limit mH<114 GeV
    - TeVatron searches
  - LHC:
    -- main channels overview
    -- dissect on analysis
    -- combine information from all channels
    -- differential measurements
    -- off-shell measurements
  - Future:
    -- pseudo-observables / EFT
    -- Beyond Standard Model

**Literature**
- Higgs Hunter's Guide
  (by S.Dawson, J. Gunion, H. Haber and G. Kane)

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**402-0849-00L**

**Introduction to Lattice QCD**

**W** 6 credits 2V+1U P. De Forcrand

**Abstract**
This course offers an introduction to quantum field theories, in particular QCD, formulated on a space-time lattice. The lattice provides a non-perturbative, gauge-invariant regularization scheme for the Euclidean path integral. The course introduces both the theoretical background and the computational tools, like Monte Carlo simulations, used for the quantitative study of quarks and gluons.

**Objective**
To gain familiarity with the formalism of lattice field theories and their numerical simulation methods.
1.) Wave propagation in continuous systems
2.) Wave properties
3.) Discrete systems
4.) Local resonances
5.) Topology by example
6.) Topological classification
7.) Static systems
8.) Non-linear waves

Lecture notes
Hand-outs will be available in class.

402-0846-66L The BFKL Equation Reloaded and the Multi-Regge Kinematics in QCD and in N=4 SYM

| 402-0461-00L | Quantum Information Theory | W | 8 credits | 3V+1U | R. Renner |
| Abstract | The goal of this course is to introduce the foundations of quantum information theory. It starts with a brief introduction to the mathematical theory of information and then discusses the basic information-theoretic aspects of quantum mechanics. Further topics include applications such as quantum cryptography and quantum computing. |
| Objective | The course gives an insight into the notion of information and its relevance to physics and, in particular, quantum mechanics. It also serves as a preparation for further courses in the area of quantum information sciences. |

| 402-0611-00L | Programming Techniques for Scientific Simulations I | W | 5 credits | 4G | M. Troyer |
| Abstract | This lecture provides an overview of programming techniques for scientific simulations. The focus is on advances C++ programming techniques and scientific software libraries. Based on an overview over the hardware components of PCs and supercomputer, optimization methods for scientific simulation codes are explained. |

| 402-0809-00L | Introduction to Computational Physics | W | 8 credits | 2V+2U | H. J. Herrmann |
| Abstract | This course offers an introduction to computer simulation methods for physics problems and their implementation on PCs and super computers: classical equations of motion, partial differential equations (wave equation, diffusion equation, Maxwell’s equation), Monte Carlo simulations, percolation, phase transitions |
| Content | Einführung in die rechnergestützte Simulation physikalischer Probleme. Anhand einfacher Modelle aus der klassischen Mechanik, Elektrodynamik und statistischen Mechanik sowie interdisziplinären Anwendungen werden die wichtigsten objektorientierten Programmierrmethoden für numerische Simulationen (überwiegend in C++) erläutert. Daneben wird eine Einführung in die Programmierung von Vektorsupercomputern und parallelen Rechnern, sowie ein Überblick über vorhandene Softwarebibliotheken für numerische Simulationen geboten. |
| Prerequisites / notice | Lecture and exercise lessons in english, exams in German or in English |

| 402-0865-66L | Physics of Cold Atomic Gases | W | 6 credits | 2V+1U | W. Zwerger |

| 402-0580-00L | Superconductivity | W | 6 credits | 2V+1U | M. Sigrist |
| Abstract | Superconductivity; thermodynamics, London and Pippard theory; Ginzburg-Landau theory: spontaneous symmetry breaking, flux quantization, type I and II superconductors; microscopic BCS theory: electron-phonon mechanism, Cooper pairing, quasiparticle spectrum and tunneling, Josephson effect, superconducting quantum interference devices (SQUID), brief introduction to unconventional superconductivity. |
| Objective | Introduction to the most important concepts of superconductivity both on phenomenological and microscopic level, including experimental and theoretical aspects. |
| Content | This lecture course provides an introduction to superconductivity, covering both experimental as well as theoretical aspects. The following topics are covered: Basic phenomena of superconductivity: thermodynamics, electrodynamics, London and Pippard theory; Ginzburg-Landau theory: spontaneous symmetry breaking, flux quantization, properties of type I and II superconductors; microscopic BCS theory: electron-phonon mechanism, Cooper pairing, coherent state, quasiparticle spectrum, quasiparticle tunnel, Josephson effects, superconducting quantum interference devices (SQUID), brief extension to unconventional superconductivity. |

| 402-0863-66L | Dissipation in Quantum Systems | W | 6 credits | 2V+1U | R. Chitra |
| Abstract | The past decade has seen enormous development in nanophysics and qubit technologies for quantum computing. However, the utility of these systems is strongly limited by their coupling to the omnipresent dissipative bath. The fact that the bath typically destroys the coherence of the small open quantum system highlights the importance of understanding the effects of dissipative baths. |
| Objective | The principal aim of the course is to give the student an introduction to the field and a better appreciation of the impact of noise and dissipation on small quantum systems. |
| Content | The course will basically explore the question, “What are the effects of an external environment on the dynamics of a small system?” We will start with the simplest cases of classical brownian motion and a classical harmonic oscillator connected to a dissipative bath. We will discuss the importance of fluctuation-dissipation theorems and discuss various physical examples. We will then discuss the quantum analogs of these systems. In particular, there will be a special focus on small open quantum systems, essentially qubits, where we will study the notions of decoherence and relaxation. We will introduce the concept of density matrices and associated methods like quantum master equations. These are particularly useful for studying the dynamics of qubits which are weakly coupled to a dissipative bath. We will also briefly explore the notions of entanglement entropy and concurrence in such systems. Some of these questions are linked to more general questions of thermalisation and relaxation of open quantum systems. |
| Prerequisites / notice | The students are expected to have a working knowledge of advanced quantum mechanics. A knowledge of very basic notions of many body theory will also be useful. |

| 402-0801-66L | Mechanical Metamaterials | W | 4 credits | 2V+1U | S. Huber |
| Abstract | A mechanical metamaterial derives its static or dynamic properties not from its microscopic composition but rather through its clever engineering at larger scales. In this course we introduce the basic principles behind the design of modern mechanical metamaterials such as the use of Bragg scattering, local resonances, topological band-structures, and non-linear effects. |
| Objective | The students should get acquainted with a modern toolbox in the design of mechanical metamaterials. Equipped with the knowledge of the key design principles, the students will be able to choose the appropriate approach to create a metamaterial with a pre-defined functionality either for dynamic applications such as vibration isolation, wave-guiding, or the design of a heat-diode, or static properties such as stress absorption or the design of mechanisms used in robotics. |
| Content | 1.) Wave propagation in continuous systems
2.) Wave properties
3.) Discrete systems
4.) Local resonances
5.) Topology by example
6.) Topological classification
7.) Static systems
8.) Non-linear waves |
| Lecture notes | Hand-outs will be available in class. |

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Autumn Semester 2016
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The goal of the course is to help the audience to keep abreast of the strong advances there have been in the study of the high energy limit of scattering amplitudes in the last decade.

The goal of the course is to help the audience to keep abreast of the strong advances there have been in the study of the high energy limit of scattering amplitudes in the last decade.

- the BFKL Hamiltonian as an integrable model

- the analytic structure of the Mueller-Navelet jet cross sections in QCD

- the analytic properties of N=4 SYM amplitudes in multi-Regge kinematics

The course covers analog circuits with emphasis on neuromorphic engineering: MOS transistors in CMOS technology, static circuits.

Major topics include:

- Scientific programming and analysis tools
- How to set up your computing environment, data management, catalog generation and the Virtual Observatory, collaborative tools
- Optical imaging and spectroscopy:
  - Basics of observatories (ground vs space), multi-wavelength data, detector types, reduction and analysis strategies for imaging and spectroscopic data, types of spectrographs, interpreting spectra including stellar and galaxy evolution models
  - X-ray, IR and radio astronomy
  - Basics of X-ray and high energy detectors and telescopes, spectral fitting, basics of radio astronomy, interferometric observations, aperture synthesis, source confusion and decomposition
- Planning of observations and proposal writing.

Astrophysics I is required and Astrophysics II is recommended. Some programming skills in Python or similar languages are necessary.

The themes we will discuss this year are:

1. How do baryons and dark matter interact?
2. Where, and in what state, do baryons reside within dark matter halos?

The goal of this course is to understand some of the phenomena that stand in the forefront of current research in astrophysics, the physical processes behind them, and how these phenomena are observed by state-of-the-art astronomical facilities. These goals will be achieved by communal discussions, led by the students and chaired by the teachers.

The course teaches the conception, simulation, and physical layout of such circuits with chip design tools.

Neuromorphic circuits include silicon retinas and cochleas for machine vision and audition, real-time emulations of networks of biological neurons, and the development of autonomous robotic systems. This course covers devices in CMOS technology (MOS transistor below and above threshold, floating-gate MOS transistor, phototransducers), static circuits (differential pair, current mirror, transconductance amplifiers, etc.), dynamic circuits (linear and nonlinear filters, adaptive circuits), systems (silicon neuron, silicon retina and cochlea) and an introduction to multi-chip systems that communicate events analogous to spikes. The lectures are accompanied by weekly laboratory sessions on the characterization of neuromorphic circuits, from elementary devices to systems.

Particular: The course is highly recommended for those who intend to take the spring semester course ‘Neuromorphic Engineering II’, that teaches the conception, simulation, and physical layout of such circuits with chip design tools.

Particular: The course is highly recommended for those who intend to take the spring semester course ‘Neuromorphic Engineering II’, that teaches the conception, simulation, and physical layout of such circuits with chip design tools.

Prerequisites: Background in basics of semiconductor physics helpful, but not required.

The course provides an introduction to the functional properties of neurons. Particularly the description of membrane electrical properties (action potentials, channels), neuronal anatomy, synaptic structures, and neuronal networks. Simple models of computation, learning, and behavior will be explained. Some artificial systems (robot, chip) are presented.

Selection: Neuroinformatics

<table>
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<tr>
<th>Number</th>
<th>Title</th>
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<tbody>
<tr>
<td>227-1037-00L</td>
<td>Introduction to Neuroinformatics</td>
<td>W</td>
<td>6 credits</td>
<td>2V+1U</td>
<td>K. A. Martin, M. Cook, V. Mante, M. Pfeiffer</td>
</tr>
</tbody>
</table>

Selection: Astronomy

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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</thead>
<tbody>
<tr>
<td>402-0353-00L</td>
<td>Observational Techniques in Astrophysics</td>
<td>W</td>
<td>6 credits</td>
<td>2V+1U</td>
<td>K. Schawinski</td>
</tr>
</tbody>
</table>

Credits or current enrollment in Astrophysics I is recommended but not required
This lecture course targets physics students and students of interdisciplinary sciences (major physics) for their education in biophysics. In this course the basics of molecular biology are presented bearing in mind the special interests of the physics students.

### Content

The course considers the structure and function of biological neural networks at different levels. The function of neural networks lies fundamentally in their wiring and in the electro-chemical properties of nerve cell membranes. Thus, the biological structure of the nerve cell needs to be understood if biologically-realistic models are to be constructed. These simpler models are used to estimate the electrical current flow through dendritic cables and explore how a more complex geometry of neurons influences this current flow. The active properties of nerves are studied to understand both sensory transduction and the generation and transmission of nerve impulses along axons. The concept of local neuronal circuits arises in the context of the rules governing the formation of nerve connections and topographic projections within the nervous system. Communication between neurons in the network can be thought of as information flow across synapses, which can be modified by experience. We need an understanding of the action of inhibitory and excitatory neurotransmitters and neuromodulators, so that the dynamics and logic of synapses can be interpreted. Finally, the neural architectures of feedforward and recurrent networks will be discussed in the context of co-ordination, control, and integration of sensory and motor information in neural networks.

#### Selection: Biophysics, Physical Chemistry

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<tr>
<th>Number</th>
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<tbody>
<tr>
<td>551-1601-00L</td>
<td>Biophysics of Biological Macromolecules</td>
<td>W</td>
<td>6 credits</td>
<td>2V+1U</td>
<td>G. Wider, F. Allain</td>
</tr>
</tbody>
</table>

### Objective

Understanding computation by neurons and neuronal circuits is one of the great challenges of science. Many different disciplines can contribute their tools and concepts to solving mysteries of neural computation. The goal of this introductory course is to introduce the monocultures of physics, maths, computer science, engineering, biology, psychology, and even philosophy and history, to discover the enchantments and challenges that we all face in taking on this major 21st century problem and how each discipline can contribute to discovering solutions.

### Content

This course considers the structure and function of biological neural networks at different levels. The function of neural networks lies fundamentally in their wiring and in the electro-chemical properties of nerve cell membranes. Thus, the biological structure of the nerve cell needs to be understood if biologically-realistic models are to be constructed. These simpler models are used to estimate the electrical current flow through dendritic cables and explore how a more complex geometry of neurons influences this current flow. The active properties of nerves are studied to understand both sensory transduction and the generation and transmission of nerve impulses along axons. The concept of local neuronal circuits arises in the context of the rules governing the formation of nerve connections and topographic projections within the nervous system. Communication between neurons in the network can be thought of as information flow across synapses, which can be modified by experience. We need an understanding of the action of inhibitory and excitatory neurotransmitters and neuromodulators, so that the dynamics and logic of synapses can be interpreted. Finally, the neural architectures of feedforward and recurrent networks will be discussed in the context of co-ordination, control, and integration of sensory and motor information in neural networks.

#### Selection: Medical Physics

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<tr>
<th>Number</th>
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<th>ECTS</th>
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<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>402-0341-00L</td>
<td>Medical Physics I</td>
<td>W</td>
<td>6 credits</td>
<td>2V+1U</td>
<td>P. Manser</td>
</tr>
<tr>
<td>402-0674-00L</td>
<td>Physics in Medical Research: From Atoms to Cells</td>
<td>W</td>
<td>6 credits</td>
<td>2V+1U</td>
<td>B. K. R. Müller</td>
</tr>
</tbody>
</table>
Objective

The lecture series is motivated by an overview covering the skin of the crystals, roughness analysis, contact angle measurements, protein absorption/activity and monocye behaviour.

As the first step, real structures on clean surfaces including surface reconstructions and surface relaxations, defects in crystals are presented, before the preparation of clean metallic, semiconducting, oxiderd and organic surfaces are introduced.

The atomic processes on surfaces are activated by an increase of the substrate temperature. They can be studied using scanning tunneling microscopy (STM) and atomic force microscopy (AFM). The combination with molecular beam epitaxy (MBE) allows determining the sizes of the critical nuclei and the other activated processes in a hierarchical fashion. The evolution of the surface morphology is characterized by the density and size distribution of the nanostructures that could be quantified by means of the rate equation analysis, the mean-field nucleation theory, as well as the scaling theory. The surface morphology is further characterized by defects and nanostructure’s shapes, which are based on the strain relieving mechanisms and kinetic growth processes.

High-resolution electron diffraction is complementary to scanning probe techniques and provides exact mean values. Some phenomena are quantitatively described by the kinematic theory and perfectly understood by means of the Ewald construction. Other phenomena need to be described by the more complex dynamical theory. Electron diffraction is not only associated with elastic scattering but also inelastic excitation mechanisms that reflect the electronic structure of the surfaces studied. Low-energy electrons lead to phonon and high-energy electrons to plasmon excitations. Both effects are perfectly described by dipole and impact scattering.

Thin-films of rather complex organic materials are often quantitatively characterized by photons with a broad range of wavelengths from ultra-violet to infra-red light. Asymmetries and preferential orientations of the (anisotropic) molecules are verified using the optical dichrom and second harmonic generation measurements. These characterization techniques are vital for optimizing the preparation of medical implants and the determination of tissue’s anisotropies within the human body.

Cell-surface interactions are related to the cell adhesion and the contractile cellular forces. Physical means have been developed to quantify these interactions. Other physical techniques are introduced in cell biology, namely to count and sort cells, to study cell proliferation and metabolism and to determine the relation between cell morphology and function.

3D scaffolds are important for tissue augmentation and engineering. Design, preparation methods, and characterization of these highly porous 3D microstructures are also presented.

Visiting clinical research in a leading university hospital will show the usefulness of the lecture series.

Selection: Environmental Physics

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<tr>
<th>Number</th>
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<th>Hours</th>
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</thead>
<tbody>
<tr>
<td>402-0572-00L</td>
<td>Aerosols I: Physical and Chemical Principles</td>
<td>W</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>M. Gysel, U. Baltensperger, H. Burtscher</td>
</tr>
</tbody>
</table>

Selection: Mathematics

<table>
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<tr>
<th>Number</th>
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</thead>
<tbody>
<tr>
<td>401-3531-00L</td>
<td>Differential Geometry I</td>
<td>W</td>
<td>10 credits</td>
<td>4V+1U</td>
<td>U. Lang</td>
</tr>
</tbody>
</table>
The course begins with characteristics, the definition of hyperbolicity, Baire category; Banach and Hilbert spaces, bounded linear operators; three fundamental principles: Uniform boundedness, open mapping/closed graph theorem, Hahn-Banach; convexity; dual spaces; weak and weak* topologies; Banach-Alaoglu; reflexive spaces; compact operators and Fredholm theory; closed range theorem; spectral theory of self-adjoint operators in Hilbert spaces.

Abstract
Baire category; Banach and Hilbert spaces, bounded linear operators; three fundamental principles: Uniform boundedness, open mapping/closed graph theorem, Hahn-Banach; convexity; dual spaces; weak and weak* topologies; Banach-Alaoglu; reflexive spaces; compact operators and Fredholm theory; closed range theorem; spectral theory of self-adjoint operators in Hilbert spaces.

Lecture notes
Lecture Notes on "Funktionalanalysis I" by Michael Struwe

### Functional Analysis I

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<tr>
<th>Course Code</th>
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<tbody>
<tr>
<td>401-3461-00L</td>
<td>Functional Analysis I</td>
<td>W</td>
<td>10 credits</td>
<td>4V+1U</td>
<td>M. Struve</td>
</tr>
</tbody>
</table>

This course counts as a core course in the Bachelor's degree programme in Mathematics. Holders of an ETH Zurich Bachelor's degree in Mathematics who didn't use credits from either 401-3461-00L Functional Analysis I nor 401-3462-00L Functional Analysis II for their Bachelor's degree still can have recognised this course for the Master's degree.

Furthermore, at most one of the three course units 401-3461-00L Functional Analysis I 401-3531-00L Differential Geometry I 401-3601-00L Probability Theory can be recognised for the Master's degree in Mathematics or Applied Mathematics.

### Probability Theory

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<tr>
<th>Course Code</th>
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<tbody>
<tr>
<td>401-3601-00L</td>
<td>Probability Theory</td>
<td>W</td>
<td>10 credits</td>
<td>4V+1U</td>
<td>A.S. Sznitman</td>
</tr>
</tbody>
</table>

This course counts as a core course in the Bachelor's degree programme in Mathematics. Holders of an ETH Zurich Bachelor's degree in Mathematics who didn't use credits from none of the three course units 401-3601-00L Probability Theory, 401-3642-00L Brownian Motion and Stochastic Calculus resp. 401-3602-00L Applied Stochastic Processes for their Bachelor's degree still can have recognised this course for the Master's degree.

Furthermore, at most one of the three course units 401-3461-00L Functional Analysis I 401-3531-00L Differential Geometry I 401-3601-00L Probability Theory can be recognised for the Master's degree in Mathematics or Applied Mathematics.

### Fundamentals of Mathematical Statistics

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<th>Course Code</th>
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<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>401-3621-00L</td>
<td>Fundamentals of Mathematical Statistics</td>
<td>W</td>
<td>10 credits</td>
<td>4V+1U</td>
<td>F. Balabaoui</td>
</tr>
</tbody>
</table>

The course covers the basics of inferential statistics.

### Partial Differential Equations (Hyperbolic PDEs)

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<tr>
<th>Course Code</th>
<th>Title</th>
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<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>401-4767-66L</td>
<td>Partial Differential Equations (Hyperbolic PDEs)</td>
<td>W</td>
<td>7 credits</td>
<td>4V</td>
<td>D. Christodoulou</td>
</tr>
</tbody>
</table>

The course begins with characteristics, the definition of hyperbolicity, causal structure and the domain of dependence theorem. The course then focuses on nonlinear systems of equations in two independent variables, in particular Euler equations of compressible fluids with plane symmetry and the Einstein equations of general relativity with spherical symmetry.

The objective is to introduce students in mathematics and physics to an area of mathematical analysis involving differential geometry which is of fundamental importance for the development of classical macroscopic continuum physics.

The course shall begin with the basic structure associated to hyperbolic partial differential equations, characteristic hypersurfaces and bicharacteristics, causal structure, and the domain of dependence theorem. The course shall then focus on nonlinear systems of equations in two independent variables. The first topic shall be the Euler equations of compressible fluids under plane symmetry where we shall study the formation of shocks, and second topic shall be the Einstein equations of general relativity under spherical symmetry where we shall study the formation of black holes and spacetime singularities.

### Selection: Electives at the University of Zurich

University of Zurich lecturers explicitly recommended the following courses also to physics students at ETH Zurich. Recognition of the corresponding ECTS credits has to be granted by the Director of Studies. Submit your request to the Study Administration (www.phys.ethz.ch/studies/study-administration.html).

#### Theoretical Astrophysics (University of Zurich)

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<th>Course Code</th>
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<th>Hours</th>
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</tr>
</thead>
<tbody>
<tr>
<td>401-7851-00L</td>
<td>Theoretical Astrophysics (University of Zurich)</td>
<td>W</td>
<td>10 credits</td>
<td>4V+2U</td>
<td>R. Teyssier</td>
</tr>
</tbody>
</table>

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: AST512

Mind the enrolment deadlines at UZH:
Radiative processes in the interstellar medium; stellar structure and evolution; supernovae; white dwarfs; neutron stars; black holes; planet formation.

(1) "Formation of stars" (S. Stahler and F. Palla - Wiley editions, this is the book on which about half of the classes will be based and photocopies will be organized during first lecture).
(2) "Radiative processes in astrophysics" (R. Ribycki and A. Lightman)
(3) "The Physics of Stars" (A.C. Phillips)
(4) "Black Holes, White Dwarfs and Neutron Stars: The physics of compact objects" (S. Shapiro and S.A. Teukolski).

Additionally PowerPoint slides will be prepared by the lecturer on these and extra topics (e.g. planet formation).

Prerequisites: Elementary atomic physics, thermodynamics, mechanics, fluid dynamics.

Introduction to astrophysics (preferred but not obligatory).

Computational Astrophysics (University of Zurich)

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.

UZH Module Code: AST245

Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

Abstract

Acquire knowledge of main methodologies for computer-based models of astrophysical systems, the physical equations behind them, and train such knowledge with simple examples of computer programmes.

Objective

Acquire knowledge of main methodologies for computer-based models of astrophysical systems, the physical equations behind them, and train such knowledge with simple examples of computer programmes.

Content

1. Integration of ODE, Hamiltonians and Symplectic integration techniques, time adaptivity, time reversibility
2. Large-N gravity calculation, collisionless N-body systems and their simulation
3. Fast Fourier Transform and spectral methods in general
4. Eulerian Hydrodynamics: Upwinding, Riemann solvers, Limiters
5. Lagrangian Hydrodynamics: The SPH method
6. Resolution and instabilities in Hydrodynamics
7. Initial Conditions: Cosmological Simulations and Astrophysical Disks
8. Physical Approximations and Methods for Radiative Transfer in Astrophysics

Literature

Galactic Dynamics (Binney & Tremaine, Princeton University Press),
Computer Simulation using Particles (Hockney & Eastwood CRC press),
Targeted journal reviews on computational methods for astrophysical fluids (SPH, AMR, moving mesh)

Prerequisites / notice

Some knowledge of UNIX, scripting languages (see www.physik.uzh.ch/lectures/informatik/python/ as an example), some prior experience programming, knowledge of C, C++ beneficial.

Understanding Topological Phases of Matter from Toy Models (University of Zurich)

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.

UZH Module Code: PHY576

Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

Abstract

In this course, we will study classic models such as the Su-Schrieffer-Heeger model, Kitaev’s Majorana chain, and the toric code. We will use them to understand topological band insulators and the basic concepts of topological order in systems with anyon excitations. The presentation will be as self-contained as possible with an emphasis on explicit derivations of all the relevant properties.

Content

The exploration of topological phases of matter is to a large extend guided by a range of exactly soluble toy models that illustrate the physics at play. In this course, we will study classic models such as the Su-Schrieffer-Heeger model, Kitaev’s Majorana chain, and the toric code. We will use them to understand topological band insulators and the basic concepts of topological order in systems with anyon excitations. The presentation will be as self-contained as possible with an emphasis on explicit derivations of all the relevant properties.

General Electives

Students may choose General Electives from the entire course programme of ETH Zurich - with the following restrictions: courses that belong to the first or second year of a Bachelor curriculum at ETH Zurich as well as courses from GESS "Science in Perspective" are not eligible here.
The following courses are explicitly recommended to physics students by their lecturers. (Courses in this list may be assigned to the category "General Electives" directly in myStudies. For the category assignment of other eligible courses keep the choice "no category" and take contact with the Study Administration (www.phys.ethz.ch/studies/study-administration.html) after having received the credits.)

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<tr>
<th>Number</th>
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<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>529-0433-00L</td>
<td>Advanced Physical Chemistry: Statistical Thermodynamics</td>
<td>W</td>
<td>7</td>
<td>3G</td>
<td>G. Jeschke</td>
</tr>
<tr>
<td>151-0163-00L</td>
<td>Nuclear Energy Conversion</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>H.M. Prasser</td>
</tr>
</tbody>
</table>

Abstract

Introduction to statistical mechanics and thermodynamics. Prediction of thermodynamic and kinetic properties from molecular data.

Introduction to statistical mechanics and thermodynamics. Prediction of thermodynamic and kinetic properties from molecular data.


See homepage of the lecture.

See homepage of the lecture.

Chemical Thermodynamics, Reaction Kinetics, Molecular Quantum Mechanics and Spectroscopy; Mathematical Foundations (Analysis, Combinatorial Relations, Integral and Differential Calculus)

Physical fundamentals of the fission reaction and the sustainable chain reaction, thermal design, construction, function and operation of nuclear reactors and power plants, light water reactors and other reactor types, conversion and breeding
Objective
Students get an overview on energy conversion in nuclear power plants, on construction and function of the most important types of nuclear reactors with special emphasis to light water reactors. They obtain the mathematical/physical basis for quantitative assessments concerning most relevant aspects of design, dynamic behaviour as well as material and energy flows.

Content
Nuclear physics of fission and chain reaction. Thermodynamics of nuclear reactors. Design of the reactor core. Introduction into the dynamic behaviour of nuclear reactors. Overview on types of nuclear reactors, difference between thermal reactors and fast breeders. Construction and operation of nuclear power plants with pressurized and boiling water reactors, role and function of the most important safety systems, special features of the energy conversion. Development tendencies of reactor technology.

Lecture notes
Hand-outs will be distributed. Additional literature and information on the website of the lab: https://www.ethz.ch/content/specialinterest/mav/energy-technology/lab-of-nuclear-energy-systems/en/studium/teaching-materials/151-0163-00-nuclear-energy-conversion.html

Literature
R. L. Murray: Nuclear Energy (Sixth Edition), An Introduction to the Concepts, Systems, and Applications of Nuclear Processes, Elsevier

151-0103-00L
Fluid Dynamics II
W 3 credits 2V+1U P. Jenny

Abstract
Two-dimensional irrotational (potential) flows: stream function and potential, singularity method, unsteady flow, aerodynamic concepts. Vorticity dynamics; vorticity and circulation, vorticity equation, vortex theorems of Helmholtz and Kelvin. Compressible flows: isentropic flow along stream tube, normal and oblique shocks, Laval nozzle, Prandtl-Meyer expansion, viscous effects.

Objective
Expand basic knowledge of fluid dynamics. Concepts, phenomena and quantitative description of irrotational (potential), rotational, and one-dimensional compressible flows.

Content

Lecture notes
Lecture notes are available (in German).
(See also info on literature below.)

Literature
Relevant chapters (corresponding to lecture notes) from the textbook

Prerequisites / notice
Analysis I/II, Knowledge of Fluid Dynamics I, thermodynamics of ideal gas

151-0532-00L
Nonlinear Dynamics and Chaos I
W 4 credits 2V+2U G. Haller, F. Kogelbauer

Abstract
Basic facts about nonlinear systems; stability and near-equilibrium dynamics; bifurcations; dynamical systems on the plane; non-autonomous dynamical systems; chaotic dynamics.

Objective
This course is intended for Masters and Ph.D. students in engineering sciences, physics and applied mathematics who are interested in the behavior of nonlinear dynamical systems. It offers an introduction to the qualitative study of nonlinear physical phenomena modeled by differential equations or discrete maps. We discuss applications in classical mechanics, electrical engineering, fluid mechanics, and biology. A more advanced Part II of this class is offered every other year.

Content
(1) Basic facts about nonlinear systems: Existence, uniqueness, and dependence on initial data.

(2) Near equilibrium dynamics: Linear and Lyapunov stability

(3) Bifurcations of equilibria: Center manifolds, normal forms, and elementary bifurcations

(4) Nonlinear dynamical systems on the plane: Phase plane techniques, limit sets, and limit cycles.

(5) Time-dependent dynamical systems: Floquet theory, Poincare maps, averaging methods, resonance

Lecture notes
The class lecture notes will be posted electronically after each lecture. Students should not rely on these but prepare their own notes during the lecture.
- Prerequisites: Analysis, linear algebra and a basic course in differential equations.
- Exam: two-hour written exam in English.
- Homework: A homework assignment will be due roughly every other week. Hints to solutions will be posted after the homework due dates.

151-0213-00L
Fluid Dynamics with the Lattice Boltzmann Method
W 4 credits 3G I. Karlin

Abstract
The course provides an introduction to theoretical foundations and practical usage of the Lattice Boltzmann Method for fluid dynamics simulations.

Objective
Methods like molecular dynamics, DSMC, lattice Boltzmann etc are being increasingly used by engineers all over and these methods require knowledge of kinetic theory and statistical mechanics which are traditionally not taught at engineering departments. The goal of this course is to give an introduction to ideas of kinetic theory and non-equilibrium thermodynamics with a focus on developing simulation algorithms and their realizations.

During the course, students will be able to develop a lattice Boltzmann code on their own. Practical issues about implementation and performance on parallel machines will be demonstrated hands on.

Central element of the course is the completion of a lattice Boltzmann code (using the framework specifically designed for this course).

The course will also include a review of topics of current interest in various fields of fluid dynamics, such as multiphase flows, reactive flows, microlow flows among others.

Optionally, we offer an opportunity to complete a project of student's choice as an alternative to the oral exam. Samples of projects completed by previous students will be made available.
The course builds upon three parts:
I Elementary kinetic theory and lattice Boltzmann simulations introduced on simple examples.
II Theoretical basis of statistical mechanics and kinetic equations.
III Lattice Boltzmann method for real-world applications.

The content of the course includes:

1. Background: Elements of statistical mechanics and kinetic theory:
   Particle's distribution function, Liouville equation, entropy, ensembles; Kinetic theory: Boltzmann equation for rarefied gas, H-theorem, hydrodynamic limit and derivation of Navier-Stokes equations, Chapman-Enskog method, Grad method, boundary conditions; mean-field interactions, Vasov equation;
   Kinetic models: BGK model, generalized BGK model for mixtures, chemical reactions and other fluids.

2. Basics of the Lattice Boltzmann Method and Simulations:
   Minimal kinetic models: lattice Boltzmann method for single-component fluid, discretization of velocity space, time-space discretization, boundary conditions, forcing, thermal models, mixtures.

3. Hands on:
   Development of the basic lattice Boltzmann code and its validation on standard benchmarks (Taylor-Green vortex, lid-driven cavity flow etc).

4. Practical issues of LBM for fluid dynamics simulations:
   Lattice Boltzmann simulations of turbulent flows;
   numerical stability and accuracy.

5. Microflow:
   Rarefaction effects in moderately dilute gases; Boundary conditions, exact solutions to Couette and Poiseuille flows; micro-channel simulations.

6. Advanced lattice Boltzmann methods:
   Entropic lattice Boltzmann scheme, subgrid simulations at high Reynolds numbers; Boundary conditions for complex geometries.

7. Introduction to LB models beyond hydrodynamics:
   Relativistic fluid dynamics; flows with phase transitions.

Lecture notes
Lecture notes on the theoretical parts of the course will be made available.
Selected original and review papers are provided for some of the lectures on advanced topics.
Handouts and basic code framework for implementation of the lattice Boltzmann models will be provided.

Prerequisites / notice
The course addresses mainly graduate students (MSc/Ph D) but BSc students can also attend.

**151-0105-00L**
Quantitative Flow Visualization

<table>
<thead>
<tr>
<th>Content</th>
<th>Objective</th>
<th>Lecture notes</th>
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<tbody>
<tr>
<td>The course provides an introduction to digital image analysis in modern flow diagnostics. Different techniques which are discussed include image velocimetry, laser induced fluorescence, liquid crystal thermography and interferometry. The physical foundations and measurement configurations are explained. Image analysis algorithms are presented in detail and programmed during the exercises.</td>
<td>Introduction to modern imaging techniques and post processing algorithms with special emphasis on flow analysis and visualization. Development of basic programming skills for (generic) imaging applications.</td>
<td>available</td>
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**151-0911-00L**
Introduction to Plasmonics

<table>
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<tr>
<th>Content</th>
<th>Literature</th>
<th>Prerequisites / notice</th>
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<tr>
<td>This course provides fundamental knowledge of surface plasmon polaritons and discusses their applications in plasmonics. Electromagnetic oscillations known as surface plasmon polaritons have many unique properties that are useful across a broad set of applications in biology, chemistry, physics, and optics. The field of plasmonics has arisen to understand the behavior of surface plasmon polaritons and to develop applications in areas such as catalysis, imaging, photovoltaics, and sensing. In particular, metallic nanoparticles and patterned metallic interfaces have been developed to utilize plasmonic resonances. The aim of this course is to provide the basic knowledge to understand and apply the principles of plasmonics. The course will strive to be approachable to students from a diverse set of science and engineering backgrounds.</td>
<td>S. A. Maier, Plasmonics: Fundamentals and Applications, 2007, Springer Physics I, Physics II</td>
<td>Prerequisites: Fluidodynamics I, Numerical Mathematics, programming skills. Language: German on request.</td>
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**151-0107-00L**
High Performance Computing for Science and Engineering (HPCSE) I

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<th>Content</th>
<th>License notes</th>
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<tbody>
<tr>
<td>Development of the basic lattice Boltzmann code and its validation on standard benchmarks (Taylor-Green vortex, lid-driven cavity flow etc).</td>
<td>Class notes and handouts</td>
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</table>

Handouts and basic code framework for implementation of the lattice Boltzmann models will be provided.

Selected original and review papers are provided for some of the lectures on advanced topics.

Language: German on request.
We display articles pertaining to the issues we cover in the class on the course's webpage. 
http://www.cse-lab.ethz.ch/index.php/teaching/42-teaching/classes/615-hpcse1

C. Hierold
Introduction and analysis of medical imaging technology including X-ray procedures, computed tomography, nuclear imaging techniques

A. Gamma
3G
Handouts (available online)
- X-ray imaging

Biomedical Engineering
S. M. Sze: Semiconductor Devices, Physics and Technology

This course gives an introduction into algorithms and numerical methods for parallel computing for multi and many-core architectures and applications from problems in science and engineering.

Objective
Fundamental of:
1. Parallel Computing Architectures
2. MultiCores
3. ManyCores

Content
Programming models and languages:
1. C++ threading (2 weeks)
2. OpenMP (4 weeks)
3. MPI (5 weeks)

Computers and methods:
1. Hardware and architectures
2. Libraries
3. Particles: N-body solvers
4. Fields: PDEs
5. Stochastics: Monte Carlo

Lecture notes
http://www.cse-lab.ethz.ch/index.php/teaching/42-teaching/classes/615-hpcse1

Class notes, handouts

227-1047-00L
Consciousness: From Philosophy to Neuroscience (University of Zurich)

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.

UZH Module Code: IN4140

Mind the enrolment deadlines at UZH:
http://www.uZH.ch/studies/application/mobilitaet_en.html

Abstract
This seminar reviews the philosophical and phenomenological as well as the neurobiological aspects of consciousness. The subjective features of consciousness are explored, and modern research into its neural substrate, particularly in the visual domain, is explained. Emphasis is placed on students developing their own thinking through a discussion-centered course structure.

Objective
The course's goal is to give an overview of the contemporary state of consciousness research, with emphasis on the contributions brought by modern cognitive neuroscience. We aim to clarify concepts, explain their philosophical and scientific backgrounds, and to present experimental protocols that shed light on a variety of consciousness related issues.

Content
The course includes discussions of scientific as well as philosophical articles. We review current schools of thought, models of consciousness, and proposals for the neural correlate of consciousness (NCC).

Lecture notes
None

Literature
We display articles pertaining to the issues we cover in the class on the course's webpage.

Prerequisites / notice
Since we are all experts on consciousness, we expect active participation and discussions!

151-0621-00L
Microsystems Technology

Abstract
Students are introduced to the basics of micromachining and silicon process technology and will learn about the fabrication of microsystems and -devices by a sequence of defined processing steps ( = process flow).

Objective
Students are introduced to the basics of micromachining and silicon process technology and will understand the fabrication of microsystem devices by the combination of unit process steps ( = process flow).

Content
- Introduction to microsystems technology (MST) and micro electro mechanical systems (MEMS)
- Basic silicon technologies: Thermal oxidation, photolithography and etching, diffusion and ion implantation, thin film deposition.
- Specific microsystems technologies: Bulk and surface micromachining, dry and wet etching, isotropic and anisotropic etching, beam and membrane formation, wafer bonding, thin film mechanical and thermal properties, piezoelectric and piezoresitive materials.
- Selected microsystems: Mechanical sensors and actuators, microresonators, thermal sensors and actuators, system integration and encapsulation.

Lecture notes
Handouts (available online)

Literature
- S.M. Sze: Semiconductor Devices, Physics and Technology
- W. Menz, J. Mohr, O.Paul: Microsystem Technology
- G. Kovacs: Micromachined Transducer Sourcebook

Prerequisites / notice
Prerequisites: Physics I and II

227-0385-10L
Biomedical Imaging

Abstract
Introduction and analysis of medical imaging technology including X-ray procedures, computed tomography, nuclear imaging techniques using single photon and positron emission tomography, magnetic resonance imaging and ultrasound imaging techniques.

Objective
To understand the physical and technical principles underlying X-ray imaging, computed tomography, single photon and positron emission tomography, magnetic resonance imaging, ultrasound and Doppler imaging techniques. The mathematical framework is developed to describe image encoding/decoding, point-spread function/modular transfer function, signal-to-noise ratio, contrast behavior for each of the methods. Matlab exercises are used to implement and study basic concepts.

Content
- X-ray imaging
- Computed tomography
- Single photon emission tomography
- Positron emission tomography
- Magnetic resonance imaging
- Ultrasound/Doppler imaging

Lecture notes
Lecture notes and handouts

Literature
Webb A, Smith N.B. Introduction to Medical Imaging: Physics, Engineering and Clinical Applications; Cambridge University Press 2011

Prerequisites / notice
Analysis, Linear Algebra, Physics, Basics of Signal Theory, Basic skills in Matlab programming

227-0386-00L
Biomedical Engineering

Abstract
Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The focus is on learning the concepts that govern common medical instruments and the most important organs from an engineering point of view. In addition, the most recent achievements and trends of the field of biomedical engineering are also outlined.
Objective
Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The course provides an overview of the various topics of the different tracks of the biomedical engineering master course and helps orienting the students in selecting their specialized classes and project locations.

Content

Lecture notes
Introduction to Biomedical Engineering by Enderle, Banchard, and Bronzino

Literature
Available online

https://www1.ethz.ch/lbb/Education/BME

227-0965-00L Micro and Nano-Tomography of Biological Tissues W 4 credits 3G M. Stamparoni, P. A. Kaestner

Abstract
The lecture introduces the physical and technical know-how of X-ray tomographic microscopy. Several X-ray imaging techniques (absorption-, phase- and darkfield contrast) will be discussed and their use in daily research, in particular biology, is presented. The course discusses the aspects of quantitative evaluation of tomographic data sets like segmentation, morphometry and statistics.

Objective
Introduction to the basic concepts of X-ray tomographic imaging, image analysis and data quantification at the micro and nano scale with particular emphasis on biological applications.

Content
Synchrotron-based X-ray micro- and nano-tomography is today a powerful technique for non-destructive, high-resolution investigations of a broad range of materials. The high-brilliance and high-coherence of third generation synchrotron radiation facilities allow quantitative, three-dimensional imaging at the micro and nanometer scale and extend the traditional absorption imaging technique to edge-enhanced and phase-sensitive measurements, which are particularly suited for investigating biological samples.

The lecture includes a general introduction to the principles of tomographic imaging from image formation to image reconstruction. It provides the physical and engineering basics to understand how imaging beamlines at synchrotron facilities work, looks into the recently developed phase contrast methods, and explores the first applications of X-ray nano-tomographic experiments.

The course finally provides the necessary background to understand the quantitative evaluation of tomographic data, from basic image analysis to complex morphometrical computations and 3D visualization, keeping the focus on biomedical applications.

227-0157-00L Semiconductor Devices: Physical Bases and Simulation W 4 credits 3G A. Schenk

Abstract
The course addresses the physical principles of modern semiconductor devices and the foundations of their modeling and numerical simulation. Necessary basic knowledge on quantum-mechanics, semiconductor physics and device physics is provided. Computer simulations of the most important devices and of interesting physical effects supplement the lectures.

Objective
The course aims at understanding the principle physics of modern semiconductor devices, of the foundations in the physical modeling of transport and its numerical simulation. During the course also basic knowledge on quantum-mechanics, semiconductor physics and device physics is provided.

Content
The main topics are: transport models for semiconductor devices (quantum transport, Boltzmann equation, drift-diffusion model, hydrodynamic model), physical characterization of silicon (intrinsic properties, scattering processes), mobility of cold and hot carriers, recombination (Shockley-Read-Hall statistics, Auger recombination), impact ionization, metal-semiconductor contact, metal-insulator-semiconductor structure, and heterojunctions.

The exercises are focussed on the theory and the basic understanding of the operation of special devices, as single-electron transistor, resonant tunneling diode, pn-diode, bipolar transistor, MOSFET, and laser. Numerical simulations of such devices are performed with an advanced simulation package (Sentaurus-Synopsys). This enables to understand the physical effects by means of computer experiments.

227-0147-00L VLSI II: Design of Very Large Scale Integration Circuits W 7 credits 5G H. Kaeslin, F. K. Gürkaynak, M. Korb

Abstract
This second course in our VLSI series is concerned with how to turn digital circuit netlists into safe, testable and manufacturable mask layout, taking into account various parasitic effects. Low-power circuit design is another important topic. Economic aspects and management issues of VLSI projects round off the course.

Objective
Know how to design digital VLSI circuits that are safe, testable, durable, and make economic sense.
Nano-Optics

Nano-Optics is the study of optical phenomena and techniques on the nanometer scale. It is an emerging field of study motivated by the rapid advance of nanoscience and technology. It embraces topics such as plasmonics, optical antennas, optical trapping and manipulation, and high-resolution imaging and spectroscopy.

Prerequisites:
- Physics I+II
- Electrodynamics (or equivalent)

Content
- Molecular spectroscopy, light forces and optical trapping, photonic bandgap materials, and theoretical methods in nano-optics.
- Imaging and microscopy. Further topics are: optical interactions between nanoparticles, atomic decay rates in inhomogeneous environments, single molecule spectroscopy, light forces and optical trapping, photonic bandgap materials, and theoretical methods in nano-optics.

Objective
- Understanding concepts of light localization and light-matter interactions on the nanoscale.
- Starting with an angular spectrum representation of optical fields the role of inhomogeneous evanescent fields is discussed. Among the topics are: theory of strongly focused light, point spread functions, resolution criteria, confocal microscopy, and near-field optical microscopy. Further topics are: optical interactions between nanoparticles, atomic decay rates in inhomogeneous environments, single molecule spectroscopy, light forces and optical trapping, photonic bandgap materials, and theoretical methods in nano-optics.

Literature
- Govind P. Agrawal; "Fiber-Optic Communication Systems"; Wiley, 2010
- J. Leuthold
- Embedded MEMS Lab

Prerequisites / notice
- Electrodymanics (or equivalent)
- Physics I+II

Lecture notes
- All written documents in English.

Further details:
http://www.iis.ee.ethz.ch/stud_area/vorlesungen/vlsi2.en.html

Optical Communication Fundamentals

The path of an analog signal in the transmitter to the digital world in a communication link and back to the analog world at the receiver is discussed. The lecture covers the fundamentals of all important optical and optoelectronic components in a fiber communication system. This includes the transmitter, the fiber channel and the receiver with the electronic digital signal processing elements.

Abstract
- An in-depth understanding on how information is transmitted from source to destination. Also the mathematical framework to describe the important elements will be passed on. Students attending the lecture will further get engaged in critical discussion on societal, economical and environmental aspects related to the on-going exponential growth in the field of communications.

Content
- Chapter 1: Introduction: Analog/Digital conversion, The communication channel, Shannon channel capacity, Capacity requirements.
- Chapter 4: The Receiver: Photodiodes, Receiver noise, Detector schemes (direct detection, coherent detection), Bit-error ratios and error estimations.
- Chapter 5: Digital Signal Processing Techniques: Digital signal processing in a coherent receiver, Error detection techniques, Error correction coding.
- Chapter 6: Pulse Shaping and Multiplexing Techniques: WDM/FDM, TDM, OFDM, Nyquist Multiplexing, OCDMA.
- Chapter 7: Optical Amplifiers : Semiconductor Optical Amplifiers, Erbium Doped Fiber Amplifiers, Raman Amplifiers.

Prerequisites / notice

Lecture notes
- Lecture notes are handed out.
Objective

Students learn the individual process steps that are required to make a MEMS (Micro Electro Mechanical System). Students carry out the process steps themselves in laboratories and clean rooms. Furthermore, participants become familiar with the special requirements (cleanliness, safety, operation of equipment and handling hazardous chemicals) of working in the clean rooms and laboratories. The entire production, processing, and characterization of the MEMS is documented and evaluated in a final report.

Content

With guidance from a tutor, the individual silicon microsystem process steps that are required for the fabrication of an accelerometer are carried out:
- Photolithography, dry etching, wet etching, sacrificial layer etching, critical point drying, various cleaning procedures
- Packaging and electrical connection of a MEMS device
- Testing and characterization of the MEMS device
- Written documentation and evaluation of the entire production, processing and characterization

Lecture notes

A document containing theory, background and practical course content is distributed at the first meeting of the course. The document provides sufficient information for the participants to successfully participate in the course.

Prerequisites / notice

Participating students are required to attend all scheduled lectures and meetings of the course.

This master's level course is limited to 15 students per semester for safety and efficiency reasons. If there are more than 15 students registered, we regret to restrict access to this course by the following rules:

Priority 1: master students of the master's program in "Micro and Nanosystems"

Priority 2: master students of the master's program in "Mechanical Engineering" with a specialization in Microsystems and Nanoscale Engineering (MAVT-tutors Profs Daraio, Dual, Hierold, Kourmoutsakos, Nelson, Norris, Park, Poulikakos, Pratsinis, Stemmer), who attended the bachelor course "151-0621-00L Microsystems Technology" successfully.

Priority 3: master students, who attended the bachelor course "151-0621-00L Microsystems Technology" successfully.

Priority 4: all other students (PhD, bachelor, master) with a background in silicon or microsystems process technology.

If there are more students in one of these priority groups than places available, we will decide by drawing lots.

Students will be notified at the first lecture of the course (introductory lecture) as to whether they are able to participate.

The course is offered in autumn and spring semester.

529-0443-00L Advanced Magnetic Resonance W 7 credits 3G B. H. Meier, M. Ernst

Abstract

The course is for advanced students and covers selected topics from magnetic resonance spectroscopy. This year, the lecture will introduce and discuss relaxation theory and its applications in magnetic resonance.

Objective

The aim of the course is to familiarize the students with the basic concepts of magnetic resonance relaxation theory in liquids and solids. Starting from the mathematical description of spin dynamics, the effect of stochastic motional processes on the density operator will be analyzed. In the end students should understand the Redfield formulation of relaxation and be able to understand the effect of dynamics on magnetic resonance experiments.

Content

The aim of the course is to familiarize the students with the basic concepts of magnetic resonance relaxation theory in liquids and solids. Starting from the mathematical description of spin dynamics, the effect of stochastic motional processes on the density operator will be analyzed. In the end students should understand the Redfield formulation of relaxation and be able to understand the effect of dynamics on magnetic resonance experiments.

Lecture notes

A script which covers the topics will be distributed in the lecture and will be accessible through the web page http://www.ssnmr.ethz.ch/education/

327-0703-00L Electron Microscopy in Material Science W 4 credits 2V+2U K. Kunze, R. Erni, S. Gerstl, F. Gramm, F. Krumeich

Abstract

A comprehensive understanding of the interaction of electrons with condensed matter and details on the instrumentation and methods designed to use these probes in the structural and chemical analysis of various materials.

Objective

A comprehensive understanding of the interaction of electrons with condensed matter and details on the instrumentation and methods designed to use these probes in the structural and chemical analysis of various materials.

Content

This course provides a general introduction into electron microscopy of organic and inorganic materials. In the first part, the basics of transmission- and scanning electron microscopy are presented. The second part includes the most important aspects of specimen preparation, imaging and image processing. In the third part, recent applications in materials science, solid state physics, structural biology, structural geology and structural chemistry will be reported.

Lecture notes

Englisch

Literature


327-0702-00L EM-Practical Course in Material Sciences W 2 credits 4P K. Kunze, F. Gramm, F. Krumeich, J. Reuteler

Abstract

Practical work on a TEM and on SEM, treatment of typical problems, data analysis, writing of a report

Objective

Application of basic electron microscopic techniques to materials science problems

Literature

see lecture Electron Microscopy (327-0703-00L)

Prerequisites / notice

Prerequisite: the lecture Electron Microscopy (327-0703-00L) has to be attended with success, maximum number of participants 15, work in groups of 3 people.

327-2125-00L Microscopy Training SEM I - Introduction to SEM W 1 credit 3P S. Rodighiero, A. G. Bittermann, K. Kunze, J. Reuteler

Abstract

The introductory course on Scanning Electron Microscopy (SEM) emphasizes hands-on learning. Using 2 SEM instruments, students have the opportunity to study their own samples, or standard test samples, as well as solving exercises provided by ScopeM scientists.
Objective
- Set-up, align and operate a SEM successfully and safely.
- Accomplish imaging tasks successfully and optimize microscope performances.
- Master the operation of a low-vacuum and field-emission SEM and EDX instrument.
- Perform sample preparation with corresponding techniques and equipment for imaging and analysis
- Acquire techniques in obtaining secondary electron and backscatter electron micrographs
- Perform EDX qualitative and semi-quantitative analysis

Content
During the course, students learn through lectures, demonstrations, and hands-on sessions how to setup and operate SEM instruments, including low-vacuum and low-voltage applications. This course gives basic skills for students new to SEM. At the end of the course, students with no prior experience are able to align a SEM, to obtain secondary electron (SE) and backscatter electron (BSE) micrographs and to perform energy dispersive X-ray spectroscopy (EDX) qualitative and semi-quantitative analysis. The procedures to better utilize SEM to solve practical problems and to optimize SEM analysis for a wide range of materials will be emphasized.

- Discussion of students’ sample/interest
- Introduction and discussion on Electron Microscopy and instrumentation
- Lectures on electron sources, electron lenses and probe formation
- Lectures on beam/specimen interaction, image formation, image contrast and imaging modes.
- Lectures on sample preparation techniques for EM
- Brief description and demonstration of the SEM microscope
- Practice on beam/specimen interaction, image formation, image contrast (and image processing)
- Student participation on sample preparation techniques
- Scanning Electron Microscopy lab exercises: setup and operate the instrument under various imaging modalities
- Lecture and demonstrations on X-ray micro-analysis (theory and detection), qualitative and semi-quantitative EDX and point analysis, linescans and spectral mapping
- Practice on real-world samples and report results

Literature
- Detailed course manual

Prerequisites / notice
No mandatory prerequisites. Please consider the prior attendance to EM Basic lectures (551-1618-00V; 227-0390-00L; 327-0703-00L) as suggested prerequisite.

327-2126-00L Microscopy Training TEM I - Introduction to TEM W 1 credit 3P
Does not take place this semester.
Number of participants limited to 6.

The participants will be chosen based on a short motivation letter. Please send this letter to S. Rodighiero (main lecturer).

Abstract
The introductory course on Transmission Electron Microscopy (TEM) provides theoretical and hands-on learning for new operators, utilizing lectures, demonstrations, and hands-on sessions.

Objective
- Overview of TEM theory, instrumentation, operation and applications.
- Alignment and operation of a TEM, as well as acquisition and interpretation of images, diffraction patterns, accomplishing basic tasks successfully.
- Knowledge of electron imaging modes (including Scanning Transmission Electron Microscopy), magnification calibration, and image acquisition using CCD cameras.
- To set up the TEM to acquire diffraction patterns, perform camera length calibration, as well as measure and interpret diffraction patterns.
- Overview of techniques for specimen preparation.

Content
Using two Transmission Electron Microscopes the students learn how to align a TEM, select parameters for acquisition of images in bright field (BF) and dark field (DF), perform scanning transmission electron microscopy (STEM) imaging, phase contrast imaging, and acquire electron diffraction patterns. The participants will also learn basic and advanced use of digital cameras and digital imaging methods.

- Introduction and discussion on Electron Microscopy and instrumentation.
- Lectures on electron sources, electron lenses and probe formation.
- Lectures on beam/specimen interaction, image formation, image contrast and imaging modes.
- Lectures on sample preparation techniques for EM.
- Brief description and demonstration of the TEM microscope.
- Practice on beam/specimen interaction, image formation, Image contrast (and image processing).
- Demonstration of Transmission Electron Microscopes and imaging modes (Phase contrast, BF, DF, STEM).
- Student participation on sample preparation techniques.
- Transmission Electron Microscopy lab exercises: setup and operate the instrument under various imaging modalities.
- TEM alignment, calibration, correction to improve image contrast and quality.
- Electron diffraction.
- Practice on real-world samples and report results.

Literature
- Detailed course manual

Prerequisites / notice
No mandatory prerequisites. Please consider the prior attendance to EM Basic lectures (551-1618-00V; 227-0390-00L; 327-0703-00L) as suggested prerequisite.

363-0541-00L Systems Dynamics and Complexity W 3 credits 3G
F. Schweitzer, G. Casiraghi, V. Nanumyan

Abstract
Finding solutions: what is complexity, problem solving cycle.
Implementing solutions: project management, critical path method, quality control feedback loop.
Controlling solutions: Vensim software, feedback cycles, control parameters, instabilities, chaos, oscillations and cycles, supply and demand, production functions, investment and consumption

Objective
A successful participant of the course is able to:
- understand why most real problems are not simple, but require solution methods that go beyond algorithmic and mathematical approaches
- apply the problem solving cycle as a systematic approach to identify problems and their solutions
- calculate project schedules according to the critical path method
- setup and run systems dynamics models by means of the Vensim software
- identify feedback cycles and reasons for unintended systems behavior
- analyse the stability of nonlinear dynamical systems and apply this to macroeconomic dynamics
Theoretical Semester Project in a Group of the
During the course, students will learn about different design thinking methods and tools. This will enable them to:

1. Finding solutions
2. Implementing solutions
3. Controlling solutions

PART 1 introduces complexity as a system immanent property that cannot be simplified. It introduces the problem solving cycle, used in systems oriented management, as an approach to structure problems and to find solutions.

PART 2 discusses selected problems of project management when implementing solutions. Methods for identifying the critical path of subtasks in a project and for calculating the allocation of resources are provided. The role of quality control as an additional feedback loop and the consequences of small changes are discussed.

PART 3, by far the largest part of the course, provides more insight into the dynamics of existing systems. Examples come from biology (population dynamics), management (inventory modeling, technology adoption, production systems) and economics (supply and demand, investment and consumption). For systems dynamics models, the software program VENSIM is used to evaluate the dynamics. For economic models analytical approaches, also used in nonlinear dynamics and control theory, are applied. These together provide a systematic understanding of the role of feedback loops and instabilities in the dynamics of systems. Emphasis is on oscillating phenomena, such as business cycles and other life cycles.

Lecture slides are provided as handouts - including notes and literature sources - to registered students only. All material is to be found on the Moodle platform. More details during the first lecture.

Self-study tasks (discussion exercises, Vensim exercises), are provided as home work. Weekly exercise sessions (45 min) are used to discuss selected solutions. Regular participation in the exercises is an efficient way to understand the concepts relevant for the final exam.

Weekly self-study tasks are used to apply the concepts introduced in the lectures and to come to grips with the software program VENSIM. The lecture slides are provided as handouts - including notes and literature sources - to registered students only. All material is to be found on the Moodle platform. More details during the first lecture.

Prerequisites / notice

Design Thinking: Human-Centred Solutions to Real World Challenges

Due to didactic reasons, the number of participants is limited to 30.

All interested students are invited to apply for this course by sending a one-page motivation letter until 14.9.16 to Florian Rittiner (frittiner@ethz.ch).

Additionally please enroll via mystudies. Places will be assigned after the first lecture on the basis of your motivation letter and commitment for the class.

Abstract

The goal of this course is to engage students in a multidisciplinary collaboration to tackle real world problems. Following a design thinking approach, students will work in teams to solve a set of design challenges that are organized as a one-week, a three-week, and a final six-week project in collaboration with an external project partner.

Information and application: www.sparklabs.ch/ethz

Objective

During the course, students will learn about different design thinking methods and tools. This will enable them to:
- Generate deep insights through the systematic observation and interaction of key stakeholders.
- Engage in collaborative ideation with a multidisciplinary (student) team.
- Rapidly prototype and iteratively test ideas and concepts by using various materials and techniques.

Content

The purpose of this course is to equip the students with methods and tools to tackle a broad range of problems. Following a Design Thinking approach, the students will learn how to observe and interact with key stakeholders in order to develop an in-depth understanding of what is truly important and emotionally meaningful to the people at the center of a problem. Based on these insights, the students ideate on possible solutions and immediately validated them through quick iterations of prototyping and testing using different tools and materials. The students will work in multidisciplinary teams on a set of challenges that are organized as a one-week, a three-week, and a final six-week project with an external project partner. In this course, the students will learn about the different Design Thinking methods and tools that are needed to generate deep insights, to engage in collaborative ideation, rapid prototyping and iterative testing.

Design Thinking is a deeply human process that taps into the creative abilities we all have, but that get often overlooked by more conventional problem solving practices. It relies on our ability to be intuitive, to recognize patterns, to construct ideas that are emotionally meaningful as well as functional, and to express ourselves through means beyond words or symbols. Design Thinking provides an integrated way by incorporating tools, processes and techniques from design, engineering, the humanities and social sciences to identify, define and address diverse challenges. This integration leads to a highly productive collaboration between different disciplines.

For more information and the application visit: http://sparklabs.ch/ethz

Proseminars and Semester Papers

To organise a semester project take contact with one of the instructors.

Not all lecturers are directly eligible in myStudies if "Professors" is the required type of lecturers. In such cases please take contact with the Study Administration (www.phys.ethz.ch/studies/study-administration.html).

Number Title Type ECTS Hours Lecturers
402-0210-96L Proseminar Theoretical Physics: Solitons and Instantons in Condensed Matter W 9 credits 4S V. Geshkenbein

Number of participants limited to 24.

A guided self-study of original papers and of advanced textbooks in theoretical physics. Within the general topic, determined each semester, participants give a presentation on a particular subject and deliver a written report.

402-0217-MSL Theoretical Semester Project in a Group of the Physics Department W 9 credits 18A Supervisors

This course unit is an alternative if no suitable "Proseminar Theoretical Physics" is available or if the proseminar is already overbooked.

Abstract
The aim of the project is to give the student experience in working in a research environment, carrying out physics experiments, analysing and interpreting the resulting data.

Prerequisites /
notice
Arbeiten in einer Forschungsgruppe sind besonders gut geeignet, die Studierenden mit aktuellen Forschungsthemen und mit moderner Instrumentierung bekannt zu machen.

402-0400-MSL

Advanced Quantum Electronics Experiments

W 9 credits 18P

Supervisors for this experimental semester paper:
Prof. Tilman Esslinger
Prof. Jerôme Faist
Prof. Rachel Grange
Prof. Jonathan Home
Prof. Atac Imamoglu
Prof. Steven Johnson
Prof. Ursula Keller

Abstract
Implementation of experiments in quantum electronics. Planning, design, realisation, evaluation, and interpretation of the experiments.

Content

402-0717-MSL

Particle Physics at CERN

W 9 credits 18P F. Nessi-Tedaldi, W. Lustermann

Abstract
During the semester break participating students stay for 4 weeks at CERN and perform experimental work relevant to our particle physics projects. Dates to be agreed upon.

Objective
Students learn, by doing, the needed skills to perform a small particle physics experiment: setup, problem solving, data taking, analysis, interpretation and presentation in a written report of publication quality.

Content
Detailed information in: http://www@cmsdoc.cern.ch/~nessif/ETHTeilchenpraktikumCERN.html

Prerequisites /
notice
Language of instruction: English or German

402-0719-MSL

Particle Physics at PSI (Paul Scherrer Institute)

W 9 credits 18P C. Grab

Abstract
During semester breaks 6-12 students stay for 3 weeks at PSI and participate in a hands-on course on experimental particle physics. A small real experiment is performed in common, including apparatus design, construction, running and data analysis. The course includes some lectures, but the focus lies on the practical aspects of experimenting.

Objective
Students learn all the different steps it takes to perform a complete particle physics experiment in a small team. They acquire skills to do this themselves in the team, including design, construction, data taking and data analysis.

402-0340-MSL

Medical Physics

W 9 credits 18P A. J. Lomax, K. P. Prüssmann, M. Rudin

Abstract
In agreement with the lecturers a semester paper in the context of the topics discussed in the lectures can be written.

GESS Science in Perspective

Recommended GESS Science in Perspective (Type B) for D-PHYS.

see GESS Science in Perspective: Type A: Enhancement of Reflection Capability

see GESS Science in Perspective: Language Courses ETH/UZH

Master's Thesis (Programme Regulations 2007)

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-2000-00L</td>
<td>Scientific Works in Physics</td>
<td>O</td>
<td>0</td>
<td></td>
<td>C. Grab</td>
</tr>
</tbody>
</table>

Target audience:
Master students who cannot document to have received an adequate training in working scientifically.

Directive
Abstract

Literature Review: ETH-Library, Journals in Physics, Google Scholar; Thesis Structure: The IMRAD Model; Document Processing: LaTeX and BibTeX, Mathematical Writing, AVETH Survival Guide; ETH Guidelines for Integrity; Authorship Guidelines; ETH Citation Etiquettes; Declaration of Originality.

Objective

Basic standards for scientific works in physics: How to write a Master Thesis. What to know about research integrity.

402-0900-00L Master's Thesis

Only students who fulfill the following criteria are allowed to begin with their master's thesis:

a. successful completion of the bachelor programme;
b. fulfilling of any additional requirements necessary to gain admission to the master programme.
c. have acquired at least 9 credits in the category Proseminars and Semester Papers.

Further information:

Please send the completed form https://www.phys.ethz.ch/content/dam/ethz/main/education/bachelor/physik/files/2014-10-Masterarbeit_Phys_Regl%202007.pdf to the Study Administration

Further information:

www.phys.ethz.ch/phys/education/master/msc-theses

Abstract

The master's thesis concludes the study programme. Thesis work should prove the students' ability to independent, structured and scientific working.

402-2000-00L Scientific Works in Physics

Target audience:

Master students who cannot document to have received an adequate training in working scientifically.

Directive


Further information:

www.phys.ethz.ch/phys/education/master/msc-theses

Abstract

The students who cannot document to have received an adequate training in working scientifically.

Objective

Basic standards for scientific works in physics: How to write a Master Thesis. What to know about research integrity.

402-0900-30L Master's Thesis

Only students who fulfill the following criteria are allowed to begin with their master's thesis:

a. successful completion of the bachelor programme;
b. fulfilling of any additional requirements necessary to gain admission to the master programme.
c. have acquired at least 8 credits in the category Proseminars and Semester Papers.

Further information:

http://www.phys.ethz.ch/phys/education/master/msc-theses

Abstract

The master's thesis concludes the study programme. Thesis work should prove the students' ability to independent, structured and scientific working.

402-0247-00L Electronics for Physicists I (Analogue)

Passive elements, linear complex networks, transmission lines, simulation of analog circuits, semiconductor els: diodes, bipolar and fieldeffect transistors, basic amplifier circuits, small signal analysis, differential amplifiers, noise in analog circuits, operational amplifiers, OTAs, gyrator circuits, feedback and stability in amplifiers, oscillators, ADCs and DACs, introduction in CMOS technology

Content

Passive elements, linear complex networks, transmission lines, simulation of analog circuits (SPICE), semiconductor elements: diodes, bipolar and fieldeffect transistors, basic amplifier circuits, small signal analysis, differential amplifiers, noise in analog circuits, operational amplifiers, OTA's, gyrator circuits, feedback and stability in amplifiers, oscillators, ADC's and DAC's, introduction in CMOS technology.

Prerequisites / notice


402-0101-00L The Zurich Physics Colloquium

Abstract

Abstract
Research colloquium

Occasionally, talks may be delivered in German.

Prerequisites / notice


Abstract
Research colloquium

Objective
The Zurich Theoretical Physics Colloquium is jointly organized by the University of Zurich and ETH Zurich. Its mission is to bring both students and faculty with diverse interests in theoretical physics together. Leading experts explain the basic questions in their field of research and communicate the fascination for their work.

402-0890-00L Seminars of the Platform for Advanced Scientific Computing (PASC) E- 0 credits 2S H. J. Herrmann, T. C. Schulthess, N. Spaldin, M. Troyer

Abstract
Seminars by invited speakers in the area of advanced scientific computing.

Objective
Discussion of state of the art techniques and methodologies in scientific computing.

Content
This course consists in a series of seminars by invited speakers on subjects of interest for the "Platform for Advanced Scientific Computing".

Lecture notes
There is no script.

Literature
Literature will be provided by the speakers in their respective presentations.

Prerequisites / notice
Participants should have experience on advanced scientific computing.

401-5330-00L Talks in Mathematical Physics E- 0 credits 1K A. Cattaneo, G. Felder, M. Gaberdiel, G. M. Graf, H. Knörrer, T. H. Willwacher, University lecturers

Abstract
Research colloquium

402-0501-00L Solid State Physics E- 0 credits 1S A. Zheludev, G. Blatter, C. Degen, K. Ensslin, D. Pescia, M. Sigrist, A. Wallraff

Abstract
Research colloquium


Abstract
Research colloquium

402-0600-00L Nuclear and Particle Physics with Applications E- 0 credits 2S A. Rubbia, G. Dissertori, C. Grab, K. S. Kirch, R. Wallny

Abstract
Research colloquium

402-0893-00L Particle Physics Seminar E- 0 credits 1S T. K. Gehrmann

Abstract
Research colloquium

Prerequisites / notice
Occasionally, talks may be delivered in German.

402-0700-00L Seminar in Elementary Particle Physics E- 0 credits 1S M. Spira

Abstract
Research colloquium

Objective
Stay informed about current research results in elementary particle physics.

402-0369-00L Research Colloquium in Astrophysics E- 0 credits 1K S. Cantalupo, M. Carollo, S. Lilly, M. F. Schawinski, H. M. Schmid

Abstract
Research colloquium

Objective
During the semester there is a colloquium every week. In general, colloquia are 20 minutes plus discussion and are given by local researchers. They inform the other members of the Institute of Astronomy about their current work, results, problems and plans. Guests are always welcome.

Ph.D. students are expected to give a first research colloquium within their first year of their graduate time, another colloquium in their third year, and their doctoral exam talk before or after the exam. Other members of the institute are also invited to give talks. The goals are:
- keep other members of the institute oriented on current research
- test new ideas within the institute before going outside
- train students to give scientific talks

402-0356-00L Astrophysics Seminar E- 0 credits 2S S. Cantalupo, M. Carollo, S. Lilly, M. F. Schawinski, H. M. Schmid

Abstract
Research colloquium

402-0746-00L Seminar: Particle and Astrophysics E- 0 credits 1S C. Grab, University lecturers

Abstract
Research colloquium

Content
In Seminarvorträgen werden aktuelle Fragestellungen aus der Teilchenphysik vom theoretischen und experimentellen Standpunkt aus diskutiert. Besonders wichtig erscheint uns der Bezug zu den eigenen Forschungsmöglichkeiten am PSI, CERN und DESY.

402-0396-00L Recent Research Highlights in Astrophysics (University of Zurich) E- 0 credits 1S University lecturers

Abstract
Research colloquium

Content
No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: AST006

Mind the enrolment deadlines at UZH: http://www.uzh.ch/studies/application/mobilitaet_en.html

402-0530-00L Mesoscopic Systems E- 0 credits 1S T. M. Ihn

Abstract
Research colloquium
## Course Units for Additional Admission Requirements

The courses below are only available for MSc students with additional admission requirements.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0620-AAL</td>
<td>Current Topics in Accelerator Mass Spectrometry and Their Applications</td>
<td>E-</td>
<td>0</td>
<td>1S</td>
<td>M. Christl, S. Willett</td>
</tr>
<tr>
<td>227-0980-AAL</td>
<td>Seminar on Biomedical Magnetic Resonance</td>
<td>E-</td>
<td>0</td>
<td>2K</td>
<td>K. P. Prüssmann, S. Kozerke, M. Rudin</td>
</tr>
<tr>
<td>227-1043-AAL</td>
<td>Neuroinformatics - Colloquia (University of Zurich)</td>
<td>E-</td>
<td>0</td>
<td>1K</td>
<td>S.C. Liu, R. Hahnloser, V. Mante, K. A. Martin</td>
</tr>
<tr>
<td>227-1044-AAL</td>
<td>Auditory Informatics (University of Zurich)</td>
<td>E-</td>
<td>2</td>
<td>1S</td>
<td>R. Stoop</td>
</tr>
<tr>
<td>651-1581-AAL</td>
<td>Seminar on Glaciology</td>
<td>E-</td>
<td>3</td>
<td>2S</td>
<td>A. Bauder</td>
</tr>
</tbody>
</table>

### Number

- 406-0204-AAL: Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.
- 406-0663-AAL: Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

### Abstract

- The seminar is aimed at all students who, during their studies, are confronted with age determination methods based on long-living radionuclides found in nature. Basic methodology, the latest developments, and special examples from a wide range of applications will be discussed.

### Objective

- Getting insight to advanced topics in Magnetic Resonance Imaging

### Content

- The topics depend heavily on the invited speakers, and thus change from week to week.
Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract

The course gives an introduction into fundamental techniques and algorithms of numerical mathematics which play a central role in numerical simulations in science and technology. The course focuses on fundamental ideas and algorithmic aspects of numerical methods. The exercises involve actual implementation of numerical methods in C++.

Objective

* Knowledge of the fundamental algorithms in numerical mathematics
* Knowledge of the essential terms in numerical mathematics and the techniques used for the analysis of numerical algorithms
* Ability to choose the appropriate numerical method for concrete problems
* Ability to interpret numerical results
* Ability to implement numerical algorithms efficiently

Content

1. Direct Methods for linear systems of equations
2. Least Squares Techniques
3. Data Interpolation and Fitting
4. Filtering Algorithms
5. Approximation of Functions
6. Numerical Quadrature
7. Iterative Methods for non-linear systems of equations
8. Single Step Methods for ODEs
9. Stiff Integrators

Lecture notes

Lecture materials (PDF documents and codes) will be made available to participants.

Literature


M. Hanke-Bourgeois "Grundlagen der Numerischen Mathematik und des wissenschaftlichen Rechnens", BG Teubner, 2002

P. Deuflhard and A. Hohmann, "Numerische Mathematik I", DeGruyter, 2002

Prerequisites / notice

Solid knowledge about fundamental concepts and techniques from linear algebra & calculus as taught in the first year of science and engineering curricula.

The course will be accompanied by programming exercises in C++ relying on the template library EIGEN. Familiarity with C++, object oriented and generic programming is an advantage. Participants of the course are expected to learn C++ by themselves.

Physics Master - Key for Type

<table>
<thead>
<tr>
<th>W+</th>
<th>Eligible for credits and recommended</th>
<th>Z</th>
<th>Courses outside the curriculum</th>
</tr>
</thead>
<tbody>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
<td>O</td>
<td>Compulsory</td>
</tr>
</tbody>
</table>

Key for Hours

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
<th>P</th>
<th>practical/laboratory course</th>
</tr>
</thead>
<tbody>
<tr>
<td>G</td>
<td>lecture with exercise</td>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
<td>R</td>
<td>revision course / private study</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

ECTS

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Students in the Joint Degree Master's Programme "Quantitative Finance" must book UZH modules directly at the UZH. Those modules are not listed here.

## Core Courses

### Economic Theory for Finance

For possible additional course offerings see www.msfinance.ch

### Mathematical Methods for Finance

For possible additional course offerings see www.msfinance.ch

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-3913-01L</td>
<td>Mathematical Foundations for Finance</td>
<td>W</td>
<td>4</td>
<td>3V+2U</td>
<td>E. W. Farkas, M. Schweizer</td>
</tr>
</tbody>
</table>

**Abstract**
First introduction to main modelling ideas and mathematical tools from mathematical finance

**Objective**
This course gives a first introduction to the main modelling ideas and mathematical tools from mathematical finance. It aims at a double audience: mathematicians who want to learn the modelling ideas and concepts for finance, and non-mathematicians who need an introduction to the main tools from stochastics used in mathematical finance. The main emphasis will be on ideas, but important results will be given with (sometimes partial) proofs.

**Content**
Topics to be covered include:
- financial market models in finite discrete time
- absence of arbitrage and martingale measures
- valuation and hedging in complete markets
- basics about Brownian motion
- stochastic integration
- stochastic calculus: Itô's formula, Girsanov transformation, Itô's representation theorem
- Black-Scholes formula

**Lecture notes**
Lecture notes will be sold at the beginning of the course.

**Literature**
Lecture notes will be sold at the beginning of the course. Additional (background) references are given there.

**Prerequisites / notice**
Prerequisites: Results and facts from probability theory as in the book "Probability Essentials" by J. Jacod and P. Protter will be used freely. Especially participants without a direct mathematics background are strongly advised to familiarise themselves with those tools before (or very quickly during) the course. (A possible alternative to the above English textbook are the (German) lecture notes for the standard course "Wahrscheinlichkeitsrechnung").

For those who are not sure about their background, we suggest to look at the exercises in Chapters 8, 9, 22-25, 28 of the Jacod/Protter book. If these pose problems, you will have a hard time during the course. So be prepared.

## Elective Courses

### Economic Theory for Finance

For possible additional course offerings see www.msfinance.ch

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-4633-00L</td>
<td>Data Analytics in Organisations and Business</td>
<td>W</td>
<td>5</td>
<td>2V+1U</td>
<td>I. Flückiger</td>
</tr>
</tbody>
</table>

**Abstract**
On the end-to-end process of data analytics in organisations & business and how to transform data into insights for fact based decisions. Presentation of the process from the beginning with framing the business problem to presenting the results and making decisions by the use of data analytics. For each topic case studies from the financial service, healthcare and retail sectors will be presented.

**Objective**
The goal of this course is to give the students the understanding of the data analytics process in the business world, with special focus on the skills and techniques used besides the technical skills. The student will become familiar with the "business language", current problems and thinking in organisations and business and tools used.

**Content**
- Framing the Business Problem
- Framing the Analytics Problem
- Data Methodology
- Model Building
- Deployment
- Model Lifecycle

**Lecture notes**
Lecture Notes will be available.

**Prerequisites / notice**
Prerequisites: Basic statistics and probability theory and regression

## Mathematical Methods for Finance

For possible additional course offerings see www.msfinance.ch

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-3925-00L</td>
<td>Non-Life Insurance: Mathematics and Statistics</td>
<td>W</td>
<td>6</td>
<td>4G</td>
<td>M. V. Wüthrich</td>
</tr>
</tbody>
</table>

**Abstract**
The lecture aims at providing a basis in non-life insurance mathematics which forms a core subject of actuarial sciences. It discusses collective risk modeling, individual claim size modeling, approximations for compound distributions, ruin theory, premium calculation principles, tariffication with generalized linear models, credibility theory, claims reserving and solvency.

**Objective**
The student is familiar with the basics in non-life insurance mathematics and statistics. This includes the basic mathematical models for insurance liability modeling, pricing concepts, stochastic claims reserving models and ruin and solvency considerations.
Content

The following topics are treated:

- Collective Risk Modeling
- Individual Claim Size Modeling
- Approximations for Compound Distributions
- Ruin Theory in Discrete Time
- Premium Calculation Principles
- Tariffication and Generalized Linear Models
- Bayesian Models and Credibility Theory
- Claims Reserving
- Solvency Considerations

Lecture notes

M. V. Wüthrich, Non-Life Insurance: Mathematics & Statistics

http://ssrn.com/abstract=2319328

Prerequisites / notice

The exams ONLY take place during the official ETH examination period.

This course will be held in English and counts towards the diploma of “Aktuar SAV”. For the latter, see details under www.actuaries.ch.

Prerequisites: knowledge of probability theory, statistics and applied stochastic processes.

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<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Lectures</th>
<th>Credits</th>
<th>Prerequisites</th>
</tr>
</thead>
</table>
| 401-4889-00L | Mathematical Finance | 11 | 4V+2U | | 401-4889-00L | Mathematical Finance | W | 11 credits | 4V+2U | M. Schweizer

Abstract

Advanced introduction to mathematical finance:
- absence of arbitrage and martingale measures
- option pricing and hedging
- optimal investment problems
- additional topics

Objective

Advanced level introduction to mathematical finance, presupposing knowledge in probability theory and stochastic processes

Content

This is an advanced level introduction to mathematical finance for students with a good background in probability. We want to give an overview of main concepts, questions and approaches, and we do this in both discrete- and continuous-time models. Topics include absence of arbitrage and martingale measures, option pricing and hedging, optimal investment problems, and probably others.

Prerequisites are probability theory and stochastic processes (for which lecture notes are available).

Lecture notes

None available

Literature

Details will be announced in the course.

Prerequisites / notice

Prerequisites are probability theory and stochastic processes (for which lecture notes are available).

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<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Lectures</th>
<th>Credits</th>
<th>Prerequisites</th>
</tr>
</thead>
</table>
| 401-4657-00L | Numerical Analysis of Stochastic Ordinary Differential Equations | 6 | 3V+1U | | 401-4657-00L | Numerical Analysis of Stochastic Ordinary Differential Equations | W | 6 credits | 3V+1U | A. Jentzen

Abstract

Course on numerical approximations of stochastic ordinary differential equations driven by Wiener processes. These equations have several applications, for example in financial option valuation. This course also contains an introduction to random number generation and Monte Carlo methods for random variables.

Objective

The aim of this course is to enable the students to carry out simulations and their mathematical convergence analysis for stochastic models originating from applications such as mathematical finance. For this the course teaches a decent knowledge of the different numerical methods, their underlying ideas, convergence properties and implementation issues.

Content

- Generation of random numbers
- Monte Carlo methods for the numerical integration of random variables
- Stochastic processes and Brownian motion
- Stochastic ordinary differential equations (SODEs)
- Numerical approximations of SODEs
- Multilevel Monte Carlo methods for SODEs
- Applications to computational finance: Option valuation

Lecture notes

Lecture Notes are available in the lecture homepage (please follow the link in the Learning materials section).

Literature

P. Glassermann:
Monte Carlo Methods in Financial Engineering.

P. E. Kloeden and E. Platen:
Numerical Solution of Stochastic Differential Equations.

Prerequisites / notice

Mandatory: Probability and measure theory,
basic numerical analysis and
basics of MATLAB programming.

a) mandatory courses:
Elementary Probability,
Probability Theory I.

b) recommended courses:
Stochastic Processes.

Start of lectures: Wednesday, September 21, 2016
For more details, please follow the link in the Learning materials section.

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<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Lectures</th>
<th>Credits</th>
<th>Prerequisites</th>
</tr>
</thead>
</table>

Abstract

Investment returns are an important source of funding for social and pension insurance, and financial risk is an important threat to stability.

We study short-term and long-term financial risk and its interplay with other risk factors, and we develop methods for the measurement and management of financial risk and return in an asset/liability context with the goal of assuring sustainable funding.
The classical life insurance model is presented together with the important insurance types (insurance on one and two lives, term and
short-term solvency vs. long-term stability; effect of embedded options and guarantees; interplay between required return and risk-taking capability).

Be able to study empirical properties of financial assets: the Normal hypothesis and the deviations from it; statistical tools for investigating
relevant risk and return properties of financial assets; time aggregation properties; be able to conduct analysis of real data for the most
important asset classes.

Understand and be able to carry out portfolio construction: the concept of diversification; limitations to diversification / correlation
breakdown / what happened in 2008; the Kuhn-Tucker Theorem and optimization (mean-variance, mean-downside); incorporation of
constraints; sensitivity and shortcomings of optimized portfolios.

Understand and interpret the asset-liability interplay: the optimized portfolio in the asset-liability framework; short-term risk vs. long-term
risk; the influence of constraints; feasible and non-feasible solutions; practical considerations.

Know about active portfolio management: practical issues when implementing an investment strategy; the notion of active management;
efficient markets hypothesis and limitations to it; empirical evidence; the fundamental law of active management; Bayesian concepts and
and the Black-Litterman framework.

Have an overall view: see the big picture of what asset returns can and cannot contribute to social security; be aware of the most relevant
outcomes; know the role of the actuary in the financial risk management process.

Risk and return of financial assets cannot be separated from one another and, hence, asset management and risk management cannot be
separated either. Managing financial risk in social and pension insurance is, therefore, the task of reconciling the contradictory dimensions of

1. Required return for a sustainable funding of the institution,
2. Risk-taking capability of the institution,
3. Returns available from financial assets in the market,
4. Risks incurred by investing in these assets.

This task must be accomplished under a number of constraints. Financial risk management in social insurance also means reconciling the
long time horizon of the promised insurance benefits with the short time horizon of financial markets and financial risk.

It is not the goal of this lecture to provide the students with any cookbook recipes that can readily be applied without further reflection. The
goal is rather to enable the students to develop their own understanding of the problems and possible solutions associated with the
management of financial risks in social and pension insurance.

To this end, a rigorous intellectual framework will be developed and a powerful set of mathematical tools from the fields of actuarial
mathematics and quantitative risk management will be applied. When analyzing the properties of financial assets, an empirical viewpoint
will be taken using statistical tools and considering real-world data.

Since this is the first instance of this course, there is not yet a full script. However, to complement the blackboard notes, extensive
handouts will be provided. Moreover, practical examples and data sets in Excel and Octave / Matlab will be made available to play around
with and deepen the understanding of the subject matter.

This course counts towards the diploma of "Aktuar SAV".

The exams ONLY take place during the official ETH examination period.

**Master's Thesis**
see www.oec.uzh.ch/studies/general/theses/oec_en.html

**Quantitative Finance Master - Key for Type**

<table>
<thead>
<tr>
<th>O</th>
<th>Compulsory</th>
<th>E-</th>
<th>Recommended, not eligible for credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
</tbody>
</table>
### Key for Hours

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
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<tr>
<td>K</td>
<td>colloquium</td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

**ECTS**

European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
Spatial Development and Infrastructure Systems Master

1. Semester

Compulsory Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0467-01L</td>
<td>Transport Systems</td>
<td>O</td>
<td>6</td>
<td>4G</td>
<td>U. A. Weidmann, K. W. Axhausen,</td>
</tr>
<tr>
<td></td>
<td>Only for master students, otherwise a special permission by the lecturers is required.</td>
<td></td>
<td></td>
<td></td>
<td>M. Menendez, M. Sinner</td>
</tr>
<tr>
<td></td>
<td>History, impact and principles of the design and operation of transport systems</td>
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<tr>
<td></td>
<td>Introduction of the basic principles of the design and operation of transport systems (road, rail, air) and of the essential pathways of their impacts (investment, generalised costs, accessibility, external effects)</td>
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<td></td>
<td>Transport systems and land use; network design; fundamental model of mobility behaviour; costs and benefits of mobility; transport history</td>
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<td></td>
<td>Classification of public transport systems; Characteristics of rail systems, bus systems, cable cars and funiculars, unconventional systems; introduction to logistics; fundamentals of rail freight transports; freight transport systems; intermodular transportation</td>
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<td></td>
<td>Network layout and its impact on road traffic. Traffic control systems for urban and inter-urban areas. Fundamentals of road safety and infrastructure maintenance.</td>
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<tr>
<td></td>
<td>Lecturer notes and slides as well as hints to further literature will be given during the course.</td>
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<td></td>
<td>Remark: parts of the lecture will be given in German.</td>
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<tr>
<td>103-0317-00L</td>
<td>Sustainable Spatial Development I</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>B. Scholl</td>
</tr>
<tr>
<td></td>
<td>Only for master students, otherwise a special permission by the lecturers is required.</td>
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<tr>
<td></td>
<td>The lectures imparts important knowledge for solving spatial relevant conflicts and problems. Case studies will be used to demonstrate the implementation in practice.</td>
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<tr>
<td></td>
<td>Spatial development deals with the development and the design of our living space. To meet the expectations, the interests and the plans of the different actors, it is needed a planning approach considering the overview of both the actual and future situation.</td>
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<td></td>
<td>The concept of sustainable development in spatial planning leads necessarily to an efficient management of the resources, especially regarding the resource land. The basics of this important discipline will be the subject of this lecture, which is therefore organised in three parts:</td>
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<td></td>
<td>- Inner development</td>
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<td></td>
<td>- Integrated spatial and infrastructure development</td>
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<td></td>
<td>- Cross-border issues in spatial development</td>
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<td></td>
<td>Tasks of Spatial Planning and development</td>
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<td></td>
<td>Issues of local and supra-local interest</td>
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<td></td>
<td>Recurring spatial changes, impacts and key figures</td>
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<td>Formal and informal instruments and procedures in spatial planning</td>
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<td>Spatial Design - Ideas about the future</td>
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<td></td>
<td>Reasoning and assessing the situation in spatial planning</td>
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<td>Spatial planning as a sequence of decisions and interventions</td>
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<td>Process and procedures management</td>
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<td></td>
<td>Focus issues - Inner development before external development</td>
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<td></td>
<td>Focus issues - Cross-border tasks</td>
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<tr>
<td></td>
<td>Focus Issues - Integrated spatial and infrastructure development</td>
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<td></td>
<td>Further information and the documents for the lecture can be found on the homepage of the Chair of Spatial Development.</td>
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<tr>
<td>103-0347-00L</td>
<td>Landscape Planning and Environmental Systems</td>
<td>O</td>
<td>3</td>
<td>2V</td>
<td>A. Grêt-Regamey</td>
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<td></td>
<td>Only for master students, otherwise a special permission by the lecturers is required.</td>
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<td></td>
<td>In the course, methods for the identification and measurement of landscape characteristics, as well as measures and implementation of landscape planning are taught. Landscape planning is put into the context of the environmental systems (soil, water, air, climate, flora and fauna) and discussed with regard to socio-political questions of the future.</td>
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<td></td>
<td>The aims of this course are:</td>
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<td></td>
<td>1) To illustrate the concept of landscape planning, the economic relevance of landscape and nature in the context of the environmental systems (soil, water, air, climate, flora and fauna)</td>
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<td>2) To show landscape planning as an integral information system for the coordination of different instruments by illustrating the aims, methods, instruments and their functions in landscape planning.</td>
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<td>3) To show the importance of ecosystem services.</td>
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<td>4) To point out basic information about nature and landscape: Analysis and assessment of the complex interactions between landscape elements, effects of existing and foreseeable utilization of space (nature goods and services and landscape functions).</td>
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<td>5) To identify and measure the characteristics of landscape.</td>
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<td>6) Learn how to use the instrument of GIS appropriately in landscape planning.</td>
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<td>In this course, the following topics are discussed:</td>
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<td></td>
<td>- Definition of the concept of landscape</td>
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<td>- Landscape change</td>
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<td></td>
<td>- Landscape planning</td>
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<td></td>
<td>- Methods, instruments and aims of landscape planning (politics)</td>
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<td></td>
<td>- Socio-political questions of the future</td>
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<td></td>
<td>- Environmental systems, IUCN Red List, ecological connectivity</td>
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<td></td>
<td>- Urban landscape services</td>
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<td></td>
<td>- Practice of landscape planning</td>
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<td></td>
<td>- Use of GIS in landscape planning</td>
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<tr>
<td></td>
<td>No script. The documentation, consisting of presentation slides are partly handed out and are provided for download on the PLUS website.</td>
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<td></td>
<td>The contents of the course will be illustrated in the associated lecture 103-0347-01 U (Landscape Planning and Environmental Systems (GIS Exercises)). An combination of courses is recommended.</td>
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</tbody>
</table>
In the first semester an introduction to the discipline and the methods are given along the thematic issues from the beginning of urban culture until the mid-19th century.

Prerequisites:
- Site and market analysis
- Real estate development
- Project development from the perspective of project developers and investors
- Parking and transportation models
- Cooperative planning, participation processes, mediation

The theory is discussed and illustrated at case studies and exercises. Specific large-scale projects that are currently in the development phase will be discussed, for example the area Sihl-Manegg in Zurich (GreenCity) or the area Alter Pilatusmarkt (Niedfeld) Luzern. For one specific industrial wasteland area the students will develop a vision for a possible redevelopment and a new land-use concept, which will be discussed with experts.

Objective
- Lecturers:
  - M. Nollert

Content
- The subjects are:
  - Site and market analysis
  - Real estate development
  - Project development from the perspective of project developers and investors
  - Parking and transportation models
  - Cooperative planning, participation processes, mediation

The lecture covers the time from the beginning of urban culture until the mid 19th century. With selected examples it emphasizes on the Site and Project Development.

Prerequisites:
- History of Urban Design from antiquity to the 19th century

Content
- Important illustrations showed and the names and dates of the buildings and its builders along with a short introductory note.
- Urban design (HIL D 75.2) at the price of CHF 30.-. The script serves as an auxiliary means to the attended lecture compiling the most important illustrations showed.

Objectives of the lecture are:
1. Get knowledge of comprehensive and multifunctional large-scale projects and their area problems
2. Get deepened knowledge in selected fields (site analysis, market analysis, project development, cooperative planning, participation processes)
3. Practical orientation, insight into occupational fields
4. Independent acquirement and acquisition of theoretical knowledge

The lecture consists of several modules. The main focus is on site and project development questions in relation to recycling of industrial wasteland. Technical presentations, lectured by scientific staff of the division of Planning of Landscape and Urban Systems PLUS as well as well guest referees treat different subjects.

Abstract
- The main focus of the lecture is on site and project development questions in relation to recycling of industrial wasteland. A semester exercise covers a specific major project and serves as the semester grade (project report and presentation).

Objective
- The participants know the interdependencies between the assessment of a situation, decision making, knowledge and language. They know the nature of a decision dilemma und maximes, how to deal with it. Especially they learn that the requirement of information for a decision depends upon the preferences of the deciding acteur. They are also familiar with difficulties and pitfalls within these contexts and know what can be done against it.

Content
- Assessment of the situation, deciding, language and knowledge are the main parts.

Lecturer:
- G. Nussbaumer

Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
103-0337-00L | Site and Project Development | W | 3 credits | 2G | G. Nussbaumer
103-0417-02L | Theory and Methodology of Spatial Planning | W | 3 credits | 2G | M. Nollert
051-0363-00L | History of Urban Design I | W | 2 credits | 2G | V. Magnago Lampugnani
051-0363-00L | History of Urban Design II | W | 3 credits | 2G | V. Magnago Lampugnani

Download: http://www.irl.ethz.ch/plus/education

Lecture notes
- Handouts of the lectures
- Extracts from relevant scientific articles and theory literature
- Exercise material

Literature
- Further recommended literature to consult is listed within the script.
<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
<th>Type</th>
<th>Instructor</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0707-00L</td>
<td>Space Planning Law and Environment</td>
<td>2</td>
<td>W</td>
<td>O. Bucher</td>
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<tr>
<td></td>
<td>Particularly suitable for students of D-ARCH, D-BAUG, D-USYS</td>
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<tr>
<td>Abstract</td>
<td>System of swiss planning law, Constitutional and statutory provisions, Space planning and fundamental rights, Instruments, Application, legal protection, enforcement, Practical training.</td>
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<tr>
<td>Objective</td>
<td>Basic understanding of nature and function of space planning from a legal point of view. Basic knowledge of space planning instruments, relationship between space planning and constitutional law (especially property rights), solving of practical cases.</td>
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<tr>
<td>103-0327-00L</td>
<td>History of Spatial Planning</td>
<td>1</td>
<td>W</td>
<td>M. Koll-Schretzenmayr</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course examines the patterns of cleavage, conflict, convergence of interest, and consensus that have structured spatial planning.</td>
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<tr>
<td>Objective</td>
<td>This course aims to provide students with knowledge of the historical background to understand the current spatial structure and to face the current challenges in spatial planning. Social, cultural, and economic forces will be analyzed for the roles they have played in shaping the landscapes and cityscapes and the answers spatial planning had to spatial development. The course focuses on the history of planning ideas, paradigms and approaches. A link is made to current challenges in spatial planning.</td>
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<tr>
<td>Content</td>
<td>Die Veranstaltung gibt einen Überblick über die Geschichte der Raumplanung. Sie möchte das Verständnis für die Ideengeschichte wecken und den historischen Kontext für die gegenwärtige Raumplanung und Raumstruktur vermitteln.</td>
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<tr>
<td>103-0569-00L</td>
<td>European Aspects of Spatial Development</td>
<td>3</td>
<td>W</td>
<td>A. Peric Momcilovic</td>
</tr>
<tr>
<td>Abstract</td>
<td>Following the insight into historical perspective and contemporary models of governance and planning, the course focuses on the international dimension of spatial planning in Europe. This includes a discussion of how European spatial policy is made and by whom, how planners can participate in such process and how they can address transnational challenges of spatial development cooperatively.</td>
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<tr>
<td>Objective</td>
<td>Keeping the general aim of exploring the European dimension of spatial planning in mind, the specific course learning objectives are as follows:</td>
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<td></td>
<td>- to interpret the history of spatial planning at the transnational scale</td>
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<td>- to understand and explain the content of the European spatial policy agenda</td>
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<td>- to describe and analyse the role of territorial cooperation in making European spatial development patterns and planning procedures</td>
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<td></td>
<td>- to discuss the changing role of planners and evaluate the ways of their engagement in European spatial policy-making</td>
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<tr>
<td>Content</td>
<td>- European spatial policy agenda: introduction and basic directives</td>
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<td></td>
<td>- governance models</td>
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<td></td>
<td>- planning models; collaborative planning model (main concepts &amp; critics)</td>
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<td></td>
<td>- post-positivist approach to spatial planning</td>
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<td>- transnational spatial planning in Europe; questioning the European spatial planning; spatial development trends in Europe</td>
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<td>- EU as a political system: EU institutions &amp; non-EU actors</td>
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<td>- planning families in Europe; the European spatial planning agenda</td>
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<td></td>
<td>- spatial planning strategies and programmes on territorial cooperation</td>
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<td></td>
<td>- the notion of planning culture and planning system; planning cultures in Europe</td>
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<td></td>
<td>- basic characteristics of planning systems in Europe</td>
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<td></td>
<td>- the relevance of European transnational cooperation for spatial planning</td>
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<tr>
<td></td>
<td>- European transnational initiatives: CODE 24 (Rotterdam-Genoa), Orient/east-Med corridor (Hamburg-Athens), Danube region</td>
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</tr>
<tr>
<td>Lecture notes</td>
<td>The documents for the lecture will be provided at the moodle, <a href="https://moodle-app2.let.ethz.ch/course/view.php?id=2298">https://moodle-app2.let.ethz.ch/course/view.php?id=2298</a>.</td>
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</tbody>
</table>
This course will:
- Provide hands-on training in the use of these spatial tools in R while addressing real planning problems.
- Introduce students to techniques and issues associated with spatial modeling and decision support systems, including analytical techniques that are unique to spatial analysis.
- Teach the integration of spatial data into multicriteria decision-making systems.

Prerequisites / notice

Only for master students, otherwise a special permission by the lecturer is required.

### Major in Landscape and Environmental Planning

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>103-0307-00L</td>
<td>Multi-Criteria Decision Analysis</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>A. Grêt-Regamey</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>Planners need to make decisions about the best possible mix of land uses. With increasing availability of spatial databases and the analytical capabilities of GIS, more effective decision support systems can be developed. The goal of the course is to provide the basics of spatial analysis and to teach the integration of spatial data into multicriteria decision-making systems.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>This course will: 1) introduce students to techniques and issues associated with spatial modeling and decision support systems, including analytical techniques that are unique to spatial analysis; 2) provide hands-on training in the use of these spatial tools in R while addressing real planning problems.</td>
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</tr>
<tr>
<td><strong>Lecture notes</strong></td>
<td>Handouts of the lectures; script; exercise material</td>
<td></td>
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</tr>
<tr>
<td><strong>Prerequisites / notice</strong></td>
<td>Download: <a href="http://www.irit.ethz.ch/plus/education">http://www.irit.ethz.ch/plus/education</a></td>
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<tr>
<td>103-0347-01L</td>
<td>Landscape Planning and Environmental Systems (GIS W Exercises)</td>
<td>W</td>
<td>3 credits</td>
<td>2U</td>
<td>A. Grêt-Regamey, S. Huber, S.E. Rabe, A. Strith</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>The course content of the lecture Landscape Planning and Environmental Systems (103-0347-00 V) will be illustrated.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>To show the importance of ecosystem services. Analysis and assessment of the complex interactions between landscape elements. To identify and measure the characteristics of landscapes. Learn how to use the instrument of GIS appropriately in landscape planning.</td>
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<tr>
<td><strong>Content</strong></td>
<td>Environmental systems, IUCN Red List, ecological connectivity; Calculating urban landscape services; Practice of landscape planning; Use of GIS in landscape planning; Modelling; Landscape analysis; Landscape metrics</td>
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<tr>
<td><strong>Lecture notes</strong></td>
<td>No script. The documentation, consisting of presentation slides are partly handed out and are provided for download on the PLUS website.</td>
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<tr>
<td><strong>Literature</strong></td>
<td>Will be named in the lecture.</td>
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<tr>
<td><strong>Prerequisites / notice</strong></td>
<td>Basic GIS skills are recommended. A brief introduction to GIS will be given in the first exercise.</td>
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</table>

| 851-0707-00L | Space Planning Law and Environment | W    | 2 credits | 2G     | O. Bucher |
| ** Particularly suitable for students of D-ARCH, D-BAUG, D- |
### 701-0565-00L Fundamentals of Natural Hazards Management

**Abstract**

Risks to life and human assets result when settlement areas and infrastructure overlap regions where natural hazard processes occur. This course utilizes case studies to teach how a future natural hazards-specialist should analyze, assess and manage risks.

**Literature**


**Objective**

a) propose appropriate and realistic solutions to ecosystem management problems that integrate ecological, economic and social dimensions across relevant temporal and spatial scales.

b) identify important stakeholders, their needs and interests, and the main conflicts that exist among them in the context of land and resource management.

**Content**

This course introduces the broad variety of conflicts that arise in projects focusing on sustainable management of natural resources. It explores case studies of ecosystem management approaches and considers their practicability, their achievements and possible barriers to their uptake.

This course provides an introduction to ecosystem management, and in particular the importance of integrating ecology into management systems to meet multiple societal demands. The course explores the extent to which human-managed terrestrial systems depend on underlying ecological processes, and the consequences of degradation of these processes for human welfare and environmental well-being. Building upon a theoretical foundation, the course will tackle issues in resource ecology and management, notably forests, agriculture and wild resources within the broader context of sustainability, biodiversity conservation and poverty alleviation or economic development. Case studies from tropical and temperate regions will be used to explore these issues. Dealing with ecological and economic uncertainty, and how this affects decision making, will be discussed. Strategies for conservation and management of terrestrial ecosystems will give consideration to landscape ecology, protected area systems, and community management, paying particular attention to alternative livelihood options and marketing strategies of common pool resources.
The course provides methods and tools for ecological evaluations dealing with nature conservation or landscape planning. It covers census methods, ecological criteria, indicators, indices and critically appraises objectivity and accuracy of the available methods, tools and procedures. Birds and plants are used as main example guiding through different case studies.

### Literature

Basic literature and references are listed on the webpage. Powerpoint slides are available on the webpage. Additional documents are handed out as copies.

### Prerequisites / notice

Prerequisites for attending this course are skills and knowledge equivalent to those taught in the following ETH courses:

- Pflanzen- und Vegetationsökologie
- Systematische Botanik
- Raum- und Regionalentwicklung
- Naturschutz und Stadtbiökologie

### Major in Transport Planning

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>401-0647-00L</td>
<td>Introduction to Mathematical Optimization</td>
<td>W</td>
<td>5</td>
<td>2V+1U</td>
<td>D. Adjiashvili</td>
</tr>
<tr>
<td>Abstract</td>
<td>Introduction to basic techniques and problems in mathematical optimization, and their applications to problems in engineering.</td>
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<tr>
<td>Objective</td>
<td>The goal of the course is to obtain a good understanding of some of the most fundamental mathematical optimization techniques used to solve linear programs and basic combinatorial optimization problems. The students will also practice applying the learned models to problems in engineering.</td>
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<tr>
<td>Content</td>
<td>Topics covered in this course include:</td>
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<td></td>
<td>- Linear programming (simplex method, duality theory, shadow prices, ...).</td>
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<td></td>
<td>- Basic combinatorial optimization problems (spanning trees, network flows, knapsack problem, ...).</td>
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<tr>
<td></td>
<td>- Modelling with mathematical optimization: applications of mathematical programming in engineering.</td>
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</table>

### Lecture notes

The slides of the lecture are provided electronically.

### Literature

Abstract

The first part of the course will present some basic principles of transportation economics, applied to the main issues in urban transport policy (e.g. road pricing, public transport tariffs, investment in infrastructure etc.). The second part of the course will consider some case studies where we will apply the tools acquired in the first part to actual policy issues.

Objective

The main objective of this course is to provide students with some basic tools to analyze transport policy decisions from an economic perspective. Can economics help us reduce road congestion problems? Should drivers be asked to pay for using urban roads? Should public transport tariffs depend on how roads are priced? How should the investment in transport infrastructure be financed? These are some of the questions that students should be able to tackle after completing the course.

Content

COURSE OUTLINE (preliminary):

1. Introduction
2. Travel demand:
   a. travel cost and value of time
   b. mode choice
3. Road congestion and first-best pricing
   a. Static congestion model
   b. Dynamic congestion models
   c. Examples: London Congestion Charge, Stockholm Congestion Charge
4. Second-best pricing
   a. Pricing roads with unpriced alternatives. Examples: tolled and toll-free highways
   b. Public transport: pricing with road congestion and with (or without) road tolls
5. Investment in infrastructure: public transport and roads
   a. Roads: Investment with and without pricing
   b. induced demand
   c. Economies of scale/density in public transport
6. Topics:
   a. Political economy of road pricing: why do we see road pricing in so few cities (London, Stockholm...) and not in many other cities (NYC, Manchester, Paris...)?
   b. What are the alternatives to road pricing to reduce congestion? Parking tariffs, traffic regulation (speed bumps, low emission zones), road space reduction. Examples: Zurich, San Francisco (SF-Park), Paris.
   c. Transport and land use: value of housing and transport services. Road congestion, transport subsidies and urban sprawl.

Lecture notes

Course slides will be made available to students prior to each class.

Literature

SYLLABUS (preliminary):

course slides will be made available to students.

Additional material:

Part 1 to 5: textbook: Small and Verhoef (The economics of urban transportation, 2007).

Part 6: Topics to be covered on research papers/case studies.

Major in Transport Systems

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>101-0427-01L</td>
<td>System and Network Planning</td>
<td>W</td>
<td>6</td>
<td>4G</td>
<td>U. A. Weidmann</td>
</tr>
<tr>
<td>Abstract</td>
<td>Public transport in the context of the transport systems; customer needs in the transport market; service planning processes for regular public transport services; long distance, regional and urban public transport service strategies; access to public transport and the last mile.</td>
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<tr>
<td>Objective</td>
<td>Students will develop a basic knowledge of all stages of the public transport planning process from market demand to service planning; they will understand the most relevant planning methods and will be able to use them.</td>
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<tr>
<td>Content</td>
<td>(1) Fundamentals of system and network planning: Mobility and transport systems; public transport systems; customer needs versus supply characteristics of regular services. (2) System and network planning in public passenger services: Goals of the system and network planning; generic planning process; demarcation, analysis of the situation, setting of targets; design of public transport services; evaluation and optimization; system planning. (3) Public transport services: long distance service offers; suburban and urban service offers; regional and local service offers; access to public transport and the last mile.</td>
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<tr>
<td>Lecture notes</td>
<td>A script in German will be provided for the course. The slides are made available.</td>
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<tr>
<td>Literature</td>
<td>References to technical literature will be included in the course script. An additional list of literature will be given during the course.</td>
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<td>Prerequisites / notice</td>
<td>No remarks.</td>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>101-0499-00L</td>
<td>Basics in Air Transport</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>P. Wild</td>
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<tr>
<td>Abstract</td>
<td>The course explains main principles of air transport in general and elaborates on simple interdisciplinary topics. Since working on broad topics like aerodynamics, manufacturers, airport operation, business aviation, business models etc. the students gets a good overview in air Transportation.</td>
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<td>Objective</td>
<td>Understand and explain basics, principles and contexts in the broader air transport industry. Lay the foundation of working in or with the air transport industry.</td>
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<tr>
<td>Content</td>
<td>Weekly: 1h independent preparation; 2h lectures and 1 h training with an expert in the respective field</td>
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<tr>
<td>Concept</td>
<td>Concept: This course will be taught as Aviation I. A subsequent course is under evaluation.</td>
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<tr>
<td>Lecture notes</td>
<td>Examination: written, 60 min, open books (Examination in German; Answers may be given in English)</td>
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<tr>
<td>Literature</td>
<td>Literature will be provided by the lecturers respective there will be additional Information upon registration</td>
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<tr>
<td>Prerequisites / notice</td>
<td>We will also use English papers</td>
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Traffic Engineering

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Data: 06.03.2019 12:57  Autumn Semester 2016  Page 1286 of 1571
COURSE OUTLINE (preliminary):
SYLLABUS (preliminary):
The main objective of this course is to provide students with some basic tools to analyze transport policy decisions from an economic perspective. Can economics help us reduce road congestion problems? Should drivers be asked to pay for using urban roads? Should public transport tariffs depend on how roads are priced? How should the investment in transport infrastructure be financed? These are some of the questions that students should be able to tackle after completing the course.

Content:
Introduction to fundamentals of traffic flow theory and operations. Includes understanding of traffic data collection and processing techniques, as well as data analysis, and traffic modeling.

Lecture notes:
The lecture notes and additional handouts will be provided during the lectures.

Literature:
Additional literature recommendations will be provided during the lectures.

Prerequisites / notice:
Verkehr III - Road Transport Systems 6th Sem. BSc (101-0415-00L)
Special permission from the instructor can be requested if the student has not taken Verkehr III

701-0963-00L Energy and Mobility W 3 credits 2G P. J. de Haan van der Weg M. Müller
Abstract:
The lecture Energy and Mobility imparts profound knowledge on how to reduce energy in mobility systems. Both Engineering science and social science aspects are integrated, as technological potentials, policy tools, and human decision making behaviour are combined in order to assess how to reduce energy demand for transport.

Objective:
The main objectives of this lecture are:
(i) Students gain profound knowledge on how to frame problems related to the reduction of energy demand (or greenhouse gas emissions) of mobility (sub-)systems.
(ii) Students have an overview on the most relevant technological potentials (fuel-based and vehicle-based).
(iii) Students can assess whether a given reduction goal is ambitious or not, and whether given policy tools are adequate to reach the defined reduction goal.

Content:
The lecture Energy and Mobility deals with the intersection of energy and transportation with focus on motorized individual transport. The lecture deals with the question, how the energy demand, or greenhouse gas emissions, of mobility can be reduced. A five step approach provides a common framework:
a) Status quo and Scope: Definition of the system boundary (whole transport system, or only road transport) and of the status quo of that system (energy demand and energy carrier mix for this system, current technology mix, transportation services provided);
b) Trends and Targets: Analysis of trend development of the mobility system under consideration, establishment of a trend scenario (baseline scenario): Definition of the reduction targets (expressed in terms of energy demand or greenhouse gas emissions; base year and target year; absolute or relative reduction target)
c) Potential Analysis: Analysis of currently employed technologies and of upcoming technologies. Identification of the reduction potential of current, conventional technologies and of future, alternative technologies. Technologies cover both the fuel and the vehicle side.
d) Policy Measures: Possible policy measures, direct, indirect and macro-level effects of policies, psychological aspects of decision making, elements of behavioral economics and prospect theory, combination of policies into policy mixes.
e) Effects and Side Effects: Forecasting the effects of policy measures, differentiation between effects that can be quantified and those that cannot. Identification of unintended (side) counter-effects like rebound effects and perverse incentives.

363-1047-00L Economics of Urban Transportation W 3 credits 2G A. Russo
Abstract:
The first part of the course will present some basic principles of transportation economics, applied to the main issues in urban transport policy (e.g. road pricing, public transport tariffs, investment in infrastructure etc.). The second part of the course will consider some case studies where we will apply the tools acquired in the first part to actual policy issues.

Objective:
The main objective of this course is to provide students with some basic tools to analyze transport policy decisions from an economic perspective. Can economics help us reduce road congestion problems? Should drivers be asked to pay for using urban roads? Should public transport tariffs depend on how roads are priced? How should the investment in transport infrastructure be financed? These are some of the questions that students should be able to tackle after completing the course.

Content:
1. Introduction
2. Travel demand:
   a. travel cost and value of time
   b. mode choice
3. Road congestion and first-best pricing
   a. Static congestion model
   b. Dynamic congestion models
   c. Examples: London Congestion Charge, Stockholm Congestion Charge
4. Second-best pricing
   a. Pricing roads with unpriced alternatives. Examples: tolled and toll-free highways
   b. Public transport: pricing with road congestion and with (or without) road tolls
5. Investment in infrastructure: public transport and roads
   a. Roads: Investment with and without pricing
   b. induced demand
   c. Economies of scale/density in public transport
6. Topics:
   a. Political economy of road pricing: why do we see road pricing in so few cities (London, Stockholm...) and not in many other cities (e.g. Manchester, Paris...)?
   b. What are the alternatives to road pricing to reduce congestion? Parking tariffs, traffic regulation (speed bumps, low emission zones), road space reduction. Examples: Zurich, San Francisco (SFPark), Paris.
   c. Transport and land use: value of housing and transport services. Road congestion, transport subsidies and urban sprawl.

Lecture notes:
Course slides will be made available to students prior to each class.

Literature:
SYLLABUS (preliminary):
course slides will be made available to students.

Additional material:
Part 1 to 5: textbook: Small and Verhoef (The economics of urban transportation, 2007).
Part 6: Topics to be covered on research papers/case studies.

Infrastructure Management

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<tr>
<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>101-0579-00L</td>
<td>Infrastructure Maintenance Processes</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>B. T. Adey</td>
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</table>

Does not take place this semester.
101-0579-00L *Infrastructure Maintenance Processes* will
### Abstract
This course provides an introduction to the tools that can be used to evaluate infrastructure. In particular:
- to measure the level of service being obtained from infrastructure,
- to predict slow changes in infrastructure over time, and
- to predict fast changes in infrastructure over time, fits of monitoring.

### Objective
To equip students with tools to be used to evaluate infrastructure and the level of service being provided from infrastructure.

### Content
- Introduction
- Levels of service
- Reliability of infrastructure
- Availability and maintainability of infrastructure
- Mechanistic-empirical models
- Regression analysis
- Event trees
- Fault trees
- Markov chains
- Neural networks
- Bayesian networks

### Literature
- Appropriate reading material will be assigned when necessary.
- Stöckli P./Siegenthaler Th. (Hrsg.) Die Planerverträge, Schulthess 2013
- B. Sudret, D. Trümpy, H. Briner: Tafeln zu den Grundzügen des öffentlichen Raumplanungs-, Bau- und Umweltrechts (Vorlesungsunterlage)
- Briner: Tafeln zu den Grundzügen des öffentlichen Raumplanungs-, Bau- und Umweltrechts (Vorlesungsunterlage)
- Gauch Peter, Werkvertrag, 5. Auflage, Schulthess 2011
- D. Trümpy: Tafeln zu den Grundzügen des österreichischen Bauvertragsrechts (Vorlesungsunterlage)

### Prerequisites / notice
Basic knowledge in public and private law of civil engineering. Examples of the subjects treated: space management, conception of buildings, protection of the environment, legal procedures, standards for building technology and contracts.

### Prerequisites / notice
Basic course on probability theory and statistics.

### Literature
- S. Marelli, R. Schöbi, B. Sudret, UQLab user manual - Structural reliability (rare events estimation), Report UQLab-V0.92-107.

### Prerequisites / notice
Basic course on probability theory and statistics.

### Prerequisites / notice
All necessary materials (e.g. transparencies and hand-outs) will be distributed before class.

### Abstract
Structural reliability aims at quantifying the probability of failure of systems due to uncertainties in their design, manufacturing and environmental conditions. Risk analysis combines this information with the consequences of failure in view of optimal decision making. The course presents the underlying probabilistic modelling and computational methods for reliability and risk assessment.

### Objective
The goal of this course is to provide the students with a thorough understanding of the key concepts behind structural reliability and risk analysis. After this course the students will have refreshed their knowledge of probability theory and statistics to model uncertainties in view of engineering applications. They will be able to analyze the reliability of a structure and to use risk assessment methods for decision making under uncertain conditions. They will be aware of the state-of-the-art computational methods and software in this field.

### Content
Engineers are confronted every day to decision making under limited amount of information and uncertain conditions. When designing new structures and systems, the design codes such as SIA or Euro- codes usually provide a framework that guarantees safety and reliability. However the level of safety is not quantified explicitly, which does not allow the analyst to properly choose between design variants and evaluate a total cost in case of failure. In contrast, the framework of risk analysis allows one to incorporate the uncertainty in decision making.

The first part of the course is a reminder on probability theory that is used as a main tool for reliability and risk analysis. Classical concepts such as random variables and vectors, dependence and correlation are recalled. Basic statistical inference methods used for building a probabilistic model from the available data, e.g. the maximum likelihood method, are presented.

The second part is related to structural reliability analysis, i.e. methods that allow one to compute probabilities of failure of a given system with respect to prescribed criteria. The framework of reliability analysis is first set up. Reliability indices are introduced together with the first order-second moment method (FOSM) and the first order reliability method (FORM). Methods based on Monte Carlo simulation are then reviewed and illustrated through various examples. By-products of reliability analysis such as sensitivity measures and partial safety coefficients are derived and their links to structural design codes is shown. The reliability of structural systems is also introduced as well as the methods used to reassess existing structures based on new information.

The third part of the course addresses risk assessment methods. Techniques for the identification of hazard scenarios and their representation by fault trees and event trees are described. Risk is defined with respect to the concept of expected utility in the framework of decision making. Elements of Bayesian decision making, i.e. pre-, post- and pre-post risk assessment methods are presented.

### Lecture notes
The course also includes a tutorial using the UQlab software dedicated to real world structural reliability analysis. Slides of the lectures are available online every week. A printed version of the full set of slides is proposed to the students at the beginning of the semester.

### Literature

### Conclusion
Neural networks
Markov chains
Event trees
Regression analysis

### Notice
- to measure the level of service being obtained from infrastructure,
- to predict slow changes in infrastructure over time, and
- to predict fast changes in infrastructure over time, fits of monitoring.

### Major Courses for all Majors
103-0377-00L Introduction to the Data Analysis Software R  ■  W  1 credit  1G  A. Grêt-Regamey, M. J. Van Strien

Number of participants limited to 36.

Abstract
R is one of the most popular statistical open-source software for data analysis and data modeling. It has proved very useful for a variety of tasks commonly faced by planners, such as data preparation, exploratory analysis, model estimation or graphical display. R is also a programming language providing users with a more flexible and powerful tool for solving more complex problems.

Objective
The aim of this course is to provide participants with an introduction to the statistical open-source software R. Students will learn how to read data from files and write data to files, and how these data can be used to plot graphs and maps. Since R is a command-line software, that is, one has to type in text commands at a prompt, rather than just clicking menus and buttons, students will also learn how to write their own functions.

Content
- Reading data from files
- Creating and handling R objects such as matrices, vectors and arrays
- Plotting data: histograms, boxplots, scattered plots
- Writing data to files
- Reading raster and vector data
- Writing for- and while-loops
- Writing your own functions

Lecture notes
Handouts of the lectures and exercises will be distributed

Literature

Prerequisites / notice
The course will be held in English and no prior knowledge on R is required.

364-0517-00L Urban and Spatial Economics  W  3 credits  2V  R. H. van Nieuwkoop

Abstract
This course explores the economic factors which influence location decisions of households and firms, and it explores theories of how these decisions induce the formation of cities. The course will cover the neoclassical models of land use, concepts from the new economic geography, zoning, and transportation and traffic congestion.

Objective
The objective of the course is to provide graduate students with an understanding of the economic factors which give rise to urban spatial structure and the models which have been employed to study these processes. The course aims to help students develop an appreciation for the use of economic models in both positive and normative frameworks. We will assess both the history of thought regarding the role of markets in creating urban development, and we will read about modern theories of externalities and economic factors which induce agglomeration. The final section of the course will focus on transportation problems in urban areas and the use of economic models to assess public policy measures to deal with congestion and associated externalities.

Content
- Outline of Lectures
  - Topic 1: Why do cities exist?
  - Topic 2: The Basic Muth-Mills model
  - Topic 3: The New Economic Geography
  - Topic 4: Business demand for land and Von Thünen's model
  - Topic 5: Urban spatial structure
  - Topic 6: Land use control
  - Topic 7: City size and city growth
  - Topic 8: Traffic externalities and congestion
  - Topic 9: Public transport

Lecture notes
- Textbook
  - The new introduction to geographical economics, Steven Brakman, Harry Garretsen and Charles van Marrewijk, Cambridge.
The first part of the lecture treats the fundamentals required to deal with river engineering problems. Sampling methods for the river bed material and methods to calculate the discharge in alluvial rivers are presented. The process of river bed armoring and the principles of incipient motion, initiation of erosion as well as sediment transport (bed load, suspended load) are treated. In the second part of the lecture, the procedures to quantify the sediment budget and the morphological changes (erosion, aggradation) in river systems are explained. Furthermore, the process of natural channel formation and the different plan forms of rivers (straight, meandering, braided) are discussed. Own chapters are dedicated to the topics of channel stability, bed forms, river morphology and scour. The last part of the lecture concentrates on the design and dimensioning of river engineering works. The topics focussed on are the stabilization of banks and of the longitudinal profile of rivers.

A practical exercise (voluntary, unmarked) is offered to deepen the learned subjects. This exercise bases on field data, which are partly collected by the students on a river in nature. Besides the collection of fundamentals and field data, the exercise comprehends the calculation of the stage-discharge relationship, of the critical discharges for initiation of bed load transport and bed erosion and of the annual sediment load in a given river reach.

### Major in Transport Planning

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<th>ECTS</th>
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<th>Lecturers</th>
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<tr>
<td>101-0439-00L</td>
<td>Introduction to Economic Analysis - A Case Study</td>
<td>W</td>
<td>6</td>
<td>4G</td>
<td>K. W. Axhausen, R. Schubert</td>
</tr>
<tr>
<td>363-0445-00L</td>
<td>Production and Operations Management</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>T. Netland, P. Schönsleben</td>
</tr>
<tr>
<td>101-0491-00L</td>
<td>Agent Based Modeling in Transportation</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>F. Ciarl, M. Balac</td>
</tr>
<tr>
<td>363-0445-02L</td>
<td>Production and Operations Management (Additional Cases)</td>
<td>W</td>
<td>1</td>
<td>2A</td>
<td>T. Netland, P. Schönsleben</td>
</tr>
</tbody>
</table>

**Lecture notes**

- Lecture notes "River Engineering" (in German, 470 pages, including list of references)
- Lecture notes contain a comprehensive list of references for further reading.

**Prerequisites / notice**

- Hydrology (102-0293-AAL), Hydraulics I (101-0203-01L) and Hydraulic Engineering (101-0206-00L)

**Literature**

- F. Ciari, P. Schönsleben

**Abstract**

- The course presents cost benefit analysis and related evaluation methods in transport and introduces the survey methods used to derive the monetary values of non-market goods.

**Objective**

- Familiarity with the essential methods of project appraisal

**Content**

- Cost-Benefit Analysis; multi-criteria analysis; European guidelines; stated response methods; travel cost approach and others; Valuation of travel time savings; valuation of traffic safety

**Prerequisites / notice**

- Additional relevant readings, mostly scientific articles, will be recommended throughout the course.

**Prerequisites / notice**

- There are no strict preconditions in terms of which lectures the students should have previously attended. However, it is expected that the students have some experience with some high level programming language (i.e. C, C++, Fortran or Java). If this is not the case, attending the additional java exercises (101-0491-00U) is strongly encouraged.
JAVA Exercises
Recommended for students without JAVA skills in addition to LE101-0491-00 Agent Based Modeling in Transportation.

Abstract
This course provides the basic concepts of high level programming languages to students without previous programming training. The language used is Java. Since this course is preparatory for the course Agent Based model in Transportation, the same simulation software, MATSim, will be used for several exercises.

Objective
The objective of this course is to make the students familiar with some basic concepts of object oriented programming and to give a short introduction to the Multi-agent transport simulation (MATSim) which will be used in the lecture (Agent Based Modeling in Transportation) following this one. The programming language used in the course is Java. This course, therefore, has the main goal of providing the students without previous programming training the skills necessary for the successful completion of the Agent Based Modeling in Transportation course.

Content
The main Java concepts explained in the course are:
1) Types, Variables, Operators
2) Methods, Conditionals, Loops, Arrays
3) Objects and Classes
4) Access control, Class scope, Packages, Java API
5) Design, Debugging, Interfaces
6) Inheritance, Exceptions, File I/O

MATSim will be introduced on a basic level and its basic functionalities will be explained.
Weekly exercises will be focused on building Java knowledge through various examples using the MATSim environment.

Prerequisites / notice
Keine

### Major in Transport Systems

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0449-00L</td>
<td>Management, Marketing, Quality</td>
<td>W</td>
<td>6 credits</td>
<td>4G</td>
<td>U. A. Weidmann</td>
</tr>
<tr>
<td></td>
<td>Does not take place this semester.</td>
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</table>

Abstract
Transport and administrative policy, international and national regulation, business management of public transport companies, marketing, advertising and pricing; quality management

Objective
Comprehension of the transport and administrative policy as well as of the regulation of public transport companies. To develop a full understanding of the three important public transport system operations management processes: (1) Business management; (2) Marketing; (3) Quality control. The course will teach essential working techniques in each of these processes.

Content
(1) Transport and administrative policy: Goals of the state related to public transports, governmental activities in public transport, regulation.
(2) Business management in public transport enterprises: goals of public transport companies, goals of the business management; management of public transport on the different management levels, business organization.
(3) Marketing, advertising and pricing: Fundamentals and goals; marketing strategies and concepts in public transports; marketing tools; putting marketing into action.
(4) Quality control: Quality in transport systems; goals of quality management; structuring quality control measures; collecting quality data in an operating service; use of quality control systems for service optimization.

Lecture notes
Course notes will be provided in German. Slides will be made available.

Literature
References to technical literature will be included in the course script. An additional list of literature will be given during the course.

Prerequisites / notice
Lectures System and Network Planning as well as Systems Dimensioning and Capacity recommended.

| 101-0479-00L | Safety and Reliability of Railway Systems | W    | 3 credits | 3G    | U. A. Weidmann, A. Bomhauer-Beins, O. Fink, M. Montigel |

Abstract
Railway safety policies and safety concepts, command and control technologies for railways, optimization systems, European Train Control System, reliability availability maintainability safety (RAMS) of railway systems.

Objective
The students comprehend the main principles of safety, reliability and optimization for railway systems and understand the basic concepts of command and control technologies for railways.

Content
Railway safety strategies
- Safety in public transport
- Safety relevant characteristic of railway transport
- Safety requirements for railway transport
- Safety concepts

Command and control technologies for railway systems
- protective functions
- ensure the sequence-spacing of trains
- ensure route protection
- ensure level crossing protection
- technical realization for protective functions
- European Train Control System

RAMS for railway systems
- accident investigation methods
- RAMS standards for railways
- risk analysis and hazard control
- RAMS methods
- design principles for availability and safety
- maintenance strategies
- Life Cycle Costs (LCC)
- Human Factor
- safety in long railway tunnels

operational command/control systems
- dispatching
- operational control systems
- concepts of optimization

Lecture notes
The slides will be provided in German.
### Production and Operations Management

**Number**: 101-0492-00L  
**Type**: Lecture  
**ECTS**: 4  
**Lecturers**: H. He

**Title**: Simulation of Traffic Operations  
**Abstract**: The course introduces basics of microscopic traffic simulation, including model development, calibration, validation, data analysis, identification of strategies for improving traffic performance, and evaluation of such strategies. The modelling software used is VISSIM.

**Objective**: The objective of this course is to introduce basic concepts in microscopic traffic simulation and conduct a realistic traffic engineering project from beginning to end. The students will first familiarize themselves with microscopic traffic simulation models. They will then use a simulation for modeling and analyzing the traffic operations. The emphasis is not only on building the simulation model, but also understanding of the models behind and logically evaluating results. The final goal is to make valid and concrete engineering proposals based on the simulation model.

**Content**: In this course the students will first learn some microscopic simulation concepts and then complete a traffic engineering project with microscopic traffic simulator VISSIM.

- Microscopic simulation concepts will include:
  1) Car following models
  2) Lane change models

- Specific tasks for the project will include:
  1) Building a model with the simulator VISSIM in order to replicate and analyze the traffic conditions measured/observed.
  2) Calibrating and validating the simulation model.
  3) Redesigning/extending the model to improve the traffic performance.

**Lecture notes**: The lecture notes and additional handouts will be provided before the lectures.

**Literature**: Additional literature recommendations will be provided at the lectures.

**Prerequisites / notice**: Students need to know some basic road transport concepts. The course Road Transport Systems (Verkehr III), or simultaneously taking the course Traffic Engineering is encouraged. The course Transport Simulation (101-0438-00 G) and previous experience with VISSIM is helpful but not mandatory.

### Infrastructure Management

**Number**: 101-0419-00L  
**Type**: Lecture  
**ECTS**: 4  
**Lecturers**: U. A. Weidmann, P. Güldenapfel, M. Kohler, M. J. Manhart, further speakers

**Title**: Railway Construction and Maintenance  
**Abstract**: Track geometry including calculation and measuring as well as related data systems; interaction between track and vehicles, vehicle dynamics, stress; track construction including special features of railway bridges and tunnels; track diagnostics and forecast; track maintenance and related methods.

**Objective**: The lecture gives a deeper insight into track geometry, the interaction between track and vehicles as well as in construction and dimensioning of the track. Methods for the diagnosis of the state of the track and its forecast are shown. State-of-the-art maintenance strategies and technologies are presented.

**Content**: Track geometry including calculation and measuring as well as related data systems; interaction between track and vehicles, vehicle dynamics, stress; track construction including special features of railway bridges and tunnels; track diagnostics and forecast; track maintenance and related methods.

**Lecture notes**: The slides will be made available.

**Literature**: A list with related technical literature will be handed out.

**Prerequisites / notice**: The lecture Railway Infrastructures (Transportation II) is recommended.

### Traffic Engineering

**Number**: 101-0492-00L  
**Type**: Lecture  
**ECTS**: 4  
**Lecturers**: H. He

**Title**: Road Safety  
**Abstract**: The collection and the methods of statistical and geographical analysis of road accidents are important fundamentals of this course. Safety Aspects in design of urban roads are discussed and measures for improving the safety situation are presented. Procedures of infrastructure safety management for administrations and police are another topic.

**Objective**: Imparting knowledge base about road safety and the event of accident, presenting possibilities to increase road safety

**Content**: Accident origin, collection of road accidents, statistical (descriptive and multivariate, accident prediction models) and geographical analysis of road accidents, risk analysis and rehabilitation measures, road safety instruments for infrastructure with focus on road safety audit, Swiss and international transport policy.


Further literature: will be presented during the course.
Abstract
The course provides an introduction to the steps included in the infrastructure management process. The lectures are given by a mixture of external people in German and internal people in English.

Objective
Upon completion of the course, students will
- understand the steps required to manage infrastructure effectively,
- understand the complexity of these steps, and
- have an overview of the tools that they can use in each of the steps.

Content
- The infrastructure management process and guidelines
- Knowing the infrastructure - Dealing with data
- Establishing goals and constraints
- Establishing organization structure and processes
- Making predictions
- Selecting strategies
- Developing programs
- Planning interventions
- Conducting impact analysis
- Reviewing the process

Lecture notes
Appropriate reading / and study material will be handed out during the course.
Transparencies will be handed out at the beginning of each class.

Literature
Appropriate literature will be handed out when required.

Prerequisites / notice
The courses will be given half in English and half in German. Students should have a minimum of level B2 in both to register for the course.

Major Courses for all Majors

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>103-0377-00L</td>
<td>Introduction to the Data Analysis Software R ■</td>
<td>W</td>
<td>1</td>
<td>G</td>
<td>A. Grêt-Regamey, M. J. Van Strien</td>
</tr>
<tr>
<td></td>
<td>Number of participants limited to 36.</td>
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Abstract
R is one of the most popular statistical open-source software for data analysis and data modeling. It has proved very useful for a variety of tasks commonly faced by planners, such as data preparation, exploratory analysis, model estimation or graphical display. R is also a programming language providing users with a more flexible and powerful tool for solving more complex problems.

Objective
The aim of this course is to provide participants with an introduction to the statistical open-source software R. Students will learn how to read data from files and write data to files, and how these data can be used to plot graphs and maps. Since R is a command-line software, that is, one has to type in text commands at a prompt, rather than just clicking menus and buttons, students will also learn how to write their own functions.

Content
Reading data from files
Creating and handling R objects such as matrices, vectors and arrays
Plotting data: histograms, boxplots, scattered plots
Writing data to files
Reading raster and vector data
Writing for- and while-loops
Writing your own functions

Lecture notes
Handouts of the lectures and exercises will be distributed.

Literature
“Introduction to R” by W. N. Venables and D. M. Smith available online at http://cran.r-project.org/doc/manuals/R-intro.pdf

Prerequisites / notice
The course will be held in English and no prior knowledge on R is required.

364-0517-00L Urban and Spatial Economics W 3 credits 2V R. H. van Nieuwkoop

Abstract
This course explores the economic factors which influence location decisions of households and firms, and it explores theories of how these decisions induce the formation of cities. The course will cover the neoclassical models of land use, concepts from the new economic geography, zoning, and transportation and traffic congestion.

Objective
The objective of the course is to provide graduate students with an understanding of the economic factors which give rise to urban spatial structure and the models which have been employed to study these processes. The course aims to help students develop an appreciation for the use of economic models in both positive and normative frameworks. We will assess both the history of thought regarding the role of markets in creating urban development, and we will read about modern theories of externalities and economic factors which induce agglomeration. The final section of the course will focus on transportation problems in urban areas and the use of economic models to assess public policy measures to deal with congestion and associated externalities.

Content
Outline of Lectures
Topic 1: Why do cities exist?
Topic 2: The Basic Muth-Mills model
Topic 3: The New Economic Geography
Topic 4: Business demand for land and Von Thünen's model
Topic 5: Urban spatial structure
Topic 6: Land use control
Topic 7: City size and city growth
Topic 8: Traffic externalities and congestion
Topic 9: Public transport
**Interdisciplinary Project Work**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>101-0489-02L</td>
<td>Interdisciplinary Project</td>
<td>O</td>
<td>12</td>
<td>24A</td>
<td>B. T. Adey, M. Menendez</td>
</tr>
</tbody>
</table>

Abstract: Working on a concrete interdisciplinary task on spatial development and infrastructure systems.

Objective: Promote independent, structured and scientific work; learn to apply engineering methods; deepen the knowledge in the field of the treated task.

Content: The project work is supervised by a professor. Students can choose from different subjects and tasks.

**Electives**

The entire course programs of ETH Zurich and University Zurich are open to the students to individual selection. The students have themselves to check whether they meet the admission requirements for a course.

**Recommended Electives of Bachelor Degree Programme**

Students having enrolled for 851-0703-03 earlier (i.e. bachelor's degree programme or as additional requirement for master's degree programme) cannot enrol for this again during master's degree programme.

<table>
<thead>
<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
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</thead>
<tbody>
<tr>
<td>101-0249-00L</td>
<td>Selected Topics on Hydraulic Engineering</td>
<td>W</td>
<td>3</td>
<td>2S</td>
<td>R. Boes, I. Albayrak</td>
</tr>
</tbody>
</table>

Abstract: The lecture focuses on selected topics in hydraulic engineering, water management and aquatic ecology relating to hydropower and flood protection projects.

Objective: To deepen knowledge on special aspects in hydraulic engineering and to understand the procedures and the planning sequence of hydropower projects.

Content: Different selected topics in hydraulic engineering will be focused on, e.g. dam safety, possible problems at reservoirs like sedimentation or natural hazards by impulse waves, the hydraulics of river flows, spillways and intake structures at dams and weirs, hydropower and ecology like fish-ecological aspects at low head hydropower plants and eco-hydraulics like flow-vegetation interaction. Another focus will be put on typical approaches and procedures in the planning process of hydropower projects.

Literature: Lecture notes/handouts will be available online.

Prerequisites / notice: External speakers will present current topics and projects in Switzerland and abroad.

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<tr>
<th>Number</th>
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<th>Type</th>
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</thead>
<tbody>
<tr>
<td>103-0245-01L</td>
<td>Thematic Cartography</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>L. Hurni</td>
</tr>
</tbody>
</table>

Abstract: Thematic map types (focus on quantitative information), analysis of themes and application, base maps, generalisation

Objective: Knowing of most important thematic map types.

Content: Ability to design adequate thematic maps from statistical data.

- Terry A. Slocum, Terry et al. (2004): Thematic Cartography and Geographic Visualization. 2nd ed. Prentice Hall, ISBN 0130351237

Prerequisites / notice: Further information at http://www.karto.ethz.ch/studium/lehrangebot.html

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<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>103-0227-00L</td>
<td>Cartography III</td>
<td>W</td>
<td>5</td>
<td>4G</td>
<td>L. Hurni</td>
</tr>
</tbody>
</table>

Abstract: Basic methods, technologies, scripting, and systems for interactive web mapping projects and in the internet cartography.

Objective: Gain knowledge about basic methods, technologies, scripting, and systems for interactive web mapping projects. Assessment of existing products regarding production methods. Definition of useful methods for Web-based map projects.

Content: - Web mapping
- Web Map Services (WMS)
- User Interface design
- Symbolisation
- Programming
- JavaScript
- Debugging
- Map production using GIS data
- 3D applications in cartography

401-0625-01L Applied Analysis of Variance and Experimental Design

W 5 credits 2V+1U L. Meier

Abstract

Objective
Participants will be able to plan and analyze efficient experiments in the fields of natural sciences. They will gain practical experience by using the software R.

Content

Literature

Prerequisites / notice
The exercises, but also the classes will be based on procedures from the freely available, open-source statistical software R, for which an introduction will be held.

751-1551-00L Ressourcen- und Umweltökonomie

W 3 credits 2V L. Bretschger, A. Müller

Abstract
Relationship between economy and environment, market failure, external effects and public goods, contingent valuation, internalisation of externalities; economics of non-renewable resources, economics of renewable resources, cost-benefit analysis, sustainability, and international aspects of resource and environmental economics.

Objective
Understanding of the basic issues and methods in resource and environmental economics; ability to solve typical problems in the field using the appropriate tools, which are concise verbal explanations, diagrams or mathematical expressions.

Topics are:
Introduction to resource and environmental economics
Importance of resource and environmental economics
Main issues of resource and environmental economics
Normative basis
Utilitarianism
Fairness according to Rawls
Economic growth and environment
Externalities in the environmental sphere
Governmental internalisation of externalities
Private internalisation of externalities: the Coase theorem
Free rider problem and public goods
Types of public policy
Efficient level of pollution
Tax vs. permits
Command and Control Instruments
Empirical data on non-renewable natural resources
Optimal price development: the Hotelling-rule
Effects of exploration and Backstop-technology
Effects of different types of markets.
Biological growth function
Optimal depletion of renewable resources
Social inefficiency as result of over-use of open-access resources
Cost-benefit analysis and the environment
Measuring environmental benefit
Measuring costs
Concept of sustainability
Technological feasibility
Conflicts sustainability / optimality
Indicators of sustainability
Problem of climate change
Cost and benefit of climate change
Climate change as international ecological externality
International climate policy: Kyoto protocol
Implementation of the Kyoto protocol in Switzerland

Content
Economy and natural environment, welfare concepts and market failure, external effects and public goods, measuring externalities and contingent valuation, internalising external effects and environmental policy, economics of non-renewable resources, renewable resources, cost-benefit-analysis, sustainability issues, international aspects of resource and environmental problems, selected examples and case studies.

Lecture notes
The script and lecture material are provided at: https://moodle-app2.let.ethz.ch/course/view.php?id=140

Literature

363-0541-00L Systems Dynamics and Complexity

W 3 credits 3G F. Schweitzer, G. Casiraghi, V. Nanumyan

Abstract
Finding solutions: what is complexity, problem solving cycle.

Implementing solutions: project management, critical path method, quality control feedback loop.

Controlling solutions: Vensim software, feedback cycles, control parameters, instabilities, chaos, oscillations and cycles, supply and demand, production functions, investment and consumption

Objective
A successful participant of the course is able to:
- understand why most real problems are not simple, but require solution methods that go beyond algorithmic and mathematical approaches
- apply the problem solving cycle as a systematic approach to identify problems and their solutions
- calculate project schedules according to the critical path method
- setup and run systems dynamics models by means of the Vensim software
- identify feedback cycles and reasons for unintended systems behavior
- analyse the stability of nonlinear dynamical systems and apply this to macroeconomic dynamics
Why are problems not simple? Why do some systems behave in an unintended way? How can we model and control their dynamics? The course provides answers to these questions by using a broad range of methods encompassing systems oriented management, classical systems dynamics, nonlinear dynamics and macroeconomic modeling.

The course is structured along three main tasks:
1. Finding solutions
2. Implementing solutions
3. Controlling solutions

PART 1 introduces complexity as a system immanent property that cannot be simplified. It introduces the problem solving cycle, used in systems oriented management, as an approach to structure problems and to find solutions.

PART 2 discusses selected problems of project management when implementing solutions. Methods for identifying the critical path of subtasks in a project and for calculating the allocation of resources are provided. The role of quality control as an additional feedback loop and the consequences of small changes are discussed.

PART 3, by far the largest part of the course, provides more insight into the dynamics of existing systems. Examples come from biology (population dynamics), management (inventory modeling, technology adoption, production systems) and economics (supply and demand, investment and consumption). For systems dynamics models, the software program VENSIM is used to evaluate the dynamics. For economic models analytical approaches, also used in nonlinear dynamics and control theory, are applied. These together provide a systematic understanding of the role of feedback loops and instabilities in the dynamics of systems. Emphasis is on oscillating phenomena, such as business cycles and other life cycles.

The course deals with transdisciplinary (td) methods, concepts and their applications in the context of case studies and other problem oriented research projects. Td methods are used in research at the science-society interface and when collaborating across scientific disciplines.

Students learn to apply methods within a functional framework. The format of the course is seminar-like, interactive.

At the end of the course students should:

Know:
- Function, purpose and algorithm of a selected number of transdisciplinary methods

Understand:
- Functional application in case studies and other problem oriented projects

Be able to reflect on:
- Potential, limits, and necessity of transdisciplinary methods

Be prepared for:
- Transdisciplinary Case Study 2017

The course is recommended and helpful for students participating in the Transdisciplinary Case Study 2017.
Introduction to Law for Civil Engineering

S. Scherler

EST I (Frühjahrsemester) - Begriffen, Grundlagen, Merkmale

1 Einführung:
1.1 Geschichte und Struktur des Bahnsystems
1.2 Fahrdynamik

2 Vollbahnfahrzeuge:
2.3 Mechanik: Kasten, Drehgestelle, Lauftechnik, Adhäsion
2.2 Bremsen
2.3 Traktionsantriebssysteme
2.4 Betrieb, Instandhaltung und Komfortanlagen
2.5 Straßenbau, Steuerung und Regelung

3 Infrastruktur:
3.1 Fahrweg
3.2 Bahnstromversorgung
3.3 Sicherungsanlagen

4 Betrieb:
4.1 Interoperabilität, Normen und Zulassung
4.2 RAMS, LCC
4.3 Anwendungsbeispiele

Voraussichtlich ein oder zwei Gastreferate

Geplante Exkursionen:
Betriebszentrale SBB, Zürich Flughafen
Reparatur und Unterhalt, SBB Zürich Altstetten
Fahrzeugfertigung, Stadler Bussnang

Lecture notes
Abgabe der Unterlagen (gegen eine Schutzgebühr) zu Beginn des Semesters. Rechtzeitig eingeschriebene Teilnehmer können die Unterlagen auf Wunsch und gegen eine Zusatzgebühr auch in Farbe beziehen.

Prerequisites / notice
Dozent: Dr. Markus Meyer, Emkamatik GmbH

Voraussichtlich ein oder zwei Gastvorträge von anderen Referenten.

EST I (Herbstsemester) kann als in sich geschlossene einsemestrige Vorlesung besucht werden. EST II (Frühjahrssemester) dient der weiteren Vertiefung der Fahrzeugtechnik und der Integration in die Bahnnahverkehrsbereich.

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**851-0703-03L Introduction to Law for Civil Engineering**

W 2 credits 2V G. Hertig

**Abstract**

This class introduces students to basic features of the legal system. Questions of constitutional and administrative law, contract law, tort law, corporate law, as well as litigation are covered.

**Objective**

Introduction to fundamental questions of public and private law which serves as a foundation for more advanced law classes.

1. Public Law
   - Constitutional law: sources of law, organization of the state, fundamental rights. Administrative law: administrative decisions, organization of the administration, enforcement of administrative decisions, procedural law, basics of police, environmental and zoning law.

2. Private law

**Lecture notes**

There are ‘Lecture Notes’ (in German) for this course.

**Literature**


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**851-0733-00L Traffic Law / Traffic Commercial Law**

W 2 credits 2G S. Scherler

**Abstract**

Within the scope of the lecture "Traffic Law / Traffic Commercial Law", besides an introduction into the legal basis of the national and international traffic, the main interest will be laid on actual political and economical questions and problems with respect to traffic (e.g. financing of traffic, road pricing, rail reform, air traffic vs. environment law etc.).

**Objective**

Participants are acquiring a comprehensive summary about the system Traffic Law/Traffic Commercial Law in Switzerland. With practical exercises and subsequent detailed reviews themes and subjects of special interest to participants are being treated more thoroughly.

**Content**

Within the scope of the lecture "Traffic Law / Traffic Commercial Law", besides an introduction into the legal basis of the national and international traffic, the main interest will be laid on actual political and economical questions and problems with respect to traffic (e.g. financing of traffic, road pricing, rail reform, air traffic vs. environment law etc.). With practical exercises and subsequent detailed reviews themes and subjects of special interest to participants are being treated more thoroughly.

**Lecture notes**

Script will be distributed during the lecture.

---

**151-0757-00L Environmental Management**

W 2 credits 2G R. Züst

**Abstract**

An environmental management system has the objective to continuously improve the environmental performance of the activities, products and services of a company. The company has to introduce different management procedures. The goal of this lecture is to provide basics and specific procedure to implement the environmental dimension in the planning and decision making processes of an organisation.

**Objective**

Overview on environmental management and environmental management systems, general methods and principles.

**Content**

Introduction to environmental management / environmental management systems, energy and material flows; economical and ecological problems in industry; charakterisation of an enterprise (incl. management handbook); structur and contents of an environmental management system; overview on the ISO 14001 ff. series; methods for environmental evaluation and assessment; integrated management systems; planning methodology and life-cycle-design design; planning exampl

**Lecture notes**

Information about environmental management and environmental management systems will be provided by a CD or mail.
Advanced Environmental Assessments

Master students in Environmental Engineering choosing module Ecological Systems Design are not allowed to enrol 102-0317-00 Advanced Environmental Assessments (3KP) as already included in 102-0307-01 Advanced Environmental, Social and Economic Assessments (5KP).

Abstract
This course deepens students' knowledge of the environmental assessment methodologies and their various applications.

Objective
This course has the aim of deepening students' knowledge of the environmental assessment methodologies and their various applications. In particular, students completing the course should have the:
- Ability to judge the scientific quality and reliability of environmental assessment studies, the appropriateness of inventory data and modelling, and the adequacy of life cycle impact assessment models and factors
- Knowledge about the current state of the scientific discussion and new research developments
- Ability to properly plan, conduct and interpret environmental assessment studies
- Knowledge of how to use LCA as a decision support tool for companies, public authorities, and consumers
- Inventory developments, transparency, data quality, data completeness, and data exchange formats
- Allocation (multiooutput processes and recycling)
- Hybrid LCA methods.
- Consequential and marginal analysis
- Recent development in impact assessment
- Spatial differentiation in Life Cycle Assessment
- Workplace and indoor exposure in Risk and Life Cycle Assessment
- Uncertainty analysis
- Subjectivity in environmental assessments
- Multicriteria analysis
- Case Studies

Content
- Inventory developments, transparency, data quality, data completeness, and data exchange formats
- Allocation (multiooutput processes and recycling)
- Hybrid LCA methods.
- Consequential and marginal analysis
- Recent development in impact assessment
- Spatial differentiation in Life Cycle Assessment
- Workplace and indoor exposure in Risk and Life Cycle Assessment
- Uncertainty analysis
- Subjectivity in environmental assessments
- Multicriteria analysis
- Case Studies

Lecture notes
No script. Lecture slides and literature will be made available on the lecture homepage.

Literature
Literature will be made available on the lecture homepage.

Prerequisites / notice
Basic knowledge of environmental assessment tools is a prerequisite for this class. Students that have not done classwork in this topic before are required to read an appropriate textbook before or at the beginning of this course (e.g. Jolliet, O et al. 2016: Environmental Life Cycle Assessment. CRC Press, Boca Raton - London - New York. ISBN 978-1-4398-8766-0 (Chapters 2-5.2)).
### Transport Planning (Transportation I)

**Objective**
Upon successful completion of the course the students will be able:
- to apply the basic solving problem process,
- to develop basic mathematical models to determine optimal solutions to problems, to
to develop basic models to be used in decision making, and
- to be able to conduct basic economic and cost-benefit analyses.

All of which will improve their ability to find optimal solutions to problems in the fields of Civil Engineering, Environmental Engineering, Geomatic Engineering and Spatial Planning and Infrastructure Systems.

**Content**
- Introduction
- Problem solving process
- Optimization models
- Decision making models
- Economic analysis
- Cost-benefit analysis

**Lecture notes**
The script for the original course is in German. The English material that can be used for the virtual course is:


<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
<th>Enrolment Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0414-AAL</td>
<td>Transport Planning (Transportation I)</td>
<td>3 credits</td>
<td>Enrolment only for MSc students with a decree declaring this course unit as an additional admission requirement. Any other students (e.g. incoming exchange students, doctoral students) cannot enrol for this course unit.</td>
</tr>
<tr>
<td>101-0415-AAL</td>
<td>Railway Infrastructures (Transportation II)</td>
<td>3 credits</td>
<td>Enrolment only for MSc students with a decree declaring this course unit as an additional admission requirement. Any other students (e.g. incoming exchange students, doctoral students) cannot enrol for this course unit.</td>
</tr>
<tr>
<td>101-0514-AAL</td>
<td>Project Management</td>
<td>2 credits</td>
<td>Enrolment only for MSc students with a decree declaring this course unit as an additional admission requirement. Any other students (e.g. incoming exchange students, doctoral students) cannot enrol for this course unit.</td>
</tr>
<tr>
<td>102-0516-AAL</td>
<td>Environmental Impact Assessment</td>
<td>3 credits</td>
<td>Enrolment only for MSc students with a decree declaring this course unit as an additional admission requirement. Any other students (e.g. incoming exchange students, doctoral students) cannot enrol for this course unit.</td>
</tr>
</tbody>
</table>

**Abstract**
The course introduces the basic theories and methods of transport planning.

**Objective**
Basic theoretical links between transport, space and economic development; basic terminology; measurement and observation of travel behaviour; methods of the four stage approach; cost-benefit analysis.

**Content**
- Project completion
- Risk and Quality Management
- Project planning (Schedule, cost and resource planning)
- Project organization (Structure)
- Project leadership (Leadership, Teams)
- From strategic planning to implementation (Project phases, goals, constraints, and feasibility)
- Project planning, resource management, project controlling and on team leadership and team work.

**Lecture notes**
The relevant literature for self-studies will be announced. Course notes and slides will be provided in German in addition to this.

**Literature**

**Prerequisites / notice**
No requirements.

**Data:** 06.03.2019 12:57

**Autumn Semester 2016**

**Page:** 1299 of 1571
Landmanagement

GIS I

Know the fundamentals in geoinformation technologies for the realization, application and operation of geographic information systems in spatial planning. Attended will be the themes planning as a national responsibility, Nominal and functional environmental protection in Switzerland. Students will be able to carry out the following phases of a GIS project: data modelling, mobile data acquisition and analysis, Web applications.

Objective

- Understanding the context of spatial planning and environmental protection
- Ability to use central planning instruments and procedures for assessing the environmental impacts and risks of projects
- Ability to apply quantitative methods to assess the environmental impacts and risks of projects
- Knowledge about the process and content of an EIA
- a capacity for critical review of environmental impact assessments

Content

- Nominal and functional environmental protection in Switzerland
- Instruments of environmental protection
- Need for coordination between environmental protection and spatial planning
- Environmental Protection and environmental impact assessment
- Legal basis of the EIA
- Procedure of EIA
- Content of the EIA
- Application of the impact analysis
- Monitoring and Controlling
- View regarding the strategic environmental assessment (SEA)
- Excursions to projects obligated under the EIA

Literature


103-0233-AAL GIS I Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Abstract

Fundamentals in geoinformation technologies: database principles, including modeling of spatial information, geometric and semantic models, topology and metrics; practical training with GIS software.

Objective

Know the fundamentals in geoinformation technologies for the realization, application and operation of geographic information systems in engineering projects.

Content

- Modelling of spatial information
- Geometric and semantic models
- Topology & metrics
- Raster and vector models
- Databases
- Applications
- Labs with GIS software

Literature


103-0234-AAL GIS II Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Abstract

Advanced course in geoinformation technologies: conceptual and logical modelling of networks, 3D- and 4D-data and spatial processes in GIS; raster data structures and operations; mobile GIS; Internet and GIS; interoperability and data transfer; legal and technical foundations of spatial data infrastructures (SDI).

Objective

Students will be able to carry out the following phases of a GIS project: data modelling, mobile data acquisition and analysis, Web publication of data and integration of interoperable geospatial web services into a Spatial Data Infrastructure (SDI).

Literature

### Computer Science II

**Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.**

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

**Prerequisites / notice**

- 252-0845-00 Computer Science I (D-BAUG)

**Abstract**

Introduction to programming in Java. Procedural foundations of programming and outlook to object oriented programming. Variables, types, assignments, control structures (branch, loop), data structures, algorithms, line graphics, graphical user interface. Writing small programs.

**Objective**

- Working with a professional programming environment (Eclipse).
- The students will be able to write simple programs and to modify existing programs.

**Content**

This course offers an introduction to variables, control structures (branch, loop), algorithms and data structures, as well as an outlook to modularisation and object oriented techniques.

In the exercises students train programming skills (in the programming language JAVA), Students can solve the exercises on their own laptop or in the computer labs at ETH. The software used in this course runs on MS Windows, MacOS X and Linux.

**Literature**

- M. Akveld, R. Sperb, Analysis II, vdf
- V. I. Smirnov: A course of higher mathematics. Vol. II. Advanced calculus
- J. Stewart: Multivariable Calculus, Thomson Brooks/Cole
- L. Papula: Mathematik für Ingenieure 2, Vieweg Verlag

### Analysis II

**Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.**

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

**Prerequisites / notice**

- 406-0242-AAL

**Abstract**

Mathematical tools of an engineer

**Objective**

Mathematics as a tool to solve engineering problems, mathematical formulation of problems in science and engineering. Basic mathematical knowledge of an engineer.

**Content**


**Literature**

- Textbooks in English:
  - J. Stewart: Multivariable Calculus, Thomson Brooks/Cole
  - V. I. Smirnov: A course of higher mathematics, Vol. II. Advanced calculus
  - M. Akveld, R. Sperb, Analysis II, vdf
  - L. Papula: Mathematik für Ingenieure 2, Vieweg Verlag

### Mathematics I

**Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.**

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

**Prerequisites / notice**

- 252-0845-00 Computer Science I (D-BAUG)

**Abstract**

This course covers mathematical concepts and techniques necessary to model, solve and discuss scientific problems - notably through ordinary differential equations.

**Objective**

Mathematics is of ever increasing importance to the Natural Sciences and Engineering. The key is the so-called mathematical modelling cycle, i.e. the translation of problems from outside of mathematics into mathematics, the study of the mathematical problems (often with the help of high level mathematical software packages) and the interpretation of the results in the original environment.

**Content**

1. Linear Algebra and Complex Numbers:
   - systems of linear equations, Gauss-Jordan elimination, matrices, determinants, eigenvalues and eigenvectors, cartesian and polar forms for complex numbers, complex powers, complex roots, fundamental theorem of algebra.
   - 2. Single-Variable Calculus:
     - review of differentiation, linearisation, Taylor polynomials, maxima and minima, antiderivative, fundamental theorem of calculus, integration methods, improper integrals.
   - 3. Ordinary Differential Equations:
     - review of differentiation, linearisation, Taylor polynomials, maxima and minima, antiderivative, fundamental theorem of calculus, integration methods, improper integrals.

**Literature**

- Bretscher, O.: Linear Algebra with Applications (Pearson Prentice Hall).

**Assistance**

Tuesdays and Wednesdays 17-19h, in Room HG E 41.
Stochastics (Probability and Statistics)  4 credits  9R  M. Kalisch

Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract
Introduction to basic methods and fundamental concepts of statistics and probability theory for non-mathematicians. The concepts are presented on the basis of some descriptive examples. Learning the statistical program R for applying the acquired concepts will be a central theme.

Objective
The objective of this course is to build a solid fundament in probability and statistics. The student should understand some fundamental concepts and be able to apply these concepts to applications in the real world. Furthermore, the student should have a basic knowledge of the statistical programming language "R".

Content
From "Statistics for research" (online)
Ch 1: The Role of Statistics
Ch 2: Populations, Samples, and Probability Distributions
Ch 3: Binomial Distributions
Ch 6: Sampling Distribution of Averages
Ch 7: Normal Distributions
Ch 8: Student's t Distribution
Ch 9: Distributions of Two Variables

From "Introductory Statistics with R (online)"
Ch 1: Basics
Ch 2: The R Environment
Ch 3: Probability and distributions
Ch 4: Descriptive statistics and tables
Ch 5: One- and two-sample tests
Ch 6: Regression and correlation

Literature
- "Statistics for research" by S. Dowdy et. al. (3rd edition); Print ISBN: 9780471267355; Online ISBN: 9780471477433; DOI: 10.1002/0471477435
  From within the ETH, this book is freely available online under: http://onlinelibrary.wiley.com/book/10.1002/0471477435

  From within the ETH, this book is freely available online under: http://www.springerlink.com/content/m17578/

Introduction to Law for Civil Engineering  2 credits  4R  G. Hertig

Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract
This class introduces students to basic features of the legal system. Questions of constitutional and administrative law, contract law, tort law, corporate law, as well as litigation are covered.

Objective
Introduction to fundamental questions of public and private law which serves as a foundation for more advanced law classes.

Content
1. Public Law
   Constitutional law: sources of law, organization of the state, fundamental rights. Administrative law: administrative decisions, organization of the administration, enforcement of administrative decisions, procedural law, basics of police, environmental and zoning law.

2. Private law

Lecture notes
The posted basic Skript will be in German. Course slides will be in English and German (but for the reproduction of cases, which will be posted in the original language). Additional Introduction to Law material/ information will also be posted.

Literature
Further information is available at http://www.hertig.ethz.ch/education/grundzuege-des-rechts-fuer-baug-und-arch.html

Business Administration  2 credits  4R  B. T. Adey

Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract
Introduction to business administration
Principles of accounting and financial management
Financial planning and capital budgeting of projects
Costing systems by corporations

Objective
Prepare and analyze the financial statements of organizations
Understand the major costing systems
Establish budget and determine profitability of investment
Perform some product calculations
Content
Overview in business administration
Financial Accounting
- Balance sheet, income statement
- Accounts, double-entry bookkeeping
- Year-end closing and financial statements
Financial Management
- Financial statement analysis
- Financial planning
- Investment decisions
Management Accounting
- Full costing and marginal costing
- Product costing
- Management decisions

Literature
The script for the original course 101-0031-02 Betriebswirtschaftslehre is in German. The English material that can be used for the virtual course will be given out on an as need basis.

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<thead>
<tr>
<th>Module Code</th>
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<th>Type</th>
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<tbody>
<tr>
<td>651-3070-AAL</td>
<td>Fundamentals of Geology</td>
<td>6</td>
<td>E-</td>
</tr>
</tbody>
</table>

Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Spatial Development and Infrastructure Systems Master - Key for Type

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
</tbody>
</table>

Key for Hours

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

ECTS
European Credit Transfer and Accumulation System
Special students and auditors need special permission from the lecturers.
The primary goals of this course are (1) to introduce the most important concepts of discrete mathematics, (2) to understand and appreciate the role of abstraction and mathematical proofs, and (3) to discuss a number of applications, e.g. in cryptography, coding theory, and algorithm theory.

Digital Circuits

Contents: Linear systems - the Gaussian algorithm, matrices - LU decomposition, determinants, vector spaces, least squares - QR decomposition, linear maps, eigenvalue problem, normal forms - singular value decomposition; numerical aspects; introduction to MATLAB.

Objective: Einführung in die Lineare Algebra für Ingenieure unter Berücksichtigung numerischer Aspekte


Discrete Mathematics

Abstract: Content: Mathematical reasoning and proofs, abstraction. Sets, relations (e.g. equivalence and order relations), functions, (un-)countability, number theory, algebra (groups, rings, fields, polynomials, subalgebras, morphisms), logic (propositional and predicate logic, proof calculi).

Objective: The primary goals of this course are (1) to introduce the most important concepts of discrete mathematics, (2) to understand and appreciate the role of abstraction and mathematical proofs, and (3) to discuss a number of applications, e.g. in cryptography, coding theory, and algorithm theory.

Content: See course description.

Lecture notes: available (in english)

Digital Circuits

Abstract: Digital and analogue signals and their representation, Combinational and sequential circuits and systems, boolean algebra, K-maps. Finite state machines. Memory and computing building blocks in CMOS technology, programmable logic circuits.

Objective: Provide basic knowledge and methods to understand and to design digital circuits and systems.

Content: Digital and analogue signals and their representation. Boolean Algebra, circuit analysis and synthesis, the MOS transistor, CMOS logic, static and dynamic behaviour, tristate logic, Karnaugh-Maps, hazards, binary number systems, coding. Combinational and sequential circuits and systems (boolean algebra, K-maps, etc.). Memory building blocks and memory structures, programmable logic circuits. Finite state machines, architecture of microprocessors.

Lecture notes: Lecture notes for all lessons, assignments and solutions.


Prerequisites / notice: No special prerequisites

Computer Science I

Abstract: The course covers the fundamental concepts of computer programming with a focus on systematic algorithmic problem solving. Taught language is C++. No programming experience is required.

Objective: Primary educational objective is to learn programming with C++. When successfully attended the course, students have a good command of the mechanisms to construct a program. They know the fundamental control and data structures and understand how an algorithmic problem is mapped to a computer program. They have an idea of what happens "behind the scene" when a program is translated and executed.

Secondary goals are an algorithmic computational thinking, understanding the possibilities and limits of programming and to impart the way of thinking of a computer scientist.

Content: The course covers fundamental data types, expressions and statements, (Limits of) computer arithmetic, control statements, functions, arrays, structural types and pointers. The part on object orientiation deals with classes, inheritance and polymorphy, simple dynamic data types are introduced as examples.

In general, the concepts provided in the course are motivated and illustrated with algorithms and applications.

Lecture notes: A script written in English will be provided during the semester. The script and slides will be made available for download on the course web page.


Prerequisites / notice: From AS 2013, an admission to the exam does not any more formally require an attending of the recitation sessions. Handing in solutions to the weekly exercise sheets is thus not mandatory, but we strongly recommend it.

Examination is a one hour-long written test.
Abstract
In this lecture we treat problems in applied analysis. The focus lies on the simplest cases of three fundamental types of partial differential equations of second order: the Laplace equation, the heat equation and the wave equation.

Content
1.) Klassifizierung von PDE’s
- linear, quasilinear, nicht-linear
- elliptisch, parabolisch, hyperbolisch

2.) Quasilineare PDE
- Methode der Charakteristiken (Beispiele)

3.) Elliptische PDE
- Bsp: Laplace-Gleichung
- Harmonische Funktionen, Maximumsprinzip, Mittelwerts-Formel.
- Methode der Variablenseparation

4.) Parabolische PDE
- Bsp: Wärmeleitungsgleichung
- Bsp: Inverse Wärmeleitungsgleichung
- Methode der Variablenseparation

5.) Hyperbolische PDE
- Bsp: Wellengleichung
- Formel von d’Alembert in (1+1)-Dimensionen
- Methode der Variablenseparation

6.) Green’sche Funktionen
- Rechnen mit der Dirac-Deltafunktion
- Idee der Green’schen Funktionen (Beispiele)

7.) Ausblick auf numerische Methoden
- 5-Punkt-Diskretisierung des Laplace-Operators (Beispiele)

Literature
Zusätzliche Literatur:
Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley & Sons, Kap. 8, 11, 16 (sehr gutes Buch, als Referenz zu benutzen)
Norbert Hungerbühler, "Einführung in die partiellen Differentialgleichungen", vdf Hochschulverlag AG an der ETH Zürich.
G. Felder: Partielle Differentialgleichungen.
https://people.math.ethz.ch/~felder/PDG/

Prerequisites / notice
Prerequisites: Analysis I and II, Fourier series

Programming Techniques for Scientific Simulations I
402-0811-00L

Abstract
This lecture provides an overview of programming techniques for scientific simulations. The focus is on advanced C++ programming techniques and scientific software libraries. Based on an overview over the hardware components of PCs and supercomputer, optimization methods for scientific simulation codes are explained.

Numerical Methods for CSE
401-0663-00L

Abstract
The course gives an introduction into fundamental techniques and algorithms of numerical mathematics which play a central role in numerical simulations in science and technology. The course focuses on fundamental ideas and algorithmic aspects of numerical methods. The exercises involve actual implementation of numerical methods in C++.

Objective
* Knowledge of the fundamental algorithms in numerical mathematics
* Knowledge of the essential terms in numerical mathematics and the techniques used for the analysis of numerical algorithms
* Ability to choose the appropriate numerical method for concrete problems
* Ability to interpret numerical results
* Ability to implement numerical algorithms efficiently

Content
1. Direct Methods for linear systems of equations
2. Least Squares Techniques
3. Data Interpolation and Fitting
4. Filtering Algorithms
8. Approximation of Functions
9. Numerical Quadrature
10. Iterative Methods for non-linear systems of equations
11. Single Step Methods for ODEs
12. Stiff Integrators

Lecture notes
Lecture materials (PDF documents and codes) will be made available to participants:
[Lecture document](https://people.math.ethz.ch/~grsam/HS16/NumCSE/NumCSE16.pdf)
[Lecture Git repository](https://gitlab.math.ethz.ch/NumCSE/NumCSE)
[Tablet classroom notes](http://www.sam.math.ethz.ch/~grsam/HS16/NumCSE/NCSE16_Notes/)
[Lecture recording](http://www.video.ethz.ch/lectures/d-math/2016/autumn/401-0663-00L.html)
[Homework problems](https://people.math.ethz.ch/~grsam/HS16/NumCSE/NCSEProblems.pdf)

Literature
M. Hanke-Bourgeois "Grundlagen der Numerischen Mathematik und des wissenschaftlichen Rechnens", BG Teubner, 2002
P. Deuflhard and A. Hohmann, "Numerische Mathematik I", DeGruyter, 2002

Prerequisites / notice
The course will be accompanied by programming exercises in C++ relying on the template library EIGEN. Familiarity with C++, object oriented and generic programming is an advantage. Participants of the course are expected to learn C++ by themselves.
### Block G2

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-0603-00L</td>
<td>Stochastics (Probability and Statistics)</td>
<td>O</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>M. H. Maathuis</td>
</tr>
</tbody>
</table>

**Abstract**
This class covers the following concepts: random variables, probability, discrete and continuous distributions, joint and conditional probabilities and distributions, the law of large numbers, the central limit theorem, descriptive statistics, statistical inference, inference for normally distributed data, point estimation, and two-sample tests.

**Objective**
Knowledge of the basic principles of probability and statistics.

**Content**
Introduction to probability theory, some basic principles from mathematical statistics and basic methods for applied statistics.

**Lecture notes**
Lecture notes

**Literature**
Lecture notes

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<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>252-0834-00L</td>
<td>Information Systems for Engineers</td>
<td>O</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>R. Marti</td>
</tr>
</tbody>
</table>

**Abstract**
Foundations of information systems from a user's viewpoint. The focus is on structured data: relational databases, the data language SQL, designing relational databases. Additional topics: Information Retrieval (searching documents), and estimating their relevance and authority with respect to free-text queries; XML as a format for data exchange; Characteristics and processing of "Big Data"

**Objective**
Following the course should enable students to

1. answer non-trivial queries on existing relational databases by formulating (entry-level) SQL statements, as well as to add new database content and to update or delete existing content,  
2. formalize facts as perceived in the real world in terms of the entity-relationship model, and derive a set of normalized relations (tables) which define the structure of a relational database  
3. explain how a database management system (DBMS) essentially works and what kind of services it provides  
4. understand how a web search engine such as Google basically works  
5. know and apply the core concepts to structure and query XML-documents  
6. list the characteristics of "Big Data" and know the basics of processing "Big Data"

**Content**
Die Lehrveranstaltung vermittelt Grundlagen und Konzepte von Informationssystemen aus der Sicht eines Anwenders.

Im Zentrum stehen relationale Datenbanksysteme, die Abfrage- und Datenmanipulationssprache SQL, sowie der Entwurf bzw. die Strukturierung relationaler Datenbanken. Dieser Stoff wird auch in praktischen Übungen vertieft.

Weitere Themen sind der Umgang mit unstrukturierten und semistrukturierten Daten, die Integration von Daten aus verschiedenen autonomen Informationssystemen, sowie eine Übersicht der Architektur von Datenbanksystemen.

Inhalt:
1. Einleitung,  
2. Das Relationenmodell,  
3. Die Abfrage- und Datenmanipulationssprache SQL  
5. Architektur relationaler Datenbanksysteme.  

**Literature**
Vorlesungsunterlagen (PowerPoint Folien, teilweise auch zusätzlicher Text) werden auf der Web-Site publiziert. Der Kauf eines Buches wird nicht vorausgesetzt.


Als englischsprachiges Werk kann z.B.

A. Silberschatz, H.F. Korth, S. Sudarshan:

empfohlen werden (Umfang: 1349 Seiten).

**Prerequisites / notice**
Voraussetzung:  

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<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>401-0647-00L</td>
<td>Introduction to Mathematical Optimization</td>
<td>O</td>
<td>5 credits</td>
<td>2V+1U</td>
<td>D. Adjashvili</td>
</tr>
</tbody>
</table>

**Abstract**
Introduction to basic techniques and problems in mathematical optimization, and their applications to problems in engineering.

**Objective**
The goal of the course is to obtain a good understanding of some of the most fundamental mathematical optimization techniques used to solve linear programs and basic combinatorial optimization problems. The students will also practice applying the learned models to problems in engineering.

**Content**
Topics covered in this course include:
- Linear programming (simplex method, duality theory, shadow prices, ...).
- Basic combinatorial optimization problems (spanning trees, network flows, knapsack problem, ...).
- Modelling with mathematical optimization: applications of mathematical programming in engineering.

**Literature**
Information about relevant literature will be given in the lecture.

**Prerequisites / notice**
This course is meant for students who did not already attend the course "Mathematical Optimization", which is a more advance lecture covering similar topics and more.

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### Block G3

All course units within Block G3 are offered in the spring semester.
Students that enrol for the second year in the CSE Bachelor Programme and whose first year examination did not involve the subject “Physics I” will instead take the “Physics I and II” (402-0043-00L and 402-0044-00L) courses with performance assessment as a yearly course.

### Core Courses

<table>
<thead>
<tr>
<th>Number</th>
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<tr>
<td>402-0043-00L</td>
<td>Physics I</td>
<td>W</td>
<td>4 credits</td>
<td>3V+1U</td>
<td>T. Esslinger</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
<td></td>
<td></td>
<td>Introduction to the concepts and tools in physics with the help of demonstration experiments: mechanics of point-like and ridged bodies, periodic motion and mechanical waves.</td>
</tr>
<tr>
<td></td>
<td>Objective</td>
<td></td>
<td></td>
<td></td>
<td>The concepts and tools in physics, as well as the methods of an experimental science are taught. The student should learn to identify, communicate and solve physical problems in his/her own field of science.</td>
</tr>
<tr>
<td></td>
<td>Content</td>
<td></td>
<td></td>
<td></td>
<td>Mechanics (motion, Newton's laws, work and energy, conservation of momentum, rotation, gravitation, fluids) Periodic Motion and Waves (periodic motion, mechanical waves, acoustics).</td>
</tr>
<tr>
<td></td>
<td>Lecture notes</td>
<td></td>
<td></td>
<td></td>
<td>The lecture follows the book “Physics” by Paul A. Tipler.</td>
</tr>
<tr>
<td></td>
<td>Literature</td>
<td></td>
<td></td>
<td></td>
<td>Paul A. Tipler and Gene P. Mosca, Physics (for Scientists and Engineers), W. H. Freeman and Company</td>
</tr>
<tr>
<td></td>
<td>Prerequisites / notice</td>
<td></td>
<td></td>
<td></td>
<td>Prerequisites: Mathematics I &amp; II</td>
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</table>

### Fields of Specialization

#### Astrophysics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-7851-00L</td>
<td>Theoretical Astrophysics (University of Zurich)</td>
<td>W</td>
<td>10 credits</td>
<td>4V+2U</td>
<td>R. Teyssier</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
<td></td>
<td></td>
<td>Mind the enrolment deadlines at UZH: <a href="http://www.uzh.ch/studies/application/mobilitaet_en.html">http://www.uzh.ch/studies/application/mobilitaet_en.html</a></td>
</tr>
<tr>
<td></td>
<td>Literature</td>
<td></td>
<td></td>
<td></td>
<td>Radiative processes in the interstellar medium; stellar structure and evolution; supernovae; white dwarfs; neutron stars; black holes; planet formation</td>
</tr>
<tr>
<td></td>
<td>Prerequisites / notice</td>
<td></td>
<td></td>
<td></td>
<td>Prerequisites: Elementary atomic physics, thermodynamics, mechanics, fluid dynamics, Introduction to astrophysics (preferred but not obligatory).</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-7855-00L</td>
<td>Computational Astrophysics (University of Zurich)</td>
<td>W</td>
<td>6 credits</td>
<td>2V</td>
<td>L. M. Mayer</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
<td></td>
<td></td>
<td>Acquire knowledge of main methodologies for computer-based models of astrophysical systems, the physical equations behind them, and train such knowledge with simple examples of computer programmes</td>
</tr>
<tr>
<td></td>
<td>Objective</td>
<td></td>
<td></td>
<td></td>
<td>Acquire knowledge of main methodologies for computer-based models of astrophysical systems, the physical equations behind them, and train such knowledge with simple examples of computer programmes</td>
</tr>
<tr>
<td></td>
<td>Content</td>
<td></td>
<td></td>
<td></td>
<td>1. Integration of ODE, Hamiltonians and Symplectic integration techniques, time adaptivity, time reversibility</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>2. Large-N gravity calculation, collisionless N-body systems and their simulation</td>
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<td>3. Fast Fourier Transform and spectral methods in general</td>
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<td></td>
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<td></td>
<td>4. Eulerian Hydrodynamics: Upwinding, Riemann solvers, Limiters</td>
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<tr>
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<td></td>
<td>5. Lagrangian Hydrodynamics: The SPH method</td>
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<td></td>
<td>6. Resolution and instabilities in Hydrodynamics</td>
</tr>
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<td></td>
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<td></td>
<td>7. Initial Conditions: Cosmological Simulations and Astrophysical Disks</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>8. Physical Approximations and Methods for Radiative Transfer in Astrophysics</td>
</tr>
</tbody>
</table>
### Physics of the Atmosphere

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-0023-00L</td>
<td>Atmosphere</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>H. Wernli, E. M. Fischer, T. Peter</td>
</tr>
</tbody>
</table>

**Objective**
Understanding of basic physical and chemical processes in the atmosphere. Understanding of mechanisms of and interactions between: weather - climate, atmosphere - ocean - continents, troposphere - stratosphere. Understanding of environmentally relevant structures and processes on vastly differing scales. Basis for the modelling of complex interrelations in the atmosphere.

**Content**
Basic principles of the atmosphere, physical structure and chemical composition, trace gases, atmospheric cycles, circulation, stability, radiation, condensation, clouds, oxidation capacity and ozone layer.

**Literature**

### Chemistry

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0004-00L</td>
<td>Computer Simulation in Chemistry, Biology and Physics</td>
<td>W</td>
<td>7</td>
<td>4G</td>
<td>P. H. Hünlenberger</td>
</tr>
</tbody>
</table>

**Objective**
Introduction to computer simulation of (bio)molecular systems, development of skills to carry out and interpret computer simulations of biomolecular systems.

**Content**
Molecular models, Force fields, Boundary conditions, Electrostatic interactions, Molecular dynamics, Analysis of trajectories, Quantum-mechanical simulation, Structure refinement, Application to real systems. Exercises: Analysis of papers on computer simulation, Molecular simulation in practice, Validation of molecular dynamics simulation.

For more information: www.csms.ethz.ch/education/CSCBP

**Literature**
See: www.csms.ethz.ch/education/CSCBP

**Prerequisites / notice**
Since the exercises on the computer do convey and test essentially different skills as those being conveyed during the lectures and tested at the oral exam, the results of the exercises are taken into account when evaluating the results of the exam.

### Fluid Dynamics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0103-00L</td>
<td>Fluid Dynamics II</td>
<td>W</td>
<td>3</td>
<td>2V+1U</td>
<td>P. Jenny</td>
</tr>
</tbody>
</table>

**Objective**
Expand basic knowledge of fluid dynamics.

**Content**

**Literature**
Relevant chapters (corresponding to lecture notes) from the textbook


### Systems and Control

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0103-00L</td>
<td>Control Systems</td>
<td>W</td>
<td>6</td>
<td>2V+2U</td>
<td>F. Dörfler</td>
</tr>
</tbody>
</table>

**Objective**
Study of concepts and methods for the mathematical description and analysis of dynamical systems. The concept of feedback. Design of control systems for single input - single output and multivariable systems.
Content


Literature


Prerequisites / notice

Prerequisites: Signal and Systems Theory II.
MATLAB is used for system analysis and simulation.

227-0045-00L

Signals and Systems I

W 4 credits 2V+2U H. Bölcskei

Abstract


Objective

Introduction to mathematical signal processing and system theory.

Content


Lecture notes

Lecture notes, problem set with solutions.

Roverics

Introduction to mathematical signal processing and system theory.

Content


Lecture notes

Lecture notes, problem set with solutions.

252-0535-00L

Machine Learning

W 8 credits 3V+2U+2A J. M. Buhmann

Abstract

Machine learning algorithms provide analytical methods to search data sets for characteristic patterns. Typical tasks include the classification of data, function fitting and clustering, with applications in image and speech analysis, bioinformatics and exploratory data analysis. This course is accompanied by practical machine learning projects.

Objective

Students will be familiarized with the most important concepts and algorithms for supervised and unsupervised learning: reinforce the classification knowledge which is indispensable to solve modeling problems under uncertainty. Key concepts are the generalization ability of algorithms and systematic approaches to modeling and regularization. A machine learning project will provide an opportunity to test the machine learning algorithms on real world data.

Content

The theory of fundamental machine learning concepts is presented in the lecture, and illustrated with relevant applications. Students can deepen their understanding by solving both pen-and-paper and programming exercises, where they implement and apply famous algorithms to real-world data.

Topics covered in the lecture include:

- Bayesian theory of optimal decisions
- Maximum likelihood and Bayesian parameter inference
- Classification with discriminant functions: Perceptrons, Fisher’s LDA and support vector machines (SVM)
- Ensemble methods: Bagging and Boosting
- Regression: least squares, ridge and LASSO penalization, non-linear regression and the bias-variance trade-off
- Non parametric density estimation: Parzen windows, nearest neighbour
- Dimension reduction: principal component analysis (PCA) and beyond

Lecture notes

No lecture notes, but slides will be made available on the course webpage.

Literature


Prerequisites / notice

The course requires solid basic knowledge in analysis, statistics and numerical methods for CSE as well as practical programming experience for solving assignments.
Students should at least have followed one previous course offered by the Machine Learning Institute (e.g., CIL or LIS) or an equivalent course offered by another institution.

263-5902-00L

Computer Vision

W 6 credits 3V+1U+1A L. Van Gool, V. Ferrari, A. Geiger
### Abstract
The goal of this course is to provide students with a good understanding of computer vision and image analysis techniques. The main concepts and techniques will be studied in depth and practical algorithms and approaches will be discussed and explored through the exercises.

### Objective
The objectives of this course are:
1. To introduce the fundamental problems of computer vision.
2. To introduce the main concepts and techniques used to solve these.
3. To enable participants to implement solutions for reasonably complex problems.
4. To enable participants to make sense of the computer vision literature.

### Content
Camera models and calibration, invariant features, Multiple-view geometry, Model fitting, Stereo Matching, Segmentation, 2D Shape matching, Shape from Silhouettes, Optical flow, Structure from motion, Tracking, Object recognition, Object category recognition

### Prerequisites / notice
It is recommended that students have taken the Visual Computing lecture or a similar course introducing basic image processing concepts before taking this course.

#### 151-0563-01L Dynamic Programming and Optimal Control

<table>
<thead>
<tr>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>R. D'Andrea</td>
</tr>
</tbody>
</table>

**Abstract**
Introduction to Dynamic Programming and Optimal Control.

**Objective**
Covers the fundamental concepts of Dynamic Programming & Optimal Control.

**Content**
Dynamic Programming Algorithm; Deterministic Systems and Shortest Path Problems; Infinite Horizon Problems, Bellman Equation; Deterministic Continuous-Time Optimal Control.

**Literature**

**Prerequisites / notice**
Requirements: Knowledge of advanced calculus, introductory probability theory, and matrix-vector algebra.

#### 151-0851-00L Robot Dynamics

<table>
<thead>
<tr>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>M. Hutter, R. Siegwart, T. Stastry</td>
</tr>
</tbody>
</table>

**Abstract**
We will provide an overview on how to kinematically and dynamically model typical robotic systems such as robot arms, legged robots, rotary wing systems, or fixed wing.

**Objective**
The primary objective of this course is that the student deepens an applied understanding of how to model the most common robotic systems. The student receives a solid background in kinematics, dynamics, and rotations of multi-body systems. On the basis of state of the art applications, he/she will learn all necessary tools to work in the field of design or control of robotic systems.

**Content**
The course consists of three parts: First, we will refresh and deepen the student’s knowledge in kinematics, dynamics, and rotations of multi-body systems. In this context, the learning material will build upon the courses for mechanics and dynamics available at ETH, with the particular focus on their application to robotic systems. The goal is to foster the conceptual understanding of similarities and differences among the various types of robots. In the second part, we will apply the learned material to classical robotic arms as well as legged systems and discuss kinematic constraints and interaction forces. In the third part, focus is put on modeling fixed wing aircraft, along with related design and control concepts. In this context, we also touch aerodynamics and flight mechanics to an extent typically required in robotics. The last part finally covers different helicopter types, with a focus on quadrotors and the coaxial configuration which we see today in many UAV applications. Case studies on all main topics provide the link to real applications and to the state of the art in robotics.

**Prerequisites / notice**
The contents of the following ETH Bachelor lectures or equivalent are assumed to be known: Mechanics and Dynamics, Control, Basics in Fluid Dynamics.

### Physics

#### Number 402-0809-00L Introduction to Computational Physics

<table>
<thead>
<tr>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>W</td>
<td>8</td>
<td>2V+2U</td>
<td>H. J. Herrmann</td>
</tr>
</tbody>
</table>

**Abstract**
This course offers an introduction to computer simulation methods for physics problems and their implementation on PCs and super computers: classical equations of motion, partial differential equations (wave equation, diffusion equation, Maxwell's equation), Monte Carlo simulations, percolation, phase transitions.

**Content**

**Prerequisites / notice**
Lecture and exercise lessons in english, exams in German or in English

### Computational Finance

#### Number 401-3913-01L Mathematical Foundations for Finance

<table>
<thead>
<tr>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>W</td>
<td>4</td>
<td>3V+2U</td>
<td>E. W. Farkas, M. Schweizer</td>
</tr>
</tbody>
</table>

**Abstract**
First introduction to main modelling ideas and mathematical tools from mathematical finance

**Objective**
This course gives a first introduction to the main modelling ideas and mathematical tools from mathematical finance. It aims at a double audience: mathematicians who want to learn the modelling ideas and concepts for finance, and non-mathematicians who need an introduction to the main tools from stochastics used in mathematical finance. The main emphasis will be on ideas, but important results will be given with (sometimes partial) proofs.

**Content**
Topics to be covered include
- financial market models in finite discrete time
- absence of arbitrage and martingale measures
- valuation and hedging in complete markets
- basics about Brownian motion
- stochastic integration
- stochastic calculus: Itô's formula, Girsanov transformation, Itô's representation theorem
- Black-Scholes formula

**Lecture notes**
Lecture notes will be sold at the beginning of the course.

**Literature**
Lecture notes will be sold at the beginning of the course. Additional (background) references are given there.

**Prerequisites / notice**
Prerequisites: Results and facts from probability theory as in the book "Probability Essentials" by J. Jacod and P. Protter will be used freely. Especially participants without a direct mathematics background are strongly advised to familiarise themselves with those tools before (or very quickly during) the course. (A possible alternative to the above English textbook are the (German) lecture notes for the standard course "Wahrscheinlichkeitstheorie").

For those who are not sure about their background, we suggest to look at the exercises in Chapters 8, 9, 22-25, 28 of the Jacod/Protter book. If these pose problems, you will have a hard time during the course. So be prepared.

#### Number 401-4657-00L Numerical Analysis of Stochastic Ordinary Differential Equations

<table>
<thead>
<tr>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>W</td>
<td>6</td>
<td>3V+1U</td>
<td>A. Jentzen</td>
</tr>
</tbody>
</table>

**Alternative course title:** Computational Methods for Dynamical Systems
Quantitative Finance: Monte Carlo and Sampling Methods

Abstract
Course on numerical approximations of stochastic ordinary differential equations driven by Wiener processes. These equations have several applications, for example in financial option valuation. This course also contains an introduction to random number generation and Monte Carlo methods for random variables.

Objective
The aim of this course is to enable the students to carry out simulations and their mathematical convergence analysis for stochastic models originating from applications such as mathematical finance. For this the course teaches a decent knowledge of the different numerical methods, their underlying ideas, convergence properties and implementation issues.

Content
Generation of random numbers
Monte Carlo methods for the numerical integration of random variables
Stochastic processes and Brownian motion
Stochastic ordinary differential equations (SODEs)
Numerical approximations of SODEs
Multilevel Monte Carlo methods for SODEs
Applications to computational finance: Option valuation

Lecture notes
Lecture Notes are available in the lecture homepage (please follow the link in the Learning materials section).

Literature
P. Glassermann:
Monte Carlo Methods in Financial Engineering.

P. E. Kloeden and E. Platen:
Numerical Solution of Stochastic Differential Equations.

Prerequisites / notice
Prerequisites:
Mandatory: Probability and measure theory,
basic numerical analysis and
basics of MATLAB programming.

a) mandatory courses:
Elementary Probability,
Probability Theory I.

b) recommended courses:
Stochastic Processes.

Start of lectures: Wednesday, September 21, 2016
For more details, please follow the link in the Learning materials section.

Electromagnetics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-2037-00L</td>
<td>Physical Modelling and Simulation</td>
<td>W</td>
<td>5</td>
<td>4G</td>
<td>C. Hafner, J. Leuthold, J. Smajic</td>
</tr>
</tbody>
</table>

Abstract
This module consists of (a) an introduction to fundamental equations of electromagnetics, mechanics and heat transfer, (b) a detailed overview of numerical methods for field simulations, and (c) practical examples solved in form of small projects.

Objective
The module begins with an introduction to the fundamental equations and effects of electromagnetics, mechanics, and heat transfer. After the introduction follows a detailed overview of the available numerical methods for solving electromagnetic, thermal and mechanical boundary value problems. This part of the course contains a general introduction into numerical methods, differential and integral forms, linear equation systems, Finite Difference Method (FDM), Boundary Element Method (BEM), Method of Moments (MoM), Multiple Multipole Program (MMP) and Finite Element Method (FEM). The theoretical part of the course finishes with a presentation of multiphysics simulations through several practical examples of HF-engineering such as coupled electromagnetic-mechanical and electromagnetic-thermal analysis of MEMS.

In the second part of the course the students will work in small groups on practical simulation problems. For solving practical problems the students can develop and use own simulation programs or chose an appropriate commercial field solver for their specific problem. This practical simulation work of the students is supervised by the lecturers.

Geophysics

<table>
<thead>
<tr>
<th>Subject 1 + Subject 2</th>
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<tbody>
<tr>
<td>Subject 1 + Subject 3</td>
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<tr>
<td>Subject 2 + Subject 3</td>
</tr>
<tr>
<td>Subject 3 + Subject 4</td>
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<tr>
<td>Subject 5 + Subject 6</td>
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<tr>
<td>Subject 5 + Subject 4</td>
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</tbody>
</table>

Geophysics: Subject 1

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>651-4007-00L</td>
<td>Continuum Mechanics</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>T. Gerya</td>
</tr>
</tbody>
</table>

Abstract
In this course, students learn crucial partial differential equations (conservation laws) that are applicable to any continuum including the Earth's mantle, core, atmosphere and ocean. The course will provide step-by-step introduction into the mathematical structure, physical meaning and analytical solutions of the equations. The course has a particular focus on solid Earth applications.

Objective
The goal of this course is to learn and understand few principal partial differential equations (conservation laws) that are applicable for analysing and modelling of any continuum including the Earth's mantle, core, atmosphere and ocean. By the end of the course, students should be able to write, explain and analyse the equations and apply them for simple analytical cases. Numerical solving of these equations will be discussed in the Numerical Modelling I and II course running in parallel.
The goal of this course is for students to learn how to program numerical applications from scratch. By the end of the course, students should be able to write state-of-the-art MATLAB codes that solve systems of partial-differential equations relevant to Earth and Planetary science applications. Programming will be done in MATLAB and will use the finite-difference method and marker-in-cell technique. The course will emphasise a hands-on learning approach rather than extensive theory, and will begin with an introduction to programming in MATLAB.

Week 1: The continuity equation
Theory: Definition of a geological media as a continuum. Field variables used for the representation of a continuum. Methods for definition of the field variables. Eulerian and Lagrangian points of view. Continuity equation in Eulerian and Lagrangian forms and their derivation. 
Exercise: Computing the divergence of velocity field.

Week 2: Density and gravity
Exercise: Computing density, thermal expansion and compressibility from an equation of state.

Week 3: Stress and strain
Exercise: Analysing strain rate tensor for solid body rotation.

Week 4: The momentum equation

Week 5: Viscous rheology of rocks
Theory: Solid-state creep of minerals and rocks as the major mechanism of deformation of the Earth's interior. Dislocation and diffusion creep mechanisms. Rheological equations for minerals and rocks. Effective viscosity and its dependence on temperature, pressure and strain rate. Formulation of the effective viscosity from empirical flow laws.
Exercise: Deriving viscous rheological equations for computing effective viscosities from empirical flow laws.

Week 6: The heat conservation equation
Exercise: steady temperature profile in case of channel flow.

Week 7: Elasticity and plasticity

Weeks 5: Conservative finite differences for the momentum equation. "Free slip" and "no slip" boundary conditions. Solving momentum and continuity equations in case of variable viscosity using pressure-velocity formulation with staggered grid.

Weeks 4: Staggered grid for formulating momentum and continuity equations. Indexing of unknowns. Solving momentum and continuity equations in case of constant viscosity with stream function/vorticity formulation.

Week 3: Solving momentum and continuity equations in case of constant viscosity with stream function/vorticity formulation. Indexing of unknowns. Solving momentum and continuity equations in case of variable viscosity using pressure-velocity formulation with staggered grid.


Week 1: Introduction to the finite difference approximation to differential equations. Introduction to programming in MATLAB. Solving of 1D Poisson equation.

GRADING will be based on assignments (30%) and oral exams (70%).
Exam questions: http://www.erdw.ethz.ch/people/geophysics/tgerya/EXAM_QUESTIONS

Lecture notes
Script is available by request to taras.gerya@erdw.ethz.ch

Literature

Geophysics: Subject 2

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>651-4241-00L</td>
<td>Numerical Modelling I and II: Theory and Applications</td>
<td>W</td>
<td>6</td>
<td>4G</td>
<td>T. Gerya</td>
</tr>
</tbody>
</table>

In this 13-week sequence, students learn how to write programs from scratch to solve partial differential equations that are useful for Earth science applications. Programming will be done in MATLAB and will use the finite-difference method and marker-in-cell technique. The course will emphasise a hands-on learning approach rather than extensive theory.

The goal of this course is for students to learn how to program numerical applications from scratch. By the end of the course, students should be able to write state-of-the-art MATLAB codes that solve systems of partial-differential equations relevant to Earth and Planetary Science applications using finite-difference method and marker-in-cell technique. Applications include Poisson equation, buoyancy driven variable viscosity flow, heat diffusion and advection, and state-of-the-art thermostatic code programming. The emphasis will be on commonality, i.e., using a similar approach to solve different applications, and modularity, i.e., re-use of code in different programs. The course will emphasise a hands-on learning approach rather than extensive theory, and will begin with an introduction to programming in MATLAB.

GRADING will be based on weekly homeworks (50%) and a term project (50%) to develop an application of their choice to a more advanced level.

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### Geophysics: Subject 3

**Offered in the spring semester**

#### Seismic Tomography

**Abstract**

Seismic tomography is the science of interpreting seismic measurements (seismograms) to derive information about the structure of the Earth. The subject of this course is the formal relationship existing between a seismic measurement and the nature of the Earth, or of certain regions of the Earth, and the ways to use it, to gain information about the Earth.

**Literature**


### Geophysics: Subject 4

**Offered in the spring semester**

#### Computational Systems Biology

**Abstract**

The aim of the course is to introduce students to state-of-the-art mathematical modelling of spatio-temporal problems in biology. Students will learn how to choose from a wide range of modelling techniques and how to apply these to further our understanding of biological mechanisms. The course aims at equipping students with the tools and concepts to conduct successful research in this area; both classical as well as recent research work will be discussed.

**Literature**


### Geophysics: Subject 5

**Offered in the spring semester**

#### Spatio-Temporal Modelling in Biology

**Abstract**

This course focuses on modeling spatio-temporal problems in biology, in particular on the cell and tissue level. A wide range of mathematical techniques will be presented as part of the course, including concepts from non-linear dynamics (ODE and PDE models), stochastic techniques (SDE, Master equations, Monte Carlo simulations), and thermodynamic descriptions.

**Objective**

The aim of the course is to introduce students to state-of-the-art mathematical modelling of spatio-temporal problems in biology. Students will learn how to choose from a wide range of modelling techniques and how to apply these to further our understanding of biological mechanisms. The course aims at equipping students with the tools and concepts to conduct successful research in this area; both classical as well as recent research work will be discussed.

**Content**

1. Introduction to Modelling in Biology
2. Morphogen Gradients
3. Turing Pattern
4. Travelling Waves & Wave Pinning
5. Application Example 1: Dorso-ventral axis formation
6. Chemotaxis, Cell Adhesion & Migration
7. Introduction to Numerical Methods
8. Simulations on Growing Domains
9. Image-Based Modelling
10. Branching Processes
11. Cell-based Simulation Frameworks
12. Application Example 2: Limb Development
13. Summary

**Lecture notes**

All lecture material will be made available online.

https://www.bsse.ethz.ch/cobi/education/636-0706-00L_Spatial_Modelling_in_Biology.html

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3G Lecturers

Most problems in engineering are of nonlinear nature. The nonlinearities are caused basically due to the nonlinear material behavior, contact conditions and instability of structures. The principles of the nonlinear Finite-Element-Method (FEM) will be introduced in the scope of this lecture for treating such problems. 

Finite-Element-Methods are simulations of nonlinear processes. The ability to independently create a virtual model which describes the complex non-linear systems will be acquired. The topics covered include: Emissions of liquids and gases from containers and pipelines, evaporation from pools and vaporization of gases kept under pressure, the spread and dilution of waste gas plumes in the wind, deflagration and detonation of inflammable gases, fireballs in gases held under pressure, pollution and exhaust gases in tunnels (tunnel fires etc.).

Visualization, Simulation and Interaction - Virtual Reality II

This lecture provides deeper knowledge on the possible applications of virtual reality, its basic technology, and future research fields. The goal is to provide a strong knowledge on Virtual Reality for a possible future use in business processes. Virtual Reality can not only be used for the visualization of 3D objects, but also offers a wide application field for small and medium enterprises (SME). This could be for instance an enabling technology for net-based collaboration, the interaction of the human user with the digital environment, or the use of augmented reality systems.

The goal of the lecture is to provide a deeper knowledge of today's VR environments that are used in business processes. The technical background, the algorithms, and the applied methods are explained more in detail. Finally, future tasks of VR will be discussed and an outlook on ongoing international research is given.

Prerequisites:
Requirements: successful attendance at lectures "Fluiddynamik I und II", "Thermodynamik I und II"

Literature


Electives

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0113-00L</td>
<td>Applied Fluid Dynamics</td>
<td>W</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>J.P. Kunsch</td>
</tr>
<tr>
<td>151-0709-00L</td>
<td>Stochastic Methods for Engineers and Natural Scientists</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>D. W. Meyer-Massetti, N. Noiray</td>
</tr>
<tr>
<td>151-0317-00L</td>
<td>Visualization, Simulation and Interaction - Virtual Reality II</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>A. Kunz</td>
</tr>
<tr>
<td>151-0833-00L</td>
<td>Principles of Nonlinear Finite-Element-Methods</td>
<td>W</td>
<td>5 credits</td>
<td>2V+2U</td>
<td>N. Manopulo, B. Berisha, P. Hora</td>
</tr>
</tbody>
</table>

Prerequisites / notice

The course builds on introductory courses in Computational Biology. The course assumes no background in biology but a good foundation regarding mathematical and computational techniques.

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Content
- Fundamentals of continuum mechanics to characterize large plastic deformations
- Elasto-plastic material models
- Updated-Lagrange (UL), Euler and combined Euler-Lagrange (ALE) approaches
- FEM implementation of constitutive equations
- Element formulations
- Implicit and explicit FEM methods
- FEM formulations of coupled thermo-mechanical problems
- Modeling of tool contact and the influence of friction
- Solvers and convergence
- Modeling of crack propagation
- Introduction of advanced FE-Methods

Lecture notes
yes

Literature

Prerequisites / notice
If we will have a large number of students, two dates for the exercises will be offered.

263-5001-00L Introduction to Finite Elements and Sparse Linear System Solving

Abstract
The finite element (FE) method is the method of choice for (approximately) solving partial differential equations on complicated domains. In the first third of the lecture, we give an introduction to the method. The rest of the lecture will be devoted to methods for solving the large sparse linear systems of equations that are typical for the FE method. We will consider direct and iterative methods.

Objective
Students will know the most important direct and iterative solvers for sparse linear systems. They will be able to determine which solver to choose in particular situations.

Content
I. THE FINITE ELEMENT METHOD
   (1) Introduction, model problems.
   (2) 1D problems. Piecewise polynomials in 1D.
   (3) 2D problems. Triangulations. Piecewise polynomials in 2D.
   (4) Variational formulations. Galerkin finite element method.
   (5) Implementation aspects.

II. DIRECT SOLUTION METHODS
   (6) LU and Cholesky decomposition.
   (7) Sparse matrices.
   (8) Fill-reducing orderings.

III. ITERATIVE SOLUTION METHODS
   (9) Stationary iterative methods, preconditioning.
   (10) Preconditioned conjugate gradient method (PCG).
   (11) Incomplete factorization preconditioning.
   (12) Multigrid preconditioning.
   (13) Nonsymmetric problems (GMRES, BiCGstab).
   (14) Indefinite problems (SYMMLQ, MINRES).

Literature

Prerequisites / notice
Prerequisites: Linear Algebra, Analysis, Computational Science.
The exercises are made with Matlab.

263-3010-00L Big Data

Abstract
The key challenge of the information society is to turn data into information, information into knowledge, knowledge into value. This has become increasingly complex. Data comes in larger volumes, diverse shapes, from different sources. Data is more heterogeneous and less structured than forty years ago. Nevertheless, it still needs to be processed fast, with support for complex operations.
This combination of requirements, together with the technologies that have emerged in order to address them, is typically referred to as "Big Data." This revolution has led to a completely new way to do business, e.g., develop new products and business models, but also to do science -- which is sometimes referred to as data-driven science or the "fourth paradigm".

Unfortunately, the quantity of data produced and available -- now in the Zettabyte range (that's 21 zeros) per year -- keeps growing faster than our ability to process it. Hence, new architectures and approaches for processing it were and are still needed. Harnessing them must involve a deep understanding of data not only in the large, but also in the small.

The field of databases evolves at a fast pace. In order to be prepared, to the extent possible, to the (r)evolutions that will take place in the next few decades, the emphasis of the lecture will be on the paradigms and core design ideas, while today's technologies will serve as supporting illustrations thereof.

After visiting this lecture, you should have gained an overview and understanding of the Big Data landscape, which is the basis on which one can make informed decisions, i.e., pick and orchestrate the relevant technologies together for addressing each business use case efficiently and consistently.

This course gives an overview of database technologies and of the most important database design principles that lay the foundations of the Big Data universe. The material is organized along three axes: data in the large, data in the small, data in the very small. A broad range of aspects is covered with a focus on how they fit all together in the big picture of the Big Data ecosystem.

- physical storage (HDFS, S3)
- logical storage (key-value stores, document stores, column stores, key-value stores, data warehouses)
- data formats and models (XML, JSON, CSV, XBRL)
- data shapes and models (tables, trees, graphs, cubes)
- an overview of programming languages with a focus on their type systems (SQL, XQuery, MDX)
- the most important query paradigms (selection, projection, joining, grouping, ordering, windowing)
- paradigms for parallel processing (MapReduce) and technologies (Hadoop, Spark)
- optimization techniques (functional and declarative paradigms, query plans, rewrites, indexing)
- applications.

We will also host two guest lectures to get insights from the industry: UBS and Google.

Large scale analytics and machine learning are outside of the scope of this course.

Papers from scientific conferences and journals. References will be given as part of the course material during the semester.
Context recognition in mobile communication systems like mobile phone, smart watches and wearable computer will be studied using advanced methods from sensor data fusion, pattern recognition, statistics, data mining and machine learning.

Objective
Using internal sensors and sensors in our environment including data from the wristwatch, bracelet or internet (crowd sourcing), our ‘smart phone’ detects our context continuously, e.g. where we are, what we are doing, with whom we are together, what is our constitution, what are our needs. Based on this information our ‘smart phone’ offers us the appropriate services like a personal assistant.

Content
In the data path from the sensor level to signal segmentation to the classification of the context, advanced methods of signal processing, pattern recognition and machine learning will be applied. Sensor data generated by crowdsouring methods are integrated. The validation using MATLAB is followed by implementation and testing on a smart phone.

The main topics of the course include
- Sensor nets, sensor signal processing, data fusion, time series (segmentation, similarly measures), supervised learning (Bayes Decision Theory, Decision Trees, Random Forest, kNN-Methods, Support Vector Machine, AdaBoost, Deep Learning), clustering (k-means, dbscan, topic models), Recommender Systems, Collaborative Filtering, Crowdsourcing.

The exercises show concrete design problems like motion and gesture recognition using distributed sensors, detection of activity patterns and identification of the local environment.

Presentations of the PhD students and the visit at the Wearable Computing Lab introduce in current research topics and international research projects.

Lecture notes
Lecture notes for all lessons, assignments and solutions.
http://www.ife.ee.ethz.ch/education/wearable_systems_1

Prerequisites
No special prerequisites

227-0197-00L Wearable Systems I

Abstract
Context recognition in mobile communication systems like mobile phone, smart watches and wearable computer will be studied using advanced methods from sensor data fusion, pattern recognition, statistics, data mining and machine learning. Context comprehends the behavior of individuals and of groups, their activities as well as the local and social environment.

Objective
Using internal sensors and sensors in our environment including data from the wristwatch, bracelet or internet (crowd sourcing), our ‘smart phone’ detects our context continuously, e.g. where we are, what we are doing, with whom we are together, what is our constitution, what are our needs. Based on this information our ‘smart phone’ offers us the appropriate services like a personal assistant.

Content
In the data path from the sensor level to signal segmentation to the classification of the context, advanced methods of signal processing, pattern recognition and machine learning will be applied. Sensor data generated by crowdsouring methods are integrated. The validation using MATLAB is followed by implementation and testing on a smart phone.

The main topics of the course include
- Sensor nets, sensor signal processing, data fusion, time series (segmentation, similarity measures), supervised learning (Bayes Decision Theory, Decision Trees, Random Forest, kNN-Methods, Support Vector Machine, AdaBoost, Deep Learning), clustering (k-means, dbscan, topic models), Recommender Systems, Collaborative Filtering, Crowdsourcing.

The exercises show concrete design problems like motion and gesture recognition using distributed sensors, detection of activity patterns and identification of the local environment.

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Lecture notes
Lecture notes for all lessons, assignments and solutions.
http://www.ife.ee.ethz.ch/education/wearable_systems_1

Prerequisites
No special prerequisites

227-0447-00L Image Analysis and Computer Vision

Abstract

Objective
Overview of the most important concepts of image formation, perception and analysis, and Computer Vision. Gaining own experience through practical computer and programming exercises.

Content
The first part of the course starts off from an overview of existing and emerging applications that need computer vision. It shows that the realm of image processing is no longer restricted to the factory floor, but is entering several fields of our daily life. First it is investigated how the parameters of the electromagnetic waves are related to our perception. Also the interaction of light with matter is considered. The most important hardware components of technical vision systems, such as cameras, optical devices and illumination sources are discussed. The course then turns to the steps that are necessary to arrive at the discrete images that serve as input to algorithms. The next part describes necessary preprocessing steps of image analysis, that enhance image quality and/or detect specific features. Linear and non-linear filters are introduced for that purpose. The course will continue by analyzing procedures allowing to extract additional types of basic information from multiple images, with motion and depth as two important examples. The estimation of image velocities (optical flow) will get due attention and methods for object tracking will be presented. Several techniques are discussed to extract three-dimensional information about objects and scenes. Finally, approaches for the recognition of specific objects as well as object classes will be discussed and analyzed.

Lecture notes
Course material Script, computer demonstrations, exercises and problem solutions
This course acquaints students with core knowledge in computer graphics, image processing, multimedia and computer vision. Topics include: Graphics pipeline, perception and camera models, transformation, shading, global illumination, texturing, sampling, filtering, image representations, image and video compression, edge detection and optical flow.

<table>
<thead>
<tr>
<th>Prerequisites / notice</th>
<th>Prerequisites:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Basic concepts of mathematical analysis and linear algebra. The computer exercises are based on Linux and C. The course language is English.</td>
</tr>
</tbody>
</table>

**227-0417-00L**

*Information Theory I*

**W** 6 credits 4G  A. Lapidoth

**Abstract**

This course covers the basic concepts of information theory and of communication theory. Topics covered include the entropy rate of a source, mutual information, typical sequences, the asymptotic equi-partition property, Huffman coding, channel capacity, the channel coding theorem, the source-channel separation theorem, and feedback capacity.

**Objective**

The fundamentals of Information Theory including Shannon's source coding and channel coding theorems.

**Content**

The entropy rate of a source, Typical sequences, the asymptotic equi-partition property, the source coding theorem, Huffman coding, Arithmetic coding, channel capacity, the channel coding theorem, the source-channel separation theorem, feedback capacity.

**Literature**

T.M. Cover and J. Thomas, Elements of Information Theory (second edition)

**227-0427-00L**

*Signal and Information Processing: Modeling, Filtering, Learning*

**W** 6 credits 4G  H.A. Loeliger

**Abstract**

Fundamentals in signal processing, detection/estimation, and machine learning.

I. Linear signal representation and approximation: Hilbert spaces, LMMSE estimation, regularization and sparsity.

II. Learning linear and nonlinear functions and filters; kernel methods, neural networks.


**Objective**

The course is an introduction to some basic topics in signal processing, detection/estimation theory, and machine learning.

**Content**


**Lecture notes**

Lecture notes.

**Prerequisites / notice**

- local bachelors: course "Discrete-Time and Statistical Signal Processing" (5. Sem.)
- others: solid basics in linear algebra and probability theory

**227-0627-00L**

*Applied Computer Architecture*

**W** 6 credits 4G  A. Gunzinger

**Abstract**

This lecture gives an overview of the requirements and the architecture of parallel computer systems, performance, reliability and costs.

**Objective**

Understand the function, the design and the performance modeling of parallel computer systems.

**Content**

The lecture "Applied Computer Architecture" gives technical and corporate insights in the innovative Computer Systems/Architectures (CPU, GPU, FPGA, special processors) and their real implementations and applications. Often the designs have to deal with technical limits. Which computer architecture allows the control of the over 1000 magnets at the Swiss Light Source (SLS)? Which architecture is behind the alarm center of the Swiss Railway (SBB)? Which computer architectures are applied for driver assistance systems? Which computer architecture is hidden behind a professional digital audio mixing desk? How can data streams of about 30 TB/s, produced by a proton accelerator, be processed in real time? Can the weather forecast also be processed with GPUs? How can a good computer architecture be found? Which are the driving factors in successful computer architecture design?

**Lecture notes**

Script and exercises sheets.

**Prerequisites / notice**

- local bachelors: course "Discrete-Time and Statistical Signal Processing" (5. Sem.)
- others: solid basics in computer architecture.

**252-0206-00L**

*Visual Computing*

**W** 8 credits 4V+3U  M. Gross, O. Hilliges

**Abstract**

This course acquaints students with core knowledge in computer graphics, image processing, multimedia and computer vision. Topics include: Graphics pipeline, perception and camera models, transformation, shading, global illumination, texturing, sampling, filtering, image representations, image and video compression, edge detection and optical flow.

**Objective**

This course provides an in-depth introduction to the core concepts of computer graphics, image processing, multimedia and computer vision. The course forms a basis for the specialization track Visual Computing of the CS master program at ETH.

**Content**

Course topics will include: Graphics pipeline, perception and color models, camera models, transformations and projection, projections, lighting, shading, global illumination, texturing, sampling theorem, Fourier transforms, image representations, convolution, linear filtering, diffusion, nonlinear filtering, edge detection, optical flow, image and video compression.

In theoretical and practical homework assignments students will learn to apply and implement the presented concepts and algorithms.

**Lecture notes**

A script will be handed out for a part of the course. Copies of the slides will be available for download. We will also provide a detailed list of references and textbooks.

**Literature**


**252-0417-00L**

*Randomized Algorithms and Probabilistic Methods*

**W** 7 credits 3V+2U+1A  A. Steger, E. Welzl

**Abstract**

Las Vegas & Monte Carlo algorithms; inequalities of Markov, Chebyshev, Chernoff; negative correlation; Markov chains: convergence, rapidly mixing; generating functions; Examples include: min cut, median, balls and bins, routing in hypercubes, 3SAT, card shuffling, random walks.

**Objective**

After this course students will know fundamental techniques from probabilistic combinatorics for designing randomized algorithms and will be able to apply them to solve typical problems in these areas.

**Content**

Randomized Algorithms are algorithms that "flip coins" to take certain decisions. This concept extends the classical model of deterministic algorithms and has become very popular and useful within the last twenty years. In many cases, randomized algorithms are faster, simpler or just more elegant than deterministic ones. In the course, we will discuss basic principles and techniques and derive from them a number of randomized methods for problems in different areas.

**Lecture notes**

Yes.

**Literature**


**252-0546-00L**

*Physically-Based Simulation in Computer Graphics*

**W** 4 credits 2V+1U  B. Solenthaler, B. Thomaszewski

**Abstract**

This lecture provides an introduction to physically-based animation in computer graphics and gives an overview of fundamental methods and algorithms. The practical exercises include three assignments which are to be solved in small groups. In an additional course project, topics from the lecture will be implemented into a 3D game or a comparable application.
Objective
This lecture provides an introduction to physically-based animation in computer graphics and gives an overview of fundamental methods and algorithms. The practical exercises include three assignments which are to be solved in small groups. In an additional course project, topics from the lecture will be implemented into a 3D game or a comparable application.

Content
The lecture covers topics in physically-based modeling, such as particle systems, mass-spring models, finite difference and finite element methods. These approaches are used to represent and simulate deformable objects or fluids with applications in animated movies, 3D games and medical systems. Furthermore, the lecture covers topics such as rigid body dynamics, collision detection, and character animation.

Prerequisites / notice
Fundamentals of calculus and physics, basic concepts of algorithms and data structures, basic programming skills in C++. Knowledge on numerical mathematics as well as ordinary and partial differential equations is an asset, but not required.

401-3611-00L Advanced Topics in Computational Statistics W 4 credits 2V 2V+3U M. H. Haathuis

Does not take place this semester.

Abstract
This lecture covers selected advanced topics in computational statistics, including various classification methods, the EM algorithm, clustering, handling missing data, and graphical modelling.

Objective
Students learn the theoretical foundations of the selected methods, as well as practical skills to apply these methods and to interpret their outcomes.

Content
The course is roughly divided in three parts: (1) Supervised learning via (variations of) nearest neighbor methods, (2) the EM algorithm and clustering, (3) handling missing data and graphical models.

Lecture notes
Lecture notes.

Prerequisites / notice
We assume a solid background in mathematics, an introductory lecture in probability and statistics, and at least one more advanced course in statistics.

401-3627-00L High-Dimensional Statistics W 4 credits 2V 4V+2U P. L. Bühlmann

Does not take place this semester.

Abstract
"High-Dimensional Statistics" deals with modern methods and theory for statistical inference when the number of unknown parameters is of much larger order than sample size. Statistical estimation and algorithms for complex models and aspects of multiple testing will be discussed.

Objective
Knowledge of methods and basic theory for high-dimensional statistical inference

Content
Lasso and Group Lasso for high-dimensional linear and generalized linear models; Additive models and many smooth univariate functions; Non-convex loss functions and 1-regularization; Stability selection, multiple testing and construction of p-values; Undirected graphical modeling

Literature

Prerequisites / notice
Knowledge of basic concepts in probability theory, and intermediate knowledge of statistics (e.g. a course in linear models or computational statistics).

401-4623-00L Time Series Analysis W 6 credits 3G 2V+3U N. Meinshausen

Abstract
Statistical analysis and modeling of observations in temporal order, which exhibit dependence. Stationarity, trend estimation, seasonal decomposition, autocorrelations, spectral and wavelet analysis, ARIMA-, GARCH- and state space models. Implementations in the software R.

Objective
Understanding of the basic models and techniques used in time series analysis and their implementation in the statistical software R.

Content
This course deals with modeling and analysis of variables which change randomly in time. Their essential feature is the dependence between successive observations. Applications occur in geophysics, engineering, economics and finance. Topics covered: Stationarity, trend estimation, seasonal decomposition, autocorrelations, spectral and wavelet analysis, ARIMA-, GARCH- and state space models. The models and techniques are illustrated using the statistical software R.

Lecture notes
Not available

Literature
A list of references will be distributed during the course.

Prerequisites / notice
Basic knowledge in probability and statistics.

401-3901-00L Mathematical Optimization W 11 credits 4V+2U R. Weismantel

Abstract
Mathematical treatment of diverse optimization techniques.

Objective
Advanced optimization theory and algorithms.

Content
1. Linear optimization: The geometry of linear programming, the simplex method for solving linear programming problems, Farkas' Lemma and infeasibility certificates, duality theory of linear programming.


3. Integer optimization: Ties between linear and integer optimization, total unimodularity, complexity theory, cutting plane theory.

4. Combinatorial optimization: Network flow problems, structural results and algorithms for matroids, matchings and, more generally, independence systems.

402-2203-01L Classical Mechanics W 7 credits 4V+2U G. M. Graf

Abstract
A conceptual introduction to theoretical physics: Newtonian mechanics, central force problem, oscillations, Lagrangian mechanics, symmetries and conservation laws, spinning top, relativistic space-time structure, particles in an electromagnetic field, Hamiltonian mechanics, canonical transformations, integrable systems, Hamilton-Jacobi equation.

227-1033-00L Neuromorphic Engineering I W 6 credits 2V+3U T. Delbrück, G. Indiveri, S.C. Liu

Abstract
This course covers analog circuits with emphasis on neuromorphic engineering: MOS transistors in CMOS technology, static circuits, dynamic circuits, systems (silicon neuron, silicon retina, silicon cochlea) with an introduction to multi-chip systems. The lectures are accompanied by weekly laboratory sessions.

Objective
Understanding of the characteristics of neuromorphic circuit elements.
Neuromorphic circuits are inspired by the organizing principles of biological neural circuits. Their computational primitives are based on physics of semiconductor devices. Neuromorphic architectures often rely on collective computation in parallel networks. Adaptation, learning and memory are implemented locally within the individual computational elements. Transistors are often operated in weak inversion (below threshold), where they exhibit exponential i-V characteristics and low currents. These properties lead to the feasibility of high-density, low-power implementations of functions that are computationally intensive in other paradigms. Application domains of neuromorphic circuits include silicon retina and cochleas for machine vision and audition, real-time emulations of networks of biological neurons, and the development of autonomous robotic systems. This course covers devices in CMOS technology (MOS transistor below and above threshold, floating-gate MOS transistor, phototransducers), static circuits (differential pair, current mirror, transconductance amplifiers, etc.), dynamic circuits (linear and nonlinear filters, adaptive circuits), systems (silicon neuron, silicon retina and cochlea) and an introduction to multi-chip systems that communicate events analogous to spikes. The lectures are accompanied by weekly laboratory sessions on the characterization of neuromorphic circuits, from elementary devices to systems.

Prerequisites: Background in basics of semiconductor physics helpful, but not required.

227-1037-00L  Introduction to Neuroinformatics  W 6 credits  2V+1U  K. A. Martin, M. Cook, V. Mante, M. Pfeiffer

Abstract
The course provides an introduction to the functional properties of neurons. Particularly the description of membrane electrical properties (action potentials, channels), neuronal anatomy, synaptic structures, and neuronal networks. Simple models of computation, learning, and behavior will be explained. Some artificial systems (robot, chip) are presented.

Objective
Understanding computation by neurons and neuronal circuits is one of the great challenges of science. Many different disciplines can contribute their tools and concepts to solving mysteries of neural computation. The goal of this introductory course is to introduce the monographs of physics, maths, computer science, engineering, biology, psychology, and even philosophy and history, to discover the enchantments and challenges that we all face in taking on this major 21st century problem and how each discipline can contribute to discovering solutions.

Content
This course considers the structure and function of biological neural networks at different levels. The function of neural networks lies fundamentally in their wiring and in the electro-chemical properties of nerve cell membranes. Thus, the biological structure of the nerve cell needs to be understood if biologically-realistic models are to be constructed. These simpler models are used to estimate the electrical current flow through dendritic cables and explore how a more complex geometry of neurons influences this current flow. The active properties of nerves are studied to understand both sensory transduction and the generation and transmission of nerve impulses along axons. The concept of local neuronal circuits arises in the context of the rules governing the formation of nerve connections and topographic projections within the nervous system. Communication between neurons in the network can be thought of as information flow across synapses, which can be modulated by experience. We need an understanding of the action of inhibitory and excitatory neurotransmitters and neuromodulators, so that the dynamics and logic of synapses can be interpreted. Finally, the neural architectures of feedforward and recurrent networks will be discussed in the context of co-ordination, control, and integration of sensory and motor information in neural networks.

327-1201-00L  Transport Phenomena I  W 4 credits  4G  H. C. Öttinger

Abstract
Phenomenological approach to “Transport Phenomena” based on balance equations supplemented by thermodynamic considerations to formulate the undetermined fluxes in the local species mass, momentum, and energy balance equations; fundamentals, applications, and simulations

Objective
The teaching goals of this course are on five different levels:
(1) Deep understanding of fundamentals: local balance equations, constitutive equations for fluxes, entropy balance, interfaces, idea of dimensionless numbers, ...
(2) Ability to use the fundamental concepts in applications
(3) Insight into the role of boundary conditions
(4) Knowledge of a number of applications
(5) Flavor of numerical techniques: finite elements, finite differences, lattice Boltzmann, Brownian dynamics, ...

Content
Approach to Transport Phenomena
Diffusion Equation
Brownian Dynamics
Refreshing Topics in Equilibrium Thermodynamics
Balance Equations
Forces and Fluxes
Measuring Transport Coefficients
Pressure-Driven Flows
Driven Separations
Complex Fluids

Lecture notes
A detailed manuscript is provided; this manuscript will be developed into a book entitled "A Modern Course in Transport Phenomena" by David C. Venerus and Hans Christian Ottinger

Literature

Prerequisites / notice
Complex numbers, Vector analysis (integrability; Gauss’ divergence theorem). Laplace and Fourier transforms. Ordinary differential equations (basic ideas). Linear algebra (matrices; functions of matrices; eigenvectors and eigenvalues; eigentunctions). Probability theory (Gaussian distributions; Poisson distributions; averages; moments; variances; random variables). Numerical mathematics (integration). Equilibrium thermodynamics (Gibbs’ fundamental equation; thermodynamic potentials; Legendre transforms). Maxwell equations. Programming and simulation techniques (Matlab, Monte Carlo simulations).

Electives (CSE Master)

see also Fields of Specialization

Additional Electives from the Fields of Specialization (CSE Master)

Number  Title  Type  ECTS  Hours  Lecturers
651-4053-05L  Boundary Layer Meteorology  W 4 credits  3G  M. Rotach, P. Calanca

Abstract
The Planetary Boundary Layer (PBL) constitutes the interface between the atmosphere and the Earth's surface. Theory on transport processes in the PBL and their dynamics is provided. This course treats theoretical background and idealized concepts. These are contrasted to real world applications and current research issues.

Objective
Overall goals of this course are below. Focus is on the theoretical background and idealised concepts. Students have basic knowledge on atmospheric turbulence and theoretical as well as practical approaches to treat Planetary Boundary Layer flows. They are familiar with the relevant processes (turbulent transport, forcing) within, and typical states of the Planetary Boundary Layer. Idealized concepts are known as well as their adaptations under real surface conditions (as for example over complex topography).
Advanced, but fundamental topics central to the understanding of theory in chemistry and for solving actual chemical problems

The course provides an introduction to digital image analysis in modern flow diagnostics. Different techniques which are discussed include image velocimetry, laser induced fluorescence, liquid crystal thermography and interferometry. The physical foundations and measurement configurations are explained. Image analysis algorithms are presented in detail and programmed during the exercises.

Prerequisites / notice

Umwelt-Fluiddynamik (701-0479-00L) (environment fluid dynamics) or equivalent and basic knowledge in atmospheric science

701-1221-00L Dynamics of Large-Scale Atmospheric Flow

Abstract
Dynamic, synoptic Meteorology

Objective
Understanding the dynamics of large-scale atmospheric flow

Content
Dynamical Meteorology is concerned with the dynamical processes of the earth's atmosphere. The fundamental equations of motion in the atmosphere will be discussed along with the dynamics and interactions of synoptic system - i.e. the low and high pressure systems that determine our weather. The motion of such systems can be understood in terms of quasi-geostrophic theory. The lecture course provides a derivation of the mathematical basis along with some interpretations and applications of the concept.

Lecture notes
Dynamics of large-scale atmospheric flow

Literature
- Pichler H., Dynamik der Atmosphäre, Bibliographisches Institut, 456 pp. 1997

Prerequisites / notice

Physics I, II, Environmental Fluid Dynamics

529-0003-00L Advanced Quantum Chemistry

Abstract
Advanced, but fundamental topics central to the understanding of theory in chemistry and for solving actual chemical problems with a computer.

Examples are:
- Operators derived from principles of relativistic quantum mechanics
- Relativistic effects + methods of relativistic quantum chemistry
- Open-shell molecules + spin-density functional theory
- New electron-correlation theories

Objective
The aim of the course is to provide an in-depth knowledge of theory and method development in theoretical chemistry. It will be shown that this is necessary in order to be able to solve actual chemical problems on a computer with quantum chemical methods. The relativistic re-derivation of all concepts known from (nonrelativistic) quantum mechanics and quantum-chemistry lectures will finally explain the form of all operators in the molecular Hamiltonian - usually postulated rather than deduced. From this, we derive operators needed for molecular spectroscopy (like those required by magnetic resonance spectroscopy). Implications of other assumptions in standard non-relativistic quantum chemistry shall be analyzed and understood, too. Examples are the Born-Oppenheimer approximation and the expansion of the electronic wave function in a set of pre-defined many-electron basis functions (Slater determinants). Overcoming these concepts, which are so natural to the theory of chemistry, will provide deeper insights into many-particle quantum mechanics. Also revisiting the workhorse of quantum chemistry, namely density functional theory, with an emphasis on open-shell electronic structures (radicals, transition-metal complexes) will contribute to this endeavor. It will be shown how these insights allow us to make more accurate predictions in chemistry in practice - at the frontier of research in theoretical chemistry.

Content
1) Introductory lecture: basics of quantum mechanics and quantum chemistry
2) Einstein's special theory of relativity and the (classical) electromagnetic interaction of two charged particles
3) Klein-Gordon and Dirac equation; the Dirac hydrogen atom
4) Numerical methods based on the Dirac-Fock-Coulomb Hamiltonian, two-component and scalar relativistic Hamiltonians
5) Response theory and molecular properties, derivation of property operators, Breit-Pauli-Hamiltonian
6) Relativistic effects in chemistry and the emergence of spin
7) Spin in density functional theory
8) New electron-correlation theories: Tensor network and matrix product states, the density matrix renormalization group
9) Quantum chemistry without the Born-Oppenheimer approximation

Lecture notes
A set of detailed lecture notes will be provided, which cover the whole course.

Literature
2) F. Schwabl: Quantenmechanik für Fortgeschrittene (QM II), Springer-Verlag, 1997
[english version available: F. Schwabl, Advanced Quantum Mechanics]
3) R. McWeeny: Methods of Molecular Quantum Mechanics, Academic Press, 1992
http://pubs.rsc.org/en/Content/ArticleLanding/2011/CP/c0cp01883j
http://pra.aps.org/abstract/PRA/v83/i5/e052512

Note also the standard textbooks:
A) A. Szabo, N.S. Ostlund, Introduction, Dover Publications
B) L.N. Levine, Quantum Chemistry, Pearson

Prerequisites / notice

Strongly recommended (preparatory) courses are: quantum mechanics and quantum chemistry

151-0105-00L Quantitative Flow Visualization

Abstract
The course provides an introduction to digital image analysis in modern flow diagnostics. Different techniques which are discussed include image velocimetry, laser induced fluorescence, liquid crystal thermography and interferometry. The physical foundations and measurement configurations are explained. Image analysis algorithms are presented in detail and programmed during the exercises.
Introduction to modern imaging techniques and post processing algorithms with special emphasis on flow analysis and visualization. Understanding of hardware and software requirements and solutions. Development of basic programming skills for (generic) imaging applications.

Methods like molecular dynamics, DSMC, lattice Boltzmann etc are being increasingly used by engineers all over and these methods are becoming more and more important in the field of fluid dynamics. The course provides an introduction to theoretical foundations and practical usage of the Lattice Boltzmann Method for fluid dynamics simulations. The course builds upon three parts:

I. Background: Elements of statistical mechanics and kinetic theory:
   - Particle’s distribution function, Liouville equation, entropy, ensembles; Kinetic theory: Boltzmann equation for rarefied gas, H-theorem, hydrodynamic limit and derivation of Navier-Stokes equations, Chapman-Enskog method, Grad method, boundary conditions; mean-field interactions, Vlasov equation;
   - Kinetic models: BGK model, generalized BGK model for mixtures, chemical reactions and other fluids.

II. Theoretical basis of statistical mechanics and kinetic equations.
   - Minimal kinetic models; lattice Boltzmann method for single-component fluid, discretization of velocity space, time-space discretization, boundary conditions, forcing, thermal models, mixtures.

III. Lattice Boltzmann method for real-world applications.
   - The content of the course includes:
     1. Background:
        - Elements of statistical mechanics and kinetic theory: Particle’s distribution function, Liouville equation, entropy, ensembles; Kinetic theory: Boltzmann equation for rarefied gas, H-theorem, hydrodynamic limit and derivation of Navier-Stokes equations, Chapman-Enskog method, Grad method, boundary conditions; mean-field interactions, Vlasov equation;
        - Kinetic models: BGK model, generalized BGK model for mixtures, chemical reactions and other fluids.

     2. Basics of the Lattice Boltzmann Method and Simulations:
        - Minimal kinetic models; lattice Boltzmann method for single-component fluid, discretization of velocity space, time-space discretization, boundary conditions, forcing, thermal models, mixtures.

     3. Hands on:
        - Development of the basic lattice Boltzmann code and its validation on standard benchmarks (Taylor-Green vortex, lid-driven cavity flow etc).

     4. Practical issues of LBM for fluid dynamics simulations:
        - Lattice Boltzmann simulations of turbulent flows;
        - numerical stability and accuracy.

     5. Microparticle effects in moderately dilute gases; Boundary conditions, exact solutions to Couette and Poiseuille flows; micro-channel simulations.

     6. Advanced lattice Boltzmann methods:
        - Entropic lattice Boltzmann scheme, subgrid simulations at high Reynolds numbers; Boundary conditions for complex geometries.

     7. Introduction to LB models beyond hydrodynamics:
        - Relativistic fluid dynamics; flows with phase transitions.

     Lecture notes:
     - Lecture notes on the theoretical parts of the course will be made available.
     - Handouts and basic code framework for implementation of the lattice Boltzmann models will be provided.

     Language: German on request.

Prerequisites:
- Fluidodynamics I, Numerical Mathematics, programming skills.
- Fluiddynamics I, Numerical Mathematics, programming skills.

Lecture notes available.

Lecture notes on the theoretical parts of the course will be made available.

Lecture notes available.

Lecture notes available.
Theory and Modeling of Reactive Flows

The course first reviews the governing equations and combustion chemistry, setting the ground for the analysis of homogeneous gas-phase mixtures, laminar diffusion and premixed flames. Catalytic combustion and its coupling with homogeneous combustion are dealt in detail, and turbulent combustion modeling approaches are presented. Available numerical codes will be used for modeling.

Objective

Theory of combustion with numerical applications

Content

The analysis of realistic reactive flow systems necessitates the use of detailed computer models that can be constructed starting from first principles i.e. thermodynamics, fluid mechanics, chemical kinetics, and heat and mass transport. In this course, the focus will be on combustion theory and modeling. The reacting flow governing equations and the combustion chemistry are firstly reviewed, setting the ground for the analysis of homogeneous gas-phase mixtures, laminar diffusion and premixed flames. Heterogeneous (catalytic) combustion, an area of increased importance in the last years, will be dealt in detail along with its coupling with homogeneous combustion. Finally, approaches for the modeling of turbulent combustion will be presented. Available numerical codes will be used to compute the above described phenomena. Familiarity with numerical methods for the solution of partial differential equations is expected.

Machine Learning

Machine learning algorithms provide analytical methods to search data sets for characteristic patterns. Typical tasks include the classification of data, function fitting and clustering, with applications in image and speech analysis, bioinformatics and exploratory data analysis. This course is accompanied by practical machine learning projects.

Objective

Students will be familiarized with the most important concepts and algorithms for supervised and unsupervised learning; reinforce the statistics knowledge which is indispensable to solve modeling problems under uncertainty. Key concepts are the generalization ability of algorithms and systematic approaches to modeling and regularization. A machine learning project will provide an opportunity to test the machine learning algorithms on real world data.

Content

The theory of fundamental machine learning concepts is presented in the lecture, and illustrated with relevant applications. Students can deepen their understanding by solving both pen-and-paper and programming exercises, where they implement and apply famous algorithms to real-world data.

Topics covered in the lecture include:

- Bayesian theory of optimal decisions
- Maximum likelihood and Bayesian parameter inference
- Classification with discriminant functions: Perceptrons, Fisher’s LDA and support vector machines (SVM)
- Ensemble methods: Bagging and Boosting
- Regression: least squares, ridge and LASSO penalization, non-linear regression and the bias-variance trade-off
- Non parametric density estimation: Parzen windows, nearest neighbour
- Dimension reduction: principal component analysis (PCA) and beyond

Lecture notes

Handouts

Literature


Prerequisites / notice

The course requires solid basic knowledge in analysis, statistics and numerical methods for CSE as well as practical programming experience for solving assignments. Students should at least have followed one previous course offered by the Machine Learning Institute (e.g., CIL or LIS) or an equivalent course offered by another institution.
Mandatory for all Bachelor and Master students with matriculation in the autumn semester 2014 or later.

Directive

Abstract
Introduction to scientific writing for students with focus on publication standards and ethical issues, especially in the case of citations (references to works of others.)

Objective
Learn the basic standards of scientific works in mathematics.

Content
- Types of mathematical works
- Publication standards in pure and applied mathematics
- Data handling
- Ethical issues
- Citation guidelines

Lecture notes
Moodle of the Mathematics Library: https://moodle-app2.let.ethz.ch/course/view.php?id=519

Prerequisites / notice
This course is completed by the optional course "Recherchieren in der Mathematik" (held in German) by the Mathematics Library. For more details see: http://www.math.ethz.ch/library/services/schulungen

401-3990-01L Bachelor’s Thesis
No direct enrolment to this course unit in myStudies. Please fill in the online application form.
Requirements and application form under: www.math.ethz.ch/intranet/students/study-administration/theses.html
(Afterwards the enrolment will be done by the Study Administration.)

Abstract
The BSc thesis concludes the curriculum. In their BSc thesis, students should demonstrate their ability to carry out independent, structured scientific work. The purpose of the BSc thesis is to deepen knowledge in a certain subject and to bring students into closer contact with applications in an existing computational group. The BSc thesis requires approximately 160 hours of work.

Objective
In their Bsc thesis students should demonstrate their ability to carry out independent, structured scientific work. The purpose is to deepen knowledge in a certain subject and to enable students to collaborate in an existing scientific group to take a computational approach to problems encountered in applications.

Prerequisites / notice
The supervisor responsible for the Bachelor thesis defines the task and determines the start and the submission date. The Bachelor thesis concludes with a written report. The Bachelor thesis is graded.

Colloquia

<table>
<thead>
<tr>
<th>Number</th>
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Abstract
Research colloquium

Computational Science and Engineering Bachelor - Key for Type

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
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<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
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<td>W+</td>
<td>Eligible for credits and recommended</td>
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<td>Eligible for credits</td>
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Key for Hours

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<tr>
<td>V</td>
<td>lecture</td>
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<td>G</td>
<td>lecture with exercise</td>
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<td>colloquium</td>
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<td>Practical/laboratory course</td>
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<td>A</td>
<td>Independent project</td>
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<td>Diploma thesis</td>
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<td>R</td>
<td>Revision course / private study</td>
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ECTS European Credit Transfer and Accumulation System
Special students and auditors need special permission from the lecturers.
### Computational Science and Engineering TC

*Detailed information on the programme at: www.didaktischeausbildung.ethz.ch*

#### Educational Science

General course offerings in the category Educational Science are listed under "Programme: Educational Science for Teaching Diploma and TC".

<table>
<thead>
<tr>
<th>Number</th>
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<tbody>
<tr>
<td>851-0240-00L</td>
<td>Human Learning (EW1)</td>
<td>O</td>
<td>2 credits</td>
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<td>E. Stern</td>
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<td>This course looks into scientific theories and also empirical studies on human learning and relates them to the school.</td>
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<td>Anyone wishing to be a successful teacher must first of all understand the learning process. Against this background, theories and findings on the way humans process information and on human behaviour are prepared in such a manner that they can be used for planning and conducting lessons. Students additionally gain an understanding of what is going on in learning and behavioural research so that teachers are put in a position where they can further educate themselves in the field of research into teaching and learning.</td>
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<td>Thematische Schwerpunkte: Lernen als Verhaltensänderung und als Informationsverarbeitung: Das menschliche Gedächtnis unter besonderer Berücksichtigung der Verarbeitung symbolischer Information; Lernen als Wissenskonstruktion und Kompetenzentwicklung unter besonderer Berücksichtigung des Wissenstransfers; Lernen durch Instruktion und Erklärungen; Die Rolle von Emotion und Motivation beim Lernen; Interindividuelle Unterschiede in der Lernfähigkeit und ihre Ursachen; Intelligenztheorien, Geschlechtsunterschiede beim Lernen</td>
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<td>This lecture is only apt for students who intend to enrol in the programs &quot;Lerdiplom&quot; or &quot;Didaktisches Zertifikat&quot;. It is about learning in childhood and adolescence.</td>
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<tbody>
<tr>
<td>851-0240-03L</td>
<td>Introduction to Test Theory and Test Construction in Educational Contexts (University of Zurich)</td>
<td>W</td>
<td>4 credits</td>
<td>2S</td>
<td>University lecturers</td>
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<td>Enrolment only possible with Teaching Diploma or DC matriculation.</td>
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<td>Mind the enrolment deadlines at UZH: <a href="http://www.uzh.ch/studies/application/mobilitaet_en.html">http://www.uzh.ch/studies/application/mobilitaet_en.html</a></td>
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<td>In this seminar, students will study fundamental scientific fundamentals of performance measurement and educational diagnostics and study them on the basis of different current issues.</td>
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<td>At the end of the seminar, participants will be in a position to:</td>
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<td>- describe the fundamental scientific fundamentals of test theory and test structure.</td>
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<td>- evaluate examples of scientifically-developed tests in their application context.</td>
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<td>- if necessary, critically question the performance assessment that they employ in practice and professionalise it still further.</td>
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<td></td>
<td>Die konkreten Inhalte des Seminars ergeben sich aufgrund der Präferenzen der Teilnehmenden und der daraus abgeleiteten Themenübersicht für Vorträge und Seminararbeiten. Im Rahmen der Startveranstaltung wird eine Liste mit möglichen Themen abgegeben und erläutert. Schwerpunkte der Themenvorschläge sind:</td>
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<td>- Testentwicklung:</td>
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<td>- Gütekriterien von Tests</td>
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<td>- Aufgabenkonstruktion</td>
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<td>- Datenauswertung</td>
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<td>- Rasch-Modell</td>
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<td>- Internationale Vergleichstests</td>
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<td>- Zulassungsstests</td>
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<td>Lecture notes</td>
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<td>Im Verlaufe des Semesters werden einzelne Unterlagen in den Veranstaltungen abgegeben. Dazu gehören auch die Handouts der verschiedenen, studentischen Vorträge.</td>
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<td>Als Grundlagenliteratur werden folgende Werke empfohlen:</td>
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<td>- Weitere Literatur wird in der Lehrveranstaltung genannt.</td>
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<td>Prerequisites / notice</td>
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<td>Die Leistungsanforderungen richten sich im Umfang nach der Zahl zu erwerbender ECTS-Punkte, wobei 1 ECTS-Punkt einem Zeitaufwand von ca. 30 Arbeitsstunden entspricht. ETHZ-Studierende können im Rahmen dieser Veranstaltung 3 ECTS-Punkte erwerben. Dazu sind folgende Leistungen zu erbringen:</td>
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<td>- Präsenz und aktive mündliche Mitarbeit in der Lehrveranstaltung (MA)</td>
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<td>- Pflichtlektüre entsprechend der Angaben in der Lehrveranstaltung</td>
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<td>- Referat (RE)</td>
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<td>- Schreiben einer schriftlichen Arbeit</td>
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<td>Weitere Angaben zu den Leistungsanforderungen werden im Rahmen der Startveranstaltung abgegeben und erläutert.</td>
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<tr>
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<tbody>
<tr>
<td>851-0240-16L</td>
<td>Colloquium on the Science of Learning and Instruction</td>
<td>W</td>
<td>1 credit</td>
<td>1K</td>
<td>E. Stern, P. Greutmann, further lecturers</td>
</tr>
<tr>
<td></td>
<td>In the colloquium we discuss scientific projects concerning the teaching in mathematics, computer science, natural sciences and technology (STEM). The colloquium is conducted by the professorships participating in the Competence Center EducETH (ETH) and in the Institute for Educational Sciences (UZH).</td>
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<td>Participants are exemplarily introduced to different research methods used in research on learning and instruction and learn to weigh advantages and disadvantages of these approaches.</td>
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</thead>
<tbody>
<tr>
<td>851-0240-22L</td>
<td>Coping with Psychosocial Demands of Teaching (EW4 W</td>
<td>W</td>
<td>2 credits</td>
<td>3S</td>
<td>A. Deiglmayr, P. Greutmann,</td>
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<td>This course looks into scientific theories and also empirical studies on human learning and relates them to the school.</td>
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<td></td>
<td>This course looks into scientific theories and also empirical studies on human learning and relates them to the school.</td>
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<tr>
<td></td>
<td>Objective</td>
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<td>Anyone wishing to be a successful teacher must first of all understand the learning process. Against this background, theories and findings on the way humans process information and on human behaviour are prepared in such a manner that they can be used for planning and conducting lessons. Students additionally gain an understanding of what is going on in learning and behavioural research so that teachers are put in a position where they can further educate themselves in the field of research into teaching and learning.</td>
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<tr>
<td></td>
<td>Content</td>
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<tr>
<td></td>
<td>Thematische Schwerpunkte: Lernen als Verhaltensänderung und als Informationsverarbeitung: Das menschliche Gedächtnis unter besonderer Berücksichtigung der Verarbeitung symbolischer Information; Lernen als Wissenskonstruktion und Kompetenzentwicklung unter besonderer Berücksichtigung des Wissenstransfers; Lernen durch Instruktion und Erklärungen; Die Rolle von Emotion und Motivation beim Lernen; Interindividuelle Unterschiede in der Lernfähigkeit und ihre Ursachen; Intelligenztheorien, Geschlechtsunterschiede beim Lernen</td>
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<tr>
<td></td>
<td>Literature</td>
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<tr>
<td></td>
<td>Prerequisites / notice</td>
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<td>This lecture is only apt for students who intend to enrol in the programs &quot;Lerdiplom&quot; or &quot;Didaktisches Zertifikat&quot;. It is about learning in childhood and adolescence.</td>
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</tbody>
</table>
Cognitively Activating Instructions in MINT Subjects

**Objective**
Students possess theoretical knowledge and practical competences to be able to cope with the psychosocial demands of teaching.

1. They know the basic rules of negotiation and conflict management (e.g., mediation) and can apply them in the school context (e.g., in conversations with parents).
2. They can apply diverse techniques of classroom management (e.g., prevention of disciplinary problems in the classroom) and know relevant authorities for further information (e.g., legal conditions).

**Prerequisites / notice**
Für eine reibungslose Semesterplanung wird um frühe Anmeldung und persönliches Erscheinen zum ersten Lehrveranstaltungstermin ersucht.

**Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).**

851-0242-06L

**Research Methods in Educational Science**

**Objective**
Understand research methods used in the empirical educational sciences
- Understand and critically examine information from scientific journals and media
- Understand pedagogically relevant findings from the empirical educational sciences

**Prerequisites**
- Get to know findings relevant for education
- Get to know intelligence tests
- Working groups (5 - 10 students) will be discussed.

**Abstract**
Literature from the learning sciences is critically discussed with a focus on research methods.

851-0242-07L

**Human Intelligence**

**Objective**
Understanding findings relevant for education
- Understanding findings relevant for education
- Getting to know intelligence tests

**Prerequisites**
- Understanding pedagogically relevant findings from the empirical educational sciences

**Abstract**
The focus will be on the book "Intelligenz: Grosse Unterschiede und ihre Folgen" by Stern and Neubauer. Participation at the first meeting is obligatory. It is required that all participants read the complete book. Furthermore, in two meetings of 90 minutes, concept papers developed in small groups (5 - 10 students) will be discussed.

**Subject Didactics and Professional Training**

**Teaching Internship Including Examination Lessons W 6 credits 13P J. Hromkovic, G. Serafini**

*Only for students who enrolled from HS 2011 on into TC.

The teaching internship can just be visited if all other courses of TC are completed.

Repetition of the teaching internship is excluded even if the examination lessons are to be repeated.

**Objective**
Students apply the insights, abilities and skills they have acquired within the context of an educational institution. They observe 10 lessons and teach 20 lessons independently. Two of them are as assessed as Examination Lessons.

- Students use their specialist-subject, educational-science and subject-didactics training to draw up concepts for teaching.
- They are able to assess the significance of tuition topics for their subject from different angles (including interdisciplinary angles) and impart these to their pupils.
- They learn the skills of the teaching trade.
- They practise finding the balance between instruction and openness so that pupils can and, indeed, must make their own cognitive contribution.
- They learn to assess pupils work.
- Together with the teacher in charge of their teacher training, the students constantly evaluate their own performance.

**Teaching Internship Computational Science and Engineering W 2 credits 2S R. Schumacher**

7ECTS

This seminar focuses on teaching units in chemistry, physics and mathematics that have been developed at the MINT Learning Center of the ETH Zurich. In the first meeting, the mission of the MINT Learning Center will be communicated. Furthermore, in groups of two, the students will intensively work on, refine and optimize a teaching unit following a goal set in advance.

**Prerequisites / notice**
- Get to know cognitively activating instructions in MINT subjects
- Get information about recent literature on learning and instruction
Subject Didactics of Computer Science I

Simultaneous enrolment in Introductory Practical in Computer Science - course 272-0201-00L - is compulsory.

The unit "Subject Didactics of Computer Science I" addresses key contributions of computer science to general education. The course deals with the thoughtful choice of educational contents for computer science classes, which takes into account its comprehensibility for different age groups as well as didactic approaches suitable for a successful knowledge transfer.

The general objective of the course consists in highlighting the tight connection between the mathematical and algorithmic way of thinking and the approaches adopted by engineering disciplines, and in reflecting on teaching approaches for sustainable computer science teaching activities.

The students understand the fundamental concepts of computer science in the context of a broad and deep knowledge. Through this understanding, they manage to prepare teaching materials for a successful knowledge transfer and to pass their passion for the subject on to their pupils.

The students know various teaching methods as well as their advantages and disadvantages. They can handle inhomogeneous prior knowledge of the learners inside a class. Besides holding classes, the students do care about the individual pupil support.

They encourage the autonomy of the learners, manage to work with diverse target groups and to establish a positive learning environment.

The students are able to express themselves using a comprehensible and refined professional language, both in a spoken and a written way, and they master the basic terminology of computer science. Besides the English terms, they are familiar with the corresponding German expressions. The students are able to produce detailed, matured, linguistically correct and design-wise appealing teaching materials.

The course "Subject Didactics of Computer Science I" addresses key contributions of computer science to general education. The chosen topics support the young learners in developing a unique and indispensable way of thinking, in enhancing their understanding of our world as well as in achieving university education entrance qualifications.

The main topics of the course unit "Subject Didactics of Computer Science I" are the didactics of finite state automata, of formal languages and of the introduction to programming. The unit focuses on contents of computer science that contribute to general education. This involves the understanding of fundamental scientific concepts such as algorithm, complexity, determinism, computation, automata, verification, testing and programming language as well as the way to embed them into a scientifically sound and didactically sustainable computer science course.

In a semester exercise, the students develop and document an adaptive teaching unit for computer science. They learn to employ the didactics methods and techniques that are introduced at the beginning of the semester.

Content


Anlässlich der Hospitalationen erläutert die Praktikumslehrperson ihre fachlichen, fachdidaktischen und pädagogischen Überlegungen, auf deren Basis sie den Unterricht geplant hat und tauscht sich mit dem/der Studierenden aus. Die vom dem/der Studierenden gehaltenen Lektionen werden vor- und nachbesprochen.

Die Themen für die beiden Prüfungslektionen am Schluss des Praktikums erfahren die Studierenden in der Regel eine Woche vor dem Prüfungstermin. Sie erstellen eine Vorbereitung gemäss Anleitung und reichen sie bis am Vortrag um 12 Uhr den beiden Prüfungsexperten (Fachdidaktiker/-in, Departementsvertreter/-in) ein. Die gehaltenen Lektionen werden Kriterienbasiert beurteilt. Die Beurteilung umfasst auch die schriftliche Vorbereitung und eine mündliche Reflexion des Kandidaten/der Kandidatin über die gehaltenen Lektionen im Rahmen eines kurzen Kolloquiums.

Lecture notes

Dokument: schriftliche Vorbereitung für Prüfungslektionen.

Wird von der Praktikumslehrperson bestimmt.

401-9901-00L

Mentored Work Subject Didactics Computational Science and Engineering

In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.

The objective is for the students:

- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.
- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

Thematic Schwerpunkte

Die Gegenstände der mentorierten Arbeit in Fachdidaktik stammen in der Regel aus dem gymnasialen Unterricht.

Lernformen

Die Literatur ist themenspezifisch. Die Studierenden beschaffen sie sich in der Regel selber (siehe Lernziele). In besonderen Fällen wird sie vom Betreuer zur Verfügung gestellt. Die Arbeit sollte vor Beginn des Praktikums abgeschlossen werden.

**Further Subject Didactics**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>263-2800-00L</td>
<td>Design of Parallel and High-Performance Computing</td>
<td>W</td>
<td>7</td>
<td>3V+2U+1A</td>
<td>T. Hoefler, M. Püschel</td>
</tr>
<tr>
<td>Abstract</td>
<td>Advanced topics in parallel / concurrent programming. Understand concurrency paradigms and models from a higher perspective and acquire skills for designing, structuring and developing possibly large concurrent software systems. Become able to distinguish parallelism in problem space and in machine space. Become familiar with important technical concepts and with concurrency folklore.</td>
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<tr>
<td>Objective</td>
<td>Understand concurrency paradigms and models from a higher perspective and acquire skills for designing, structuring and developing possibly large concurrent software systems. Become able to distinguish parallelism in problem space and in machine space. Become familiar with important technical concepts and with concurrency folklore.</td>
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<tr>
<td>Content</td>
<td>Knowledge about basic search algorithms on the web, benchmarking of search algorithms, and relevance feedback methods.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Students should at least have followed one previous course offered by the Machine Learning Institute (e.g., CIL or LIS) or an equivalent experience for solving assignments.</td>
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<tr>
<td>Lecture notes</td>
<td>No lecture notes, but slides will be made available on the course webpage.</td>
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</tr>
<tr>
<td>252-0341-01L</td>
<td>Information Retrieval</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>T. Hofmann</td>
</tr>
<tr>
<td>Abstract</td>
<td>Introduction to information retrieval with a focus on text documents and images. Main topics comprise extraction of characteristic features from documents, index structures, retrieval models, search algorithms, benchmarking, and feedback mechanisms. Searching the web, images and XML collections demonstrate recent applications of information retrieval and their implementation.</td>
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<tr>
<td>Objective</td>
<td>In depth understanding of managing, indexing, and retrieving documents with text, image and XML content. Knowledge about basic search algorithms on the web, benchmarking of search algorithms, and relevance feedback methods.</td>
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<tr>
<td>Content</td>
<td>The theory of fundamental machine learning is presented in the lecture, and illustrated with relevant applications. Students can deepen their understanding by solving both pen-and-paper and programming exercises, where they implement and apply famous algorithms to real-world data.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>The course requires solid basic knowledge in analysis, statistics and numerical methods for CSE as well as practical programming experience for solving assignments. Students should at least have followed one previous course offered by the Machine Learning Institute (e.g., CIL or LIS) or an equivalent course offered by another institution.</td>
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<tr>
<td>Lecture notes</td>
<td>No lecture notes, but slides will be made available on the course webpage.</td>
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<tr>
<td>252-0535-00L</td>
<td>Machine Learning</td>
<td>W</td>
<td>8</td>
<td>3V+2U+2A</td>
<td>J. M. Buhmann</td>
</tr>
<tr>
<td>Abstract</td>
<td>Machine learning algorithms provide analytical methods to search data sets for characteristic patterns. Typical tasks include the classification of data, function fitting and clustering, with applications in image and speech analysis, bioinformatics and exploratory data analysis. This course is accompanied by practical machine learning projects.</td>
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<tr>
<td>Objective</td>
<td>Students will be familiarized with the most important concepts and algorithms for supervised and unsupervised learning; reinforce the statistics knowledge which is indispensable to solve modeling problems under uncertainty. Key concepts are the generalization ability of algorithms, and systematic approaches to modeling and regularization. A machine learning project will provide an opportunity to test the machine learning algorithms on real world data.</td>
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<tr>
<td>Content</td>
<td>The theory of fundamental machine learning is presented in the lecture, and illustrated with relevant applications. Students can deepen their understanding by solving both pen-and-paper and programming exercises, where they implement and apply famous algorithms to real-world data.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Students should at least have followed one previous course offered by the Machine Learning Institute (e.g., CIL or LIS) or an equivalent course offered by another institution.</td>
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<tr>
<td>Lecture notes</td>
<td>No lecture notes, but slides will be made available on the course webpage.</td>
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<tr>
<td>252-1407-00L</td>
<td>Algorithmic Game Theory</td>
<td>W</td>
<td>7</td>
<td>3V+2U+1A</td>
<td>P. Widmayer, P. Penna</td>
</tr>
<tr>
<td>Abstract</td>
<td>Game theory provides a formal model to study the behavior and interaction of self-interested users and programs in large-scale distributed computer systems without central control. The course discusses algorithmic aspects of game theory.</td>
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<tr>
<td>Objective</td>
<td>Learning the basic concepts of game theory and mechanism design, acquiring the computational paradigm of self-interested agents, and using these concepts in the computational and algorithmic setting.</td>
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<tr>
<td>Content</td>
<td>The Internet is a typical example of a large-scale distributed computer system without central control, with users that are typically only interested in their own good. For instance, they are interested in getting high bandwidth for themselves, but don't care about others, and the same is true for computational load or download rates. Game theory provides a particularly well-suited model for the behavior and interaction of such selfish users and programs. Classic game theory dates back to the 1950s and typically does not consider algorithmic aspects at all. Only a few years back, algorithms and game theory have been considered together, in an attempt to reconcile selfish behavior of independent agents with the common good.</td>
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<tr>
<td>Lecture notes</td>
<td>No lecture notes.</td>
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</table>

This course discusses algorithmic aspects of game-theoretic models, with a focus on recent algorithmic and mathematical developments. Rather than giving an overview of such developments, the course aims to study selected important topics in depth.

Outline:
- Introduction to classic game-theoretic concepts.
- Existence of stable solutions (equilibria), algorithms for computing equilibria, computational complexity.
- Speed of convergence of natural game playing dynamics such as best-response dynamics or regret minimization.
- Techniques for bounding the quality-loss due to selfish behavior versus optimal outcomes under central control (a.k.a. the 'Price of Anarchy').
- Design and analysis of mechanisms that induce truthful behavior or near-optimal outcomes at equilibrium.
- Selected current research topics, such as Google's Sponsored Search Auction, the U.S. FCC Spectrum Auction, Kidney Exchange.
Audience: Although this is a Computer Science course, we encourage the participation from all students who are interested in this topic. Requirements: You should enjoy precise mathematical reasoning. You need to have passed a course on algorithms and complexity. No knowledge of game theory is required.

Prerequisites / notice

Several copies of both books are available in the Computer Science library.

252-0417-00L Randomized Algorithms and Probabilistic Methods W 7 credits 3V+2U+1A A. Steger, E. Welzl

Abstract

Las Vegas & Monte Carlo algorithms; inequalities of Markov, Chebyshev, Chernoff; negative correlation; Markov chains: convergence, rapidly mixing; generating functions; Examples include: min cut, median, balls and bins, routing in hypercubes, 3SAT, card shuffling, random walks

Objective

After this course students will know fundamental techniques from probabilistic combinatorics for designing randomized algorithms and will be able to apply them to solve typical problems in these areas.

Content

Randomized Algorithms are algorithms that “flip coins” to take certain decisions. This concept extends the classical model of deterministic algorithms and has become very popular and useful within the last twenty years. In many cases, randomized algorithms are faster, simpler or just more elegant than deterministic ones. In the course, we will discuss basic principles and techniques and derive from them a number of randomized methods for problems in different areas.

Lecture notes

Yes.

Literature

## Computational Science and Engineering Master

### Core Courses

Two core courses out of three must be attended and examinations must be taken in both.

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>This course covers some of the fundamental concepts of computer graphics, namely 3D object representations and generation of photorealistic images from digital representations of 3D scenes.</td>
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<tr>
<td>Objective</td>
<td>At the end of the course the students will be able to build a rendering system. The students will study the basic principles of rendering and image synthesis. In addition, the course is intended to stimulate the students' curiosity to explore the field of computer graphics in subsequent courses or on their own.</td>
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<tr>
<td>Content</td>
<td>This course covers fundamental concepts of modern computer graphics. Students will learn about 3D object representations and the details of how to generate photorealistic images from digital representations of 3D scenes. Starting with an introduction to 3D shape modeling and representation, texture mapping and ray-tracing, we will move on to acceleration structures, the physics of light transport, appearance modeling and global illumination principles and algorithms. We will end with an overview of modern image-based image synthesis techniques, covering topics such as lightfields and depth-image based rendering.</td>
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<tr>
<td>Lecture notes</td>
<td>no</td>
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</tr>
<tr>
<td>Prerequisites / notice</td>
<td>Fundamentals of calculus and linear algebra, basic concepts of algorithms and data structures, programming skills in C++, Visual Computing course recommended. The programming assignments will be in C++. This will not be taught in the class.</td>
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</table>

### Fields of Specialization

#### Astrophysics

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-7851-00L</td>
<td>Theoretical Astrophysics (University of Zurich)</td>
<td>W</td>
<td>10</td>
<td>4V+2U</td>
<td>R. Teyssier</td>
</tr>
<tr>
<td>Abstract</td>
<td>Radiative processes in the interstellar medium; stellar structure and evolution; supernovae; white dwarfs; neutron stars; black holes; planet formation</td>
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</tbody>
</table>
| Literature   | (1) "Formation of stars" (S. Stahler and F. Palla - Wiley editions, this is the book on which about half of the classes will be based and photocopies will be organized during first lecture)  
(2) "Radiative processes in astrophysics" (R. Rybicki and A. Lightman)  
(3) "The Physics of Stars" (A.C. Phillips)  
(4) "Black Holes, White Dwarfs and Neutron Stars: The physics of compact objects" (S. Shapiro and S.A. Teukolski). |
| Prerequisites / notice | Prerequisites: Elementary atomic physics, thermodynamics, mechanics, fluid dynamics. Introduction to astrophysics (preferred but not obligatory). |

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-7855-00L</td>
<td>Computational Astrophysics (University of Zurich)</td>
<td>W</td>
<td>6</td>
<td>2V</td>
<td>L. M. Mayer</td>
</tr>
<tr>
<td>Abstract</td>
<td>Acquire knowledge of main methodologies for computer-based models of astrophysical systems, the physical equations behind them, and train such knowledge with simple examples of computer programmes</td>
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</tr>
<tr>
<td>Objective</td>
<td>Acquire knowledge of main methodologies for computer-based models of astrophysical systems, the physical equations behind them, and train such knowledge with simple examples of computer programmes</td>
<td></td>
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</tr>
</tbody>
</table>
| Content      | 1. Integration of ODE, Hamiltonians and Symplectic integration techniques, time adaptivity, time reversibility  
2. Large-N gravity calculation, collisionless N-body systems and their simulation  
3. Fast Fourier Transform and spectral methods in general  
4. Eulerian Hydrodynamics: Upwinding, Riemann solvers, Limiters  
5. Lagrangian Hydrodynamics: The SPH method  
6. Resolution and instabilities in Hydrodynamics  
7. Initial Conditions: Cosmological Simulations and Astrophysical Disks  
8. Physical Approximations and Methods for Radiative Transfer in Astrophysics |
| Literature   | Galactic Dynamics (Binney & Tremaine, Princeton University Press), Computer Simulation using Particles (Hockney & Eastwood CRC press), Targeted journal reviews on computational methods for astrophysical fluids (SPH, AMR, moving mesh) |
| Prerequisites / notice | Some knowledge of UNIX, scripting languages (see www.physik.uzh.ch/lectures/informatik/python/ as an example), some prior experience programming, knowledge of C, C++ beneficial |

#### Physics of the Atmosphere

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-0023-00L</td>
<td>Atmosphere</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>H. Wernli, E. M. Fischer, T. Peter</td>
</tr>
<tr>
<td>Abstract</td>
<td>Basic principles of the atmosphere, physical structure and chemical composition, trace gases, atmospheric cycles, circulation, stability, radiation, condensation, clouds, oxidation capacity and ozone layer.</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Content</td>
<td>Basic principles of the atmosphere, physical structure and chemical composition, trace gases, atmospheric cycles, circulation, stability, radiation, condensation, clouds, oxidation capacity and ozone layer.</td>
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<tr>
<td>Lecture notes</td>
<td>Written information will be supplied.</td>
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</tr>
</tbody>
</table>

Data: 06.03.2019 12:57 Autumn Semester 2016 Page 1330 of 1571
Dynamics of Large-Scale Atmospheric Flow

Abstract
The Planetary Boundary Layer (PBL) constitutes the interface between the atmosphere and the Earth's surface. Theory on transport processes in the PBL and its dynamics is provided. This course treats theoretical background and idealized concepts. These are contrasted to real world applications and current research issues.

Objective
Overall goals of this course are given below. Focus is on the theoretical background and idealised concepts.

- Students have basic knowledge on atmospheric turbulence and theoretical as well as practical approaches to treat Planetary Boundary Layer flows. They are familiar with the relevant processes (turbulent transport, forcing) within, and typical states of the Planetary Boundary Layer. Idealized concepts are known as well as their adaptations under real surface conditions (as for example over complex topography).

- Introduction
- Turbulence
- Statistical treatment of turbulence, turbulent transport
- Conservation equations in a turbulent flow
- Closure problem and closure assumptions
- Scaling and similarity theory
- Spectral characteristics
- Concepts for non-ideal boundary layer conditions

Lecture notes
available (i.e. in English)

Literature

Prerequisites / notice
Umwelt-Fluiddynamik (701-0479-00L) (environment fluid dynamics) or equivalent and basic knowledge in atmospheric science

Dynamics of Large-Scale Atmospheric Flow

Abstract
Dynamic, synoptic Meteorology

Objective
Understanding the dynamics of large-scale atmospheric flow

Content
Dynamical Meteorology is concerned with the dynamical processes of the earth's atmosphere. The fundamental equations of motion in the atmosphere will be discussed along with the dynamics and interactions of synoptic system - i.e. the low and high pressure systems that determine our weather. The motion of such systems can be understood in terms of quasi-geostrophic theory. The lecture course provides a derivation of the mathematical basis along with some interpretations and applications of the concept.

Lecture notes
Dynamics of large-scale atmospheric flow

Literature
- Pichler H., Dynamik der Atmosphäre, Bibliographisches Institut, 456 pp. 1997

Prerequisites / notice
Physics I, II, Environmental Fluid Dynamics

Seminar in Physics of the Atmosphere for CSE

Abstract
The students of this course are provided with an introduction into presentation techniques (talks and posters) and practice this knowledge by making an oral presentation about a classical or recent scientific publication.

Chemistry

Number Title Type ECTS Hours Lecturers
529-0004-00L Computer Simulation in Chemistry, Biology and Physics W 7 credits 4G P. H. Hünenberger

Abstract
Molecular models, Force fields, Boundary conditions, Electrostatic interactions, Molecular dynamics, Analysis of trajectories, Quantum-mechanical simulation, Structure refinement, Application to real systems. Exercises: Analysis of papers on computer simulation, Molecular simulation in practice, Validation of molecular dynamics simulation.

For more information: www.csms.ethz.ch/education/CSCBP

Objective
Introduction to computer simulation of (bio)molecular systems, development of skills to carry out and interpret computer simulations of biomolecular systems.

Content
Molecular models, Force fields, Spatial boundary conditions, Calculation of Coulomb forces, Molecular dynamics, Analysis of trajectories, Quantum-mechanical simulation, Structure refinement, Application to real systems. Exercises: Analysis of papers on computer simulation, Molecular simulation in practice, Validation of molecular dynamics simulation.

Lecture notes
Available (copies of powerpoint slides distributed before each lecture)

Literature
See: www.csms.ethz.ch/education/CSCBP

Prerequisites / notice
Since the exercises on the computer do convey and test essentially different skills as those being conveyed during the lectures and tested at the oral exam, the results of the exercises are taken into account when evaluating the results of the exam.

For more information about the lecture: www.csms.ethz.ch/education/CSCBP

529-0003-00L Advanced Quantum Chemistry W 7 credits 3G M. Reiher, S. Knecht

Abstract
Advanced, but fundamental topics central to the understanding of theory in chemistry and for solving actual chemical problems with a computer. Examples are:

* Operators derived from principles of relativistic quantum mechanics
* Relativistic effects + methods of relativistic quantum chemistry
* Open-shell molecules + spin-density functional theory
* New electron-correlation theories

For more information: www.csms.ethz.ch/education/CSCBP

Data: 06.03.2019 12:57 Autumn Semester 2016 Page 1331 of 1571
The aim of the course is to provide an in-depth knowledge of theory and method development in theoretical chemistry. It will be shown that this is necessary in order to be able to solve actual chemical problems on a computer with quantum chemical methods.

The relativistic re-derivation of all concepts known from (nonrelativistic) quantum mechanics and quantum-chemistry lectures will finally explain the form of all operators in the molecular Hamiltonian - usually postulated rather than deduced. From this, we derive operators needed for molecular spectroscopy (like those required by magnetic resonance spectroscopy). Implications of other assumptions in standard non-relativistic quantum chemistry shall be analyzed and understood, too. Examples are the Born-Oppenheimer approximation and the expansion of the electronic wave function in a set of predefined many-electron basis functions (Slater determinants). Overcoming these concepts, which are so natural to the theory of chemistry, will provide deeper insights into many-particle quantum mechanics. Also revisiting the workhorse of quantum chemistry, namely density functional theory, with an emphasis on open-shell electronic structures (radicals, transition-metal complexes) will contribute to this endeavor. It will be shown how these insights allow us to make more accurate predictions in chemistry in practice - at the frontier of research in theoretical chemistry.

### Content

1) Introductory lecture: basics of quantum mechanics and quantum chemistry
2) Einstein's special theory of relativity and the (classical) electromagnetic interaction of two charged particles
3) Klein-Gordon and Dirac equation; the Dirac hydrogen atom
4) Numerical methods based on the Dirac-Fock-Coulomb Hamiltonian, two-component and scalar relativistic Hamiltonians
5) Response theory and molecular properties, derivation of property operators, Breit-Pauli-Hamiltonian
6) Relativistic effects in chemistry and the emergence of spin
7) Spin in density functional theory
8) New electron-correlation theories: Tensor network and matrix product states, the density matrix renormalization group
9) Quantum chemistry without the Born-Oppenheimer approximation

### Lecture notes

A set of detailed lecture notes will be provided, which will cover the whole course.

### Literature

2. F. Schwabl: Quantenmechanik für Fortgeschrittene (QM II), Springer-Verlag, 1997

Note also the standard textbooks:

- A) Szabo, N.S. Ostlund. Verlag, Dover Publications
- B) I. N. Levine, Quantum Chemistry, Pearson

### Prerequisites / notice

Strongly recommended (preparatory) courses are: quantum mechanics and quantum chemistry

#### 401-5940-00L Seminar In Chemistry for CSE

**Abstract**
The student will carry out a literature study on a topic of his or her liking or suggested by the supervisor in the area of computer simulation in chemistry, the results of which are to be presented both orally and in written form.

For more information: www.csms.ethz.ch/education/RW

## Fluid Dynamics

**One of the course units**

151-0103-00L Fluid Dynamics II

151-0109-00L Turbulent Flows

is compulsory. Students able to follow courses in German are advised to choose 151-0103-00L Fluid Dynamics II.

### Number Title Type ECTS Hours Lecturers

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>151-0103-00L</td>
<td>Fluid Dynamics II</td>
<td>O</td>
<td>3</td>
<td>2+1U</td>
<td>P. Jenny</td>
</tr>
</tbody>
</table>

**Abstract**

Two-dimensional irrotational (potential) flows: stream function and potential, singularity method, unsteady flow, aerodynamic concepts.

Vorticity dynamics: vorticity and circulation, vorticity equations, vortex theories of Helmholtz and Kelvin.

Compressible flows: isentropic flow along stream tube, normal and oblique shocks, Laval nozzle, Prandtl-Meyer expansion, viscous effects.

**Objective**

Expand basic knowledge of fluid dynamics.

Concepts, phenomena and quantitative description of irrotational (potential), rotational, and one-dimensional compressible flows.

**Content**

Two-dimensional irrotational (potential) flows: stream function and potential, complex notation, singularity method, unsteady flow, aerodynamic concepts.

Vorticity dynamics: vorticity and circulation, vorticity equation, vortex theories of Helmholtz and Kelvin.

Compressible flows: isentropic flow along stream tube, normal and oblique shocks, Laval nozzle, Prandtl-Meyer expansion, viscous effects.

**Lecture notes**

Lecture notes are available (in German).

(See also info on literature below.)

### Literature

- Relevant chapters (corresponding to lecture notes) from the textbook

**Prerequisites / notice**

Analysis I/II, Knowledge of Fluid Dynamics I, thermodynamics of ideal gas

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<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>151-0109-00L</td>
<td>Turbulent Flows</td>
<td>W</td>
<td>4</td>
<td>2+1U</td>
<td>P. Jenny</td>
</tr>
</tbody>
</table>

**Abstract**

- Laminar and turbulent flows, instability and origin of turbulence - Statistical description: averaging, turbulent energy, dissipation, closure problem - Scalings, Homogeneous isotropic turbulence, correlations. Fourier representation, energy spectrum - Free turbulence: wake, jet, mixing layer - Wall turbulence: Channel and boundary layer - Computation and modelling of turbulent flows

**Objective**

Basic physical phenomena of turbulent flows, quantitative and statistical description, basic and averaged equations, principles of turbulent flow computation and elements of turbulence modelling
Introduction to modern imaging techniques and post processing algorithms with special emphasis on flow analysis and visualization.

Quantitative Flow Visualization

1. Governing and model equations. Brief review of equations and properties
2. Overview of basic concepts: Overview of discretization process and its consequences
3. Overview of numerical methods: Finite-difference and finite-volume methods
4. Analysis of spatially discrete equations: Consistency, accuracy, stability, convergence of semi-discrete methods
5. Time-integration methods: LMS and RK methods, consistency, accuracy, stability, convergence
6. Analysis of fully discrete equations: Consistency, accuracy, stability, convergence of fully discrete methods
7. Solution of one-dimensional advection equation: Motivation for and consequences of upwinding, Godunov's theorem, TVD methods, DRP methods
8. Solution of two-dimensional advection equation: Dimension-by-dimension methods, dimensional splitting, multidimensional methods
9. Solution of one- and two-dimensional diffusion equations: Implicit methods, ADI methods
10. Solution of one-dimensional advection-diffusion equation: Numerical vs physical viscosity, boundary layers, non-uniform grids
11. Solution of incompressible Navier-Stokes equations: Incompressibility constraint and consequences, fractional-step and pressure-correction methods
12. Solution of incompressible Navier-Stokes equations on unstructured grids

Lecture notes
The course is based mostly on notes developed by the instructor.

Literature

Prerequisites / notice
Prior knowledge of fluid dynamics, applied mathematics, basic numerical methods, and programming in Fortran and/or C++ (knowledge of MATLAB is "not" sufficient).

Fluid Dynamics with the Lattice Boltzmann Method

The course provides an introduction to the theoretical foundations and practical usage of the Lattice Boltzmann Method for fluid dynamics simulations.

Methods like molecular dynamics, DSMC, lattice Boltzmann etc are being increasingly used by engineers all over and these methods require knowledge of kinetic theory and statistical mechanics which are traditionally not taught at engineering departments. The goal of this course is to give an introduction to ideas of kinetic theory and non-equilibrium thermodynamics with a focus on developing simulation algorithms and their realizations.

During the course, students will be able to develop a lattice Boltzmann code on their own. Practical issues about implementation and performance on parallel machines will be demonstrated hands on.

Central element of the course is the completion of a lattice Boltzmann code (using the framework specifically designed for this course).

The course will also include a review of topics of current interest in various fields of fluid dynamics, such as multiphase flows, reactive flows, microflows among others.

Optionally, we offer an opportunity to complete a project of student's choice as an alternative to the oral exam. Samples of projects completed by previous students will be made available.
Content

The course builds upon three parts:
I. Elementary kinetic theory and lattice Boltzmann simulations introduced on simple examples.
II. Theoretical basis of statistical mechanics and kinetic equations.
III. Lattice Boltzmann method for real-world applications.

The content of the course includes:

1. Background: Elements of statistical mechanics and kinetic theory:
   - Particle’s distribution function, Liouville equation, entropy, ensembles; Kinetic theory: Boltzmann equation for rarefied gas, H-theorem, hydrodynamic limit and derivation of Navier-Stokes equations, Chapman-Enskog method, Grad method, boundary conditions; mean-field interactions, Vlasov equation;
   - Kinetic models: BGK model, generalized BGK model for mixtures, chemical reactions and other fluids.

2. Basics of the Lattice Boltzmann Method and Simulations:
   - Minimal kinetic models: lattice Boltzmann method for single-component fluid, discretization of velocity space, time-space discretization, boundary conditions, forcing, thermal models, mixtures.

3. Hands on:
   - Development of the basic lattice Boltzmann code and its validation on standard benchmarks (Taylor-Green vortex, lid-driven cavity flow etc).

4. Practical issues of LBM for fluid dynamics simulations:
   - Lattice Boltzmann simulations of turbulent flows;
   - Numerical stability and accuracy.

5. Microflow:
   - Rarefaction effects in moderately dilute gases; Boundary conditions, exact solutions to Couette and Poiseuille flows; micro-channel simulations.

6. Advanced lattice Boltzmann methods:
   - Entropic lattice Boltzmann scheme, subgrid simulations at high Reynolds numbers; Boundary conditions for complex geometries.

7. Introduction to LB models beyond hydrodynamics:
   - Relativistic fluid dynamics; flows with phase transitions.

Lecture notes

Lecture notes on the theoretical parts of the course will be made available.
Selected original and review papers are provided for some of the lectures on advanced topics.
Handouts and basic code framework for implementation of the lattice Boltzmann models will be provided.

Prerequisites / notice

The course addresses mainly graduate students (MSc/Ph D) but BSc students can also attend.

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<tr>
<th>Course Code</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>151-0207-00L</td>
<td>Theory and Modeling of Reactive Flows</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>C. E. Frouzakis, I. Mantzaris</td>
</tr>
<tr>
<td>401-5950-00L</td>
<td>Seminar in Fluid Dynamics for CSE</td>
<td>W</td>
<td>4 credits</td>
<td>2S</td>
<td>P. Jenny, T. Rösgen</td>
</tr>
</tbody>
</table>

Objective

Objective Content

Seminar in Fluid Dynamics for CSE

Enlarged knowledge and practical abilities in fundamentals and applications of Computational Fluid Dynamics

Enlarged knowledge and practical abilities in fundamentals and applications of Computational Fluid Dynamics

Contact Prof. P. Jenny or Prof. T. Rösgen before the beginning of the semester

Contact Prof. P. Jenny or Prof. T. Rösgen before the beginning of the semester

Systems and Control

Number | Title | Type | ECTS | Hours | Lecturers |
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<tr>
<td>227-0103-00L</td>
<td>Control Systems</td>
<td>W</td>
<td>6 credits</td>
<td>2V+2U</td>
<td>F. Dörfler</td>
</tr>
</tbody>
</table>

Abstract

Study of concepts and methods for the mathematical description and analysis of dynamical systems. The concept of feedback. Design of control systems for single input - single output and multivariable systems.

Objective


Literature

Signals arise in most engineering applications. They contain information about the behavior of physical systems. Systems respond to signals in various ways, such as through linear time-invariant systems. The behavior of systems can be characterized using analytical methods, and machine learning algorithms provide powerful tools for searching data sets for characteristic patterns. Typical tasks include classification, clustering, and anomaly detection.

### Prerequisites
- Knowledge of advanced calculus, introductory probability theory, and matrix-vector algebra.

### Literature

### Objective
- By the end of the class students should be comfortable with the fundamental results in linear system theory and the mathematical tools used to derive them.
- Rings, fields and linear spaces, normed linear spaces and inner product spaces.
- Ordinary differential equations, existence and uniqueness of solutions.
- Continuous and discrete time, time varying linear systems. Time domain solutions. Time invariant systems treated as a special case.
- Controllability and observability, canonical forms, Kalman decomposition. Time invariant systems treated as a special case.
- Stability and stabilization, observers, state and output feedback, separation principle.
- Realization theory.

### Content

### Lecture notes
Lecture notes, problem set with solutions.
The goal of this course is to provide students with a good understanding of computer vision and image analysis techniques. The main concepts and techniques will be studied in depth and practical algorithms and approaches will be discussed and explored through the exercises.

The course requires solid basic knowledge in analysis, statistics and numerical methods for CSE as well as practical programming experience for solving assignments. Students should at least have followed one previous course offered by the Machine Learning Institute (e.g., CIL or LIS) or an equivalent course offered by another institution.

It is recommended that students have taken the Visual Computing lecture or a similar course introducing basic image processing concepts before taking this course.

The primary objective of this course is that the student deepens an applied understanding of how to model the most common robotic systems such as robot arms, legged robots, rotary wing systems, or fixed wing.

The requirement for the Robotics Vertiefung and for the Masters in Mechatronics and Microsystems.

Robotics is often viewed from three perspectives: perception (sensing), manipulation (affecting changes in the world), and cognition (intelligence). Robotic systems integrate aspects of all three of these areas. This course provides an introduction to the theory of robotics, and covers the fundamentals of the field, including rigid motions, homogeneous transformations, forward and inverse kinematics of multiple degree of freedom manipulators, velocity kinematics, motion planning, trajectory generation, sensing, vision, and control. This course is a requirement for the Robotics Vertiefung and for the Masters in Mechatronics and Microsystems.

An introduction to the theory of robotics, and covers the fundamentals of the field, including rigid motions, homogeneous transformations, forward and inverse kinematics of multiple degree of freedom manipulators, velocity kinematics, motion planning, trajectory generation, sensing, vision, and control.

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The course requires solid basic knowledge in analysis, statistics and numerical methods for CSE as well as practical programming experience for solving assignments. Students should at least have followed one previous course offered by the Machine Learning Institute (e.g., CIL or LIS) or an equivalent course offered by another institution.

It is recommended that students have taken the Visual Computing lecture or a similar course introducing basic image processing concepts before taking this course.

The requirement for the Robotics Vertiefung and for the Masters in Mechatronics and Microsystems.
Content
The course consists of three parts: First, we will refresh and deepen the student's knowledge in kinematics, dynamics, and rotations of multi-body systems. In this context, the learning material will build upon the courses for mechanics and dynamics available at ETH, with the particular focus on their application to robotic systems. The goal is to foster the conceptual understanding of similarities and differences among the various types of robots. In the second part, we will apply the learned material to classical robotic arms as well as legged systems and discuss kinematic constraints and interaction forces. In the third part, focus is put on modeling fixed wing aircraft, along with related design and control concepts. In this context, we also touch aerodynamics and flight mechanics to an extent typically required in robotics. The last part finally covers different helicopter types, with a focus on quadrotors and the coaxial configuration which we see today in many UAV applications. Case studies on all main topics provide the link to real applications and to the state of the art in robotics.

Prerequisites / notice
The contents of the following ETH Bachelor lectures or equivalent are assumed to be known: Mechanics and Dynamics, Control, Basics in Fluid Dynamics.

401-5860-00L Seminar in Robotics for CSE
Type: Hours: W 3V+2U
Abstract: This course provides an opportunity to familiarize yourself with the advanced topics of robotics and mechatronics research. The study plan has to be discussed with the lecturer based on your specific interests and/or the relevant seminar series such as the IRIS's Robotics Seminars and BiRONZ lectures, for example.
Objective: The students are familiar with the challenges of the fascinating and interdisciplinary field of Robotics and Mechatronics. They are introduced in the basics of independent non-experimental scientific research and are able to summarize and to present the results efficiently.
Content: This 4 ECTS course requires each student to discuss a study plan with the lecturer and select minimum 10 relevant scientific publications to read through, or attend 5-10 lectures of the public robotics oriented seminars (e.g. Public robotics seminars such as the IRIS's Robotics Seminars http://www.iris.ethz.ch/iris/series/, and BiRONZ lectures http://www.birl.ethz.ch/bironz/index are good examples). At the end of semester, the results should be presented in an oral presentation and summarized in a report, which takes the discussion of the presentation into account.

402-0809-00L Introduction to Computational Physics
Number: Title: Type: ECTS: Hours: Lecturers
402-0809-00L Introduction to Computational Physics: W: 8 credits: 2V+2U: H. J. Herrmann
Abstract: This course offers an introduction to computer simulation methods for physics problems and their implementation on PCs and super computers: classical equations of motion, partial differential equations (wave equation, diffusion equation, Maxwell's equation), Monte Carlo simulations, percolation, phase transitions.
Content: Prerequisites / notice: Lecture and exercise lessons in english, exams in German or in English

402-0205-00L Quantum Mechanics I
Number: Title: Type: ECTS: Hours: Lecturers
402-0205-00L Quantum Mechanics I: W: 10 credits: 3V+2U: T. K. Gehrmann
Abstract: Introduction to non-relativistic single-particle quantum mechanics. In particular, the basic concepts of quantum mechanics, such as the quantisation of classical systems, wave functions and the description of observables as operators on a Hilbert space, and the formulation of symmetries will be discussed. Basic phenomena will be analysed and illustrated by generic examples.
Objective: Introduction to single-particle quantum mechanics. Familiarity with basic ideas and concepts (quantisation, operator formalism, symmetries, perturbation theory) and generic examples and applications (bound states, tunneling, scattering states, in one- and three-dimensional settings). Ability to solve simple problems.
Content: Keywords: Schrödinger equation, basic formalism of quantum mechanics (states, operators, commutators, measuring process), symmetries (translations, rotations), quantum mechanics in one dimension, spherically symmetric problems in three dimensions, scattering theory, perturbation theory, variational techniques, spin, addition of angular momenta, relation between QM and classical physics.
Literature: F. Schwabl: Quantum mechanics
J.J. Sakurai: Modern Quantum Mechanics
C. Cohen-Tannoudji: Quantum mechanics I

401-5810-00L Seminar in Physics for CSE
Number: Title: Type: ECTS: Hours: Lecturers
401-5810-00L Seminar in Physics for CSE: W: 4 credits: 2S: A. Soluyanov, M. Troyer
Abstract: In this seminar the students present a talk on an advanced topic in modern theoretical or computational physics.

401-3913-01L Mathematical Foundations for Finance
Number: Title: Type: ECTS: Hours: Lecturers
Abstract: First introduction to main modelling ideas and mathematical tools from mathematical finance
Objective: This course gives a first introduction to the main modelling ideas and mathematical tools from mathematical finance. It aims at a double audience: mathematicians who want to learn the modelling ideas and concepts for finance, and non-mathematicians who need an introduction to the main tools from stochastics used in mathematical finance. The main emphasis will be on ideas, but important results will be given with (sometimes partial) proofs.
Content: Topics to be covered include
- financial market models in finite discrete time
- absence of arbitrage and martingale measures
- valuation and hedging in complete markets
- basics about Brownian motion
- stochastic integration
- stochastic calculus: Itô's formula, Girsanov transformation, Itô's representation theorem
- Black-Scholes formula
Lecture notes: Lecture notes will be submitted at the beginning of the course.
Literature: Lecture notes will be submitted at the beginning of the course. Additional (background) references are given there.
Prerequisites / notice: Prerequisites: Results and facts from probability theory as in the book "Probability Essentials" by J. Jacod and P. Protter will be used freely. Especially participants without a direct mathematics background are strongly advised to familiarise themselves with those tools before (or very quickly during) the course. (A possible alternative to the above English textbook are the (German) lecture notes for the standard course "Wahrscheinlichkeitstheorie").
For those who are not sure about their background, we suggest to look at the exercises in Chapters 8, 9, 22-25, 28 of the Jacod/Protter book. If these pose problems, you will have a hard time during the course. So be prepared.

401-4657-00L Numerical Analysis of Stochastic Ordinary Differential
Number: Title: Type: ECTS: Hours: Lecturers
401-4657-00L Numerical Analysis of Stochastic Ordinary Differential: W: 6 credits: 3V+1U: A. Jentzen
Abstract: Data: 06.03.2019 12:57
Equations

Alternative course title: “Computational Methods for Quantitative Finance: Monte Carlo and Sampling Methods”

Abstract

Course on numerical approximations of stochastic ordinary differential equations driven by Wiener processes. These equations have several applications, for example in financial option valuation. This course also contains an introduction to random number generation and Monte Carlo methods for random variables.

Objective

The aim of this course is to enable the students to carry out simulations and their mathematical convergence analysis for stochastic models originating from applications such as mathematical finance. For this the course teaches a decent knowledge of the different numerical methods, their underlying ideas, convergence properties and implementation issues.

Content

Generation of random numbers
Monte Carlo methods for the numerical integration of random variables
Stochastic processes and Brownian motion
Stochastic ordinary differential equations (SODEs)
Numerical approximations of SODEs
Multilevel Monte Carlo methods for SODEs
Applications to computational finance: Option valuation

Lecture notes

Lecture Notes are available in the lecture homepage (please follow the link in the Learning materials section).

Literature

P. Glassermann:

P. E. Kloeden and E. Platen:

Prerequisites / notice

Prerequisites:
Mandatory: Probability and measure theory, basic numerical analysis and basics of MATLAB programming.

a) mandatory courses:
Elementary Probability, Probability Theory I.

b) recommended courses:
Stochastic Processes.

Start of lectures: Wednesday, September 21, 2016
For more details, please follow the link in the Learning materials section.
Electromagnetics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>227-0110-00L</td>
<td>Advanced Electromagnetic Waves</td>
<td>W</td>
<td>6</td>
<td>2V+2U</td>
<td>P. Leuchtmann</td>
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<tr>
<td></td>
<td>This course has been moved from the spring to the fall semester for the academic year of 2016/17. It will therefore not take place in spring 2017.</td>
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<td>Abstract</td>
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<td>This course provides advanced knowledge of electromagnetic waves in linear materials including negative index and other non classical materials.</td>
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<td>Objective</td>
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<td>The behavior of electromagnetic waves both in free space and in selected environments including stratified media, material interfaces and waveguides is understood. Material models in the time harmonic regime including negative index and plasmonic materials are clarified.</td>
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<td>Content</td>
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<td></td>
<td>Description of generic time harmonic electromagnetic fields; the role of the material in Maxwell's equations; energy transport and power loss mechanism; EM-waves in homogeneous space: ordinary and evanescent plane waves, cylindrical and spherical waves, &quot;complex origin&quot;-waves and beams; EM-waves in stratified media; generic guiding mechanism for EM waves; classical wave guides, dielectric wave guides.</td>
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<td>Lecture notes</td>
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<td>A sketch including animated wave representations is provided in electronic form.</td>
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<td>Literature</td>
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<tr>
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<td>See literature list in the script.</td>
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<td>Prerequisites / notice</td>
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<td>The lecture is taught in German while both the script and the viewgraphs are in English.</td>
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<tr>
<td>227-0301-00L</td>
<td>Physical Modelling and Simulation</td>
<td>W</td>
<td>5</td>
<td>4G</td>
<td>C. Hafner, J. Leuthold, J. Smajic</td>
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<tr>
<td></td>
<td>Abstract</td>
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<td>This module consists of (a) an introduction to fundamental equations of electromagnetics, mechanics and heat transfer, (b) a detailed overview of numerical methods for field simulations, and (c) practical examples solved in form of small projects.</td>
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<td>Basic knowledge of the fundamental equations and effects of electromagnetics, mechanics, and heat transfer. Knowledge of the main concepts of numerical methods for physical modelling and simulation. Ability (a) to develop own simple field simulation programs, (b) to select an appropriate field solver for a given problem, (c) to perform field simulations, (d) to evaluate the obtained results, and (e) to interactively improve the models until sufficiently accurate results are obtained.</td>
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<td>Content</td>
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<td>The module begins with an introduction to the fundamental equations and effects of electromagnetics, mechanics, and heat transfer. After the introduction follows a detailed overview of the available numerical methods for solving electromagnetic, thermal and mechanical boundary value problems. This part of the course contains a general introduction into numerical methods, differential and integral forms, linear equation systems, Finite Difference Method (FDM), Boundary Element Method (BEM), Method of Moments (MoM), Multiple Multipole Program (MMP) and Finite Element Method (FEM). The theoretical part of the course finishes with a presentation of multiphysics simulations through several practical examples of HF-engineering such as coupled electromagnetic-mechanical and electromagnetic-thermal analysis of MEMS. In the second part of the course the students will work in small groups on practical simulation problems. For solving practical problems the students can develop and use own simulation programs or chose an appropriate commercial field solver for their specific problem. This practical simulation work of the students is supervised by the lecturers.</td>
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<td>Prerequisites / notice</td>
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The goal of this course is to learn and understand few principal partial differential equations (conservation laws) that are applicable for
Continuum Mechanics

Taras Gerya Introduction to Numerical Geodynamic Modelling Cambridge University Press, 2010
ECTS 4G

Lecturers

Hours

Title

T. Gerya

A provisional week-by-week schedule (subject to change) is as follows:

Week 1: The continuity equation
Theory: Definition of a geological media as a continuum. Field variables used for the representation of a continuum. Methods for definition of
the field variables. Eulerian and Lagrangian points of view. Continuity equation in Eulerian and Lagrangian forms and their derivation.
Exercise: Computing the divergence of velocity field.

Week 2: Density and gravity
Theory: Density of rocks and minerals. Thermal expansion and compressibility. Dependence of density on pressure and temperature.
Equations of state. Poisson equation for gravitational potential and its derivation.
Exercise: Computing density, thermal expansion and compressibility from an equation of state.

Week 3: Stress and strain
Theory: Deformation and stresses. Definition of stress, strain and strain-rate tensors. Deviatoric stresses. Mean stress as a dynamic
(nonlithostatic) pressure. Stress and strain rate invariants.
Exercise: Analysing strain rate tensor for solid body rotation.

Week 4: The momentum equation
Stokes equation of slow laminar flow of highly viscous incompressible fluid and its application to geodynamics. Simplification of the Stokes
equation in case of constant viscosity and its relation to the Poisson equation.
Exercises: Computing velocity for magma flow in a channel.

Week 5: Viscous rheology of rocks
Theory: Solid-state creep of minerals and rocks as the major mechanism of deformation of the Earth’s interior. Dislocation and diffusion
creep mechanisms. Rheological equations for minerals and rocks. Effective viscosity and its dependence on temperature, pressure and
strain rate. Formulation of the effective viscosity from empirical flow laws.
Exercise: Deriving viscous rheological equations for computing effective viscosities from empirical flow laws.

Week 6: The heat conservation equation
Theory: Fourier’s law of heat conduction. Heat conservation equation and its derivation. Radioactive, viscous and adiabatic heating and
their relative importance. Heat conservation equation for the case of a constant thermal conductivity and its relation to the Poisson
equation.
Exercise: steady temperature profile in case of channel flow.

Week 7: Elasticity and plasticity

GRADING will be based on homeworks (30%) and oral exams (70%).
Exam questions: http://www.erdw.ethz.ch/people/geophysics/tgerya/EXAM_QUESTIONS
Script is available by request to taras.gerya@erdw.ethz.ch
Exam questions: http://www.erdw.ethz.ch/people/geophysics/tgerya/EXAM_QUESTIONS

Literature
Taras Gerya Introduction to Numerical Geodynamic Modelling Cambridge University Press, 2010

The goal of this course is for students to learn how to program numerical applications from scratch. By the end of the course, students
should be able to write, explain and analyse the equations and apply them for simple analytical cases. Numerical solving of these
equations will be discussed in the Numerical Modelling I and II course running in parallel.

A provisional week-by-week schedule (subject to change) is as follows:

Week 1: The continuity equation
Theory: Continuum Mechanics. Field variables: velocity, temperature, pressure, density. Field variables used for the representation of a
continuum. Eulerian and Lagrangian points of view. Continuity equation in Eulerian and Lagrangian forms and their derivation.
Exercise: Computing the divergence of velocity field.

Week 2: Density and gravity
Theory: Continuum Mechanics. Density and gravity. Thermal expansion and compressibility. Dependence of density on pressure and
temperature. Equations of state. Poisson equation for gravitational potential and its derivation.
Exercise: Computing density, thermal expansion and compressibility from an equation of state.

Week 3: Stress and strain
Theory: Continuum Mechanics. Stress and strain. Definition of stress, strain and strain-rate tensors. Deviatoric stresses. Mean stress as a
dynamic (nonlithostatic) pressure. Stress and strain rate invariants.
Exercise: Analysing strain rate tensor for solid body rotation.

Week 4: The momentum equation
Theory: Continuum Mechanics. Momentum equation. Viscosity and Newtonian law of viscous friction. Navier-Stokes equation for the
motion of a viscous fluid. Stokes equation of slow laminar flow of highly viscous incompressible fluid and its application to geodynamics.
Simplification of the Stokes equation in case of constant viscosity and its relation to the Poisson equation.
Exercises: Computing velocity for magma flow in a channel.

Week 5: Viscous rheology of rocks
Theory: Continuum Mechanics. Solid-state creep of minerals and rocks as the major mechanism of deformation of the Earth’s interior.
Dislocation and diffusion creep mechanisms. Rheological equations for minerals and rocks. Effective viscosity and its dependence on
temperature, pressure and strain rate. Formulation of the effective viscosity from empirical flow laws.
Exercise: Deriving viscous rheological equations for computing effective viscosities from empirical flow laws.

Week 6: The heat conservation equation
Theory: Continuum Mechanics. Fourier’s law of heat conduction. Heat conservation equation and its derivation. Radioactive, viscous and
adiabatic heating and their relative importance. Heat conservation equation for the case of a constant thermal conductivity and its
relation to the Poisson equation.
Exercise: steady temperature profile in case of channel flow.

Week 7: Elasticity and plasticity
potential. Plastic flow rule.
Content
A provisional week-by-week schedule (subject to change) is as follows:

Week 1: Introduction to the finite difference approximation to differential equations. Introduction to programming in Matlab. Solving of 1D Poisson equation.
Week 3: Solving momentum and continuity equations in case of constant viscosity with stream function/vorticity formulation.
Week 4: Staggered grid for formulating momentum and continuity equations. Indexing of unknowns. Solving momentum and continuity equations in case of constant viscosity using pressure-velocity formulation with staggered grid.
Weeks 5: Conservative finite differences for the momentum equation. “Free slip” and “no slip” boundary conditions. Solving momentum and continuity equations in case of variable viscosity using pressure-velocity formulation with staggered grid.
Week 7: Advection in 2-D with Marker-in-cell method. Combining flow calculation and advection for buoyancy driven flow.
Week 9: Solving 2D heat conservation equation in case of constant thermal conductivity with explicit and implicit approaches.
Week 10: Solving 2D heat conservation equation in case of variable thermal conductivity with implicit approach. Temperature advection with markers. Creating thermomechanical code by combining mechanical solution for 2D buoyancy driven flow with heat diffusion and advection based on marker-in-cell approach.
Week 11: Subgrid diffusion of temperature. Implementing subgrid diffusion to the thermomechanical code.
Week 12: Implementation of radioactive, adiabatic and shear heating to the thermomechanical code.
Week 13: Implementation of temperature-, pressure- and strain rate-dependent viscosity, temperature- and pressure-dependent density and temperature-dependent thermal conductivity to the thermomechanical code. Final project description.

Literature
Taras Gerya, Introduction to Numerical Geodynamic Modelling, Cambridge University Press 2010

>>>> Geophysics: Subject 3
Offered in the spring semester

>>>> Geophysics: Subject 4
Offered in the spring semester

>>>> Geophysics: Subject 5

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<tr>
<td>651-4014-00L</td>
<td>Seismic Tomography</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>E. Kissling, T. Diehl</td>
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</table>

Abstract
Seismic tomography is the science of interpreting seismographic measurements to derive information about the structure of the Earth. The subject of this course is the formal relationship existing between a seismographic measurement and the nature of the Earth, or of certain regions of the Earth, and the ways to use it, to gain information about the Earth.

Literature

>>>> Geophysics: Subject 6
Offered in the spring semester

>>>> Biology

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<tr>
<td>636-0007-00L</td>
<td>Computational Systems Biology</td>
<td>W</td>
<td>6 credits</td>
<td>3+2U</td>
<td>J. Stelling</td>
</tr>
</tbody>
</table>

Abstract
Study of fundamental concepts, models and computational methods for the analysis of complex biological networks. Topics: Systems approaches in biology, biology and reaction network fundamentals, modeling and simulation approaches (topological, probabilistic, stoichiometric, qualitative, linear / nonlinear ODEs, stochastic), and systems analysis (complexity reduction, stability, identification).

Objective
The aim of this course is to provide an introductory overview of mathematical and computational methods for the modeling, simulation and analysis of biological networks.

Content
Biology has witnessed an unprecedented increase in experimental data and, correspondingly, an increased need for computational methods to analyze this data. The explosion of sequenced genomes, and subsequently, of bioinformatics methods for the storage, analysis and comparison of genetic sequences provides a prominent example. Recently, however, an additional area of research, captured by the label “Systems Biology”, focuses on how networks, which are more than the mere sum of their parts’ properties, establish biological functions. This is essentially a task of reverse engineering. The aim of this course is to provide an introductory overview of corresponding computational methods for the modeling, simulation and analysis of biological networks.

We will start with an introduction into the basic units, functions and design principles that are relevant for biology at the level of individual cells. Making extensive use of example systems, the course will then focus on methods and algorithms that allow for the investigation of biological networks with increasing detail. These include (i) graph theoretical approaches for revealing large-scale network organization, (ii) probabilistic (Bayesian) network representations, (iii) structural network analysis based on reaction stoichiometries, (iv) qualitative methods for dynamic modeling and simulation (Boolean and piece-wise linear approaches), (v) mechanistic modeling using ordinary differential equations (ODEs) and finally (vi) stochastic simulation methods.

Lecture notes
https://www.ethz.ch/content/specialinterest/bsse/computational-systems-biology/en/education/lectures/csb/LectureMaterial.html

Literature
Abstract
This course focuses on modeling spatio-temporal problems in biology, in particular on the cell and tissue level. A wide range of mathematical techniques will be presented as part of the course, including concepts from non-linear dynamics (ODE and PDE models), stochastic techniques (SDE, Master equations, Monte Carlo simulations), and thermodynamic descriptions.

Objective
The aim of the course is to introduce students to state-of-the-art mathematical modelling of spatio-temporal problems in biology. Students will learn how to choose from a wide range of modelling techniques and how to apply these to further our understanding of biological mechanisms. The course aims at equipping students with the tools and concepts to conduct successful research in this area; both classical as well as recent research work will be discussed.

Content
1. Introduction to Modelling in Biology
2. Morphogen Gradients
3. Turing Pattern
4. Travelling Waves & Wave Pinning
5. Application Example 1: Dorso-ventral axis formation
6. Chemotaxis, Cell Adhesion & Migration
7. Introduction to Numerical Methods
8. Simulations on Growing Domains
9. Image-Based Modelling
10. Branching Processes
11. Cell-based Simulation Frameworks
12. Application Example 2: Limb Development
13. Summary

Lecture notes
All lecture material will be made available online
https://www.bsse.ethz.ch/cobi/education/636-0706-00L_Spatial_Modeling_in_Biology.html

Literature
Murray, Mathematical Biology, Springer
Forgacs and Newman, Biological Physics of the Developing Embryo, CUP
Keener and Sneyd, Mathematical Physiology, Springer
Fall et al, Computational Cell Biology, Springer
Szallasi et al, System Modeling in Cellular Biology, MIT Press
Wolkenhauer, Systems Biology
Kreyzig, Engineering Mathematics, Wiley

Prerequisites / notice
The course builds on introductory courses in Computational Biology. The course assumes no background in biology but a good foundation regarding mathematical and computational techniques.
Prerequisites:
"Visualization, Simulation and Interaction - Virtual Reality I" is recommended.

Didactical concept:
The course consists of lectures and exercises.

**151-0833-00L Principles of Nonlinear Finite-Element-Methods**

- **W 5 credits 2V+2U N. Manopulo, B. Berisha, P. Hora**

Abstract
Most problems in engineering are of nonlinear nature. The nonlinearities are caused basically due to the nonlinear material behavior, contact conditions and instability of structures. The principles of the nonlinear Finite-Element-Method (FEM) will be introduced in the scope of this lecture for treating such problems.

Objective
The goal of the lecture is to provide the students with the fundamentals of the nonlinear Finite Element Method (FEM). The lecture focuses on the principles of the nonlinear Finite-Element-Method based on explicit and implicit formulations. Typical applications of the nonlinear Finite-Element-Methods are simulations of:
- Crash
- Collapse of structures
- Materials in Biomechanics (soft materials)
- General forming processes

Content
- Fundamentals of continuum mechanics to characterize large plastic deformations
- Elasto-plastic material models
- Updated-Lagrange (UL), Euler and combined Euler-Lagrange (ALE) approaches
- FEM implementation of constitutive equations
- Element formulations
- Implicit and explicit FEM methods
- FEM formulations of coupled thermo-mechanical problems
- Modeling of tool contact and the influence of friction
- Solvers and convergence
- Modeling of crack propagation
- Introduction of advanced FE-Methods

Lecture notes
Yes

Literature

Prerequisites / notice
If we will have a large number of students, two dates for the exercises will be offered.

**263-5001-00L Introduction to Finite Elements and Sparse Linear System Solving**

- **W 4 credits 2V+1U P. Arbenz**

Abstract
The finite element (FE) method is the method of choice for (approximately) solving partial differential equations on complicated domains. In the first third of the lecture, we give an introduction to the method. The rest of the lecture will be devoted to methods for solving the large sparse linear systems of equations that are typical for the FE method. We will consider direct and iterative methods.

Objective
Students will know the most important direct and iterative solvers for sparse linear systems. They will be able to determine which solver to choose in particular situations.

Content
I. THE FINITE ELEMENT METHOD

   (1) Introduction. model problems.

   (2) 1D problems. Piecewise polynomials in 1D.

   (3) 2D problems. Triangulations. Piecewise polynomials in 2D.

   (4) Variational formulations. Galerkin finite element method.

   (5) Implementation aspects.

II. DIRECT SOLUTION METHODS

   (6) LU and Cholesky decomposition.

   (7) Sparse matrices.

   (8) Fill-reducing orderings.

III. ITERATIVE SOLUTION METHODS

   (9) Stationary iterative methods, preconditioning.

   (10) Preconditioned conjugate gradient method (PCG).

   (11) Incomplete factorization preconditioning.

   (12) Multigrid preconditioning.

   (13) Nonsymmetric problems (GMRES, BiCGstab).

   (14) Indefinite problems (SYMMLQ, MINRES).
Understand concurrency paradigms and models from a higher perspective and acquire skills for designing, structuring and developing.

Prerequisites:
- Three years of university-level computer science or related studies.
- Background in discrete structures, including algorithms, data structures, and complexity theory.
- Proficiency in a programming language.

Topics covered:
- Advanced topics in parallel / concurrent programming.
- Concurrent models and their implementation.
- Advanced topics in parallel / concurrent programming.

Concrete applications covered:
- Programming paradigms for parallel processing (MapReduce, Spark).
- The most important query paradigms (selection, projection, joining, grouping, ordering, windowing).

Objectives:
- Become familiar with important technical concepts and with concurrency folklore.
- Become able to distinguish parallelism in problem space and in machine space.
- Understand concurrency paradigms and models from a higher perspective and acquire skills for designing, structuring and developing possibly large concurrent software systems.
- Become able to distinguish parallelism in problem space and in machine space.
- Become familiar with important technical concepts and with concurrency folklore.

References:

Literature
- Prerequisites: Linear Algebra, Analysis, Computational Science.
- The exercises are made with Matlab.

The key challenge of the information society is to turn data into information, information into knowledge, knowledge into value. This has become increasingly complex. Data comes in larger volumes, diverse shapes, from different sources. Data is more heterogeneous and less structured than forty years ago. Nevertheless, it still needs to be processed fast, with support for complex operations.

Unfortunately, the quantity of data produced and available -- now in the Zettabyte range (that's 21 zeroes) per year -- keeps growing faster than our ability to process it. Hence, new architectures and approaches for processing it were and are still needed. Harnessing them must involve a deep understanding of data not only in the large, but also in the small.

The field of databases evolves at a fast pace. In order to be prepared, to the extent possible, to the (r)evolutions that will take place in the next few decades, the emphasis of the lecture will be on the paradigms and core design ideas, while today's technologies will serve as supporting illustrations thereof.

After visiting this lecture, you should have gained an overview and understanding of the Big Data landscape, which is the basis on which one can make informed decisions, i.e., pick and orchestrate the relevant technologies together for addressing each business use case efficiently and consistently.

This course gives an overview of database technologies and of the most important database design principles that lay the foundations of the Big Data universe. The material is organized along three axes: data in the large, data in the small, data in the very small. A broad range of aspects is covered with a focus on how they fit all together in the big picture of the Big Data ecosystem.

We will also host two guest lectures to get insights from the industry: UBS and Google.

Prerequisites / notice
- Prerequisites: Solid basic knowledge in statistics, algorithms and programming. Background in machine learning is helpful but not required.
- Literature
  - Papers from scientific conferences and journals. References will be given as part of the course material during the semester.

Content:
- Prerequisites: Linear Algebra, Analysis, Computational Science.
- The exercises are made with Matlab.

We will also host two guest lectures to get insights from the industry: UBS and Google.

Prerequisites / notice
- Prerequisites: Solid basic knowledge in statistics, algorithms and programming. Background in machine learning is helpful but not required.

Literature

Objective
- The participation in the course is subject to the following conditions:
  1. The number of participants is limited to 120 students (MSc and PhDs).
  2. Students must have taken the exam in Machine Learning (252-0535-00) or have acquired equivalent knowledge.
Abstract

Introduction to discrete event systems. We start out by studying popular models of discrete event systems. In the second part of the course we analyze discrete event systems from an average-case and from a worst-case perspective. Topics include: Automata and Languages, Specification Models, Stochastic Discrete Event Systems, Worst-Case Event Systems, Verification, Network Calculus.

Objective

Over the past few decades the rapid evolution of computing, communication, and information technologies has brought about the proliferation of new dynamic systems. A significant part of activity in these systems is governed by operational rules designed by humans. The dynamics of these systems are characterized by asynchronous occurrences of discrete events, some controlled (e.g. hitting a keyboard key, sending a message), some not (e.g. spontaneous failure, packet loss).

The mathematical arsenal centered around differential equations that has been employed in systems engineering to model and study processes governed by the laws of nature is often inadequate or inappropriate for discrete event systems. The challenge is to develop new modeling frameworks, analysis techniques, design tools, testing methods, and optimization processes for this new generation of systems.

In this lecture we give an introduction to discrete event systems. We start out the course by studying popular models of discrete event systems, such as automata and Petri nets. In the second part of the course we analyze discrete event systems. We first examine discrete event systems from an average-case perspective: we model discrete events as stochastic processes, and then apply Markov chains and queuing theory for an understanding of the typical behavior of a system. In the last part of the course we analyze discrete event systems from a worst-case perspective using the theory of online algorithms and adversarial queuing.

Content

1. Introduction
2. Automata and Languages
3. Smarter Automata
4. Specification Models
5. Stochastic Discrete Event Systems
6. Worst-Case Event Systems
7. Network Calculus

Lecture notes

Available

Literature

[bertsekas] Data Networks
Dimitri Bertsekas, Robert Gallager

[borodin] Online Computation and Competitive Analysis
Allan Borodin, Ran El-Yaniv.
Cambridge University Press, 1998

[boudec] Network Calculus
J.-Y. Le Boudec, P. Thiran
Springer, 2001

[cassandras] Introduction to Discrete Event Systems
Christos Cassandras, Stéphane Lafortune.

[fiat] Online Algorithms: The State of the Art
A. Fiat and G. Woeginger

D. Hochbaum

[schickinger] Diskrete Strukturen (Band 2: Wahrscheinlichkeitstheorie und Statistik)
T. Schickinger, A. Steger
Springer, Berlin, 2001

[sipser] Introduction to the Theory of Computation
Michael Sipser.

Abstract

Context recognition in mobile communication systems like mobile phone, smart watches and wearable computer will be studied using advanced methods from sensor data fusion, pattern recognition, statistics, data mining and machine learning. Context comprises the behavior of individuals and of groups, their activities as well as the local and social environment.

Objective

Using internal sensors and sensors in our environment including data from the wristwatch, bracelet or internet (crowd sourcing), our 'smart phone' detects our context continuously, e.g. where we are, what we are doing, with whom we are together, what is our constitution, what are our needs. Based on this information our 'smart phone' offers us the appropriate services like a personal assistant. Context comprises user's behavior, his activities, his local and social environment.

In the data path from the sensor level to signal segmentation to the classification of the context, advanced methods of signal processing, pattern recognition and machine learning will be applied. Sensor data generated by crowdsourcing methods are integrated. The validation using MATLAB is followed by implementation and testing on a smart phone. Context recognition as the crucial function of mobile systems is the main focus of the course. Using MatLab the participants implement and verify the discussed methods also using a smart phone.
Using internal sensors and sensors in our environment including data from the wristwatch, bracelet or internet (crowd sourcing), our ’smart phone’ detects our context continuously, e.g. where we are, what we are doing, with whom we are together, what is our constitution, what are our needs. Based on this information our ’smart phone’ offers us the appropriate services like a personal assistant. Context recognition - what is the situation of the user, his activity, his environment, how is he doing, what are his needs - as the central functionality of mobile systems constitutes the focus of the course.

The main topics of the course include
Sensor nets, sensor signal processing, data fusion, time series (segmentation, similarly measures), supervised learning (Bayes Decision Theory, Decision Trees, Random Forest, KNN-Methods, Support Vector Machine, Adaboost, Deep Learning), clustering (k-means, dbscan, topic models), Recommender Systems, Collaborative Filtering, Crowdsourcing.

The exercises show concrete design problems like motion and gesture recognition using distributed sensors, detection of activity patterns and identification of the local environment.

Presentations of the PhD students and the visit at the Wearable Computing Lab introduce in current research topics and international research projects.

Language: german/english (depending on the participants)
Lecture notes: Lecture notes for all lessons, assignments and solutions.
http://www.lfe.ee.ethz.ch/education/wearable_systems_1

Literature
Literature will be announced during the lessons.
No special prerequisites

227-0447-00L Image Analysis and Computer Vision W 6 credits 3V+1U L. Van Gool, O. Göksel, E. Konukoglu
Abstract

Objective
Overview of the most important concepts of image formation, perception and analysis, and Computer Vision. Gaining own experience through practical computer and programming exercises.

Content
The first part of the course starts off from an overview of existing and emerging applications that need computer vision. It shows that the realm of image processing is no longer restricted to the factory floor, but is entering several fields of our daily life. First it is investigated how the parameters of the electromagnetic waves are related to our perception. Also the interaction of light with matter is considered. The most important hardware components of technical vision systems, such as cameras, optical devices and illumination sources are discussed. The course then turns to the steps that are necessary to arrive at the discrete images that serve as input to algorithms. The next part describes necessary preprocessing steps of image analysis, that enhance image quality and/or detect specific features. Linear and non-linear filters are introduced for that purpose. The course will continue by analyzing procedures allowing to extract additional types of basic information from multiple images, with motion and depth as two important examples. The estimation of image velocities (optical flow) will get due attention and methods for object tracking will be presented. Several techniques are discussed to extract three-dimensional information about objects and scenes. Finally, approaches for the recognition of specific objects as well as object classes will be discussed and analyzed.

Lecture notes
Course material Script, computer demonstrations, exercises and problem solutions
Prerequisites / notice
Prerequisites:
Basic concepts of mathematical analysis and linear algebra. The computer exercises are based on Linux and C.
The course language is English.

227-0417-00L Information Theory I W 6 credits 4G A. Lapidoth
Abstract
This course covers the basics of information theory and of communication theory. Topics covered include the entropy rate of a source, mutual information, typical sequences, the asymptotic equi-partition property, Huffman coding, channel capacity, the channel coding theorem, the source-channel separation theorem, and feedback capacity.

Objective
The fundamentals of Information Theory including Shannon's source coding and channel coding theorems

Content
The entropy rate of a source, Typical sequences, the asymptotic equi-partition property, the source coding theorem, Huffman coding, Arithmetic coding, channel capacity, the channel coding theorem, the source-channel separation theorem, feedback capacity

Lecture notes
Course material Script, computer demonstrations, exercises and problem solutions
Prerequisites / notice
Prerequisites:
Basic concepts of mathematical analysis and linear algebra. The computer exercises are based on Linux and C.
The course language is English.

227-0427-00L Signal and Information Processing: Modeling, Filtering, Learning W 6 credits 4G H.A. Loeliger
Abstract
Fundamentals in signal processing, detection/estimation, and machine learning.
I. Linear signal representation and approximation: Hilbert spaces, LMMSE estimation, regularization and sparsity.

Objective
The course is an introduction to some basic topics in signal processing, detection/estimation theory, and machine learning.

Content

Lecture notes
Lecture notes.
Prerequisites:
- local bachelors: course "Discrete-Time and Statistical Signal Processing" (5. Sem.)
- others: solid basics in linear algebra and probability theory

227-0623-00L Applied Computer Architecture W 6 credits 4G A. Gunzinger
Abstract
This lecture gives an overview of the requirements and the architecture of parallel computer systems, performance, reliability and costs.

Objective
Understand the function, the design and the performance modeling of parallel computer systems.
Content
The lecture "Applied Computer Architecture" gives technical and corporate insights into innovative Computer Systems/Architectures (CPU, GPU, FPGA, special processors) and their real implementations and applications. Often the designs have to deal with technical limits. Which computer architecture allows the control of over 1000 magnets at the Swiss Light Source (SLS)? Which architecture is behind the alarm center of the Swiss Railway (SBB)? Which computer architectures are applied for driver assistance systems? Which computer architecture is hidden behind a professional digital audio mixing desk? How can data streams of about 30 TB/s, produced by a protone accelerator, be processed in real time? Can the weather forecast also be processed with GPUs? How can a good computer architecture be found?

Lecture notes
Prerequisites / notice
Basics of computer architecture.

252-0237-00L
Concepts of Object-Oriented Programming
W
6 credits
3V+2U
P. Müller

Abstract
Course that focuses on an in-depth understanding of object-oriented programming and compares designs of object-oriented programming languages. Topics include different flavors of type systems, inheritance models, encapsulation in the presence of aliasing, object and class initialization, program correctness, reflection.

Objective
After this course, students will:
- Have a deep understanding of advanced concepts of object-oriented programming and their support through various language features.
- Be able to understand language concepts on a semantic level and be able to compare and evaluate language designs.

Content
The main goal of this course is to convey a deep understanding of the key concepts of sequential object-oriented programming and their support in different programming languages. This is achieved by studying how important challenges are addressed through language features and programming idioms. In particular, the course discusses alternative language designs by contrasting solutions in languages such as C++, C#, Eiffel, Java, Python, and Scala. The course also introduces novel ideas from research languages that may influence the design of future mainstream languages.

The topics discussed in the course include among others:
- The pros and cons of different flavors of type systems (for instance, static vs. dynamic typing, nominal vs. structural, syntactic vs. behavioral typing).
- The key problems of single and multiple inheritance and how different languages address them.
- Generic type systems, in particular, Java generics, C# generics, and C++ templates.
- The situations in which object-oriented programming does not provide encapsulation, and how to avoid them.
- The pitfalls of object initialization, exemplified by a research type system that prevents null pointer dereferencing.
- How to maintain the consistency of data structures.

Literature
Will be announced in the lecture.

Prerequisites / notice
Prerequisites:
- Mastering at least one object-oriented programming language (this course will NOT provide an introduction to object-oriented programming).
- Programming experience.

252-0417-00L
Randomized Algorithms and Probabilistic Methods
W
7 credits
3V+2U+1A
A. Steger, E. Welzl

Abstract
Las Vegas & Monte Carlo algorithms; inequalities of Markov, Chebyshev, Chernoff; negative correlation; Markov chains: convergence, rapidly mixing; generating functions; Examples include: min cut, median, balls and bins, routing in hypercubes, 3SAT, card shuffling, random walks.

Objective
After this course students will know fundamental techniques from probabilistic combinatorics for designing randomized algorithms and will be able to apply them to solve typical problems in these areas.

Content
Randomized Algorithms are algorithms that "flip coins" to take certain decisions. This concept extends the classical model of deterministic algorithms and has become very popular and useful within the last twenty years. In many cases, randomized algorithms are faster, simpler or just more elegant than deterministic ones. In the course, we will discuss basic principles and techniques and derive from them a number of randomized methods for problems in different areas.

Literature

252-0546-00L
Physically-Based Simulation in Computer Graphics
W
4 credits
2V+1U
B. Solenthaler, B. Thomaszewski

Abstract
This lecture provides an introduction to physically-based animation in computer graphics and gives an overview of fundamental methods and algorithms. The practical exercises include three assignments which are to be solved in small groups. In an additional course project, topics from the lecture will be implemented into a 3D game or a comparable application.

Objective
The lecture covers topics in physically-based modeling, such as particle systems, mass-spring models, finite difference and finite element methods. These approaches are used to represent and simulate deformable objects or fluids with applications in animated movies, 3D games and medical systems. Furthermore, the lecture covers topics such as rigid body dynamics, collision detection, and character animation.

Content
The lecture covers topics in physically-based modeling.

Prerequisites / notice
Fundamentals of calculus and physics, basic concepts of algorithms and data structures, basic programming skills in C++. Knowledge on numerical mathematics as well as ordinary and partial differential equations is an asset, but not required.

401-3611-00L
Advanced Topics in Computational Statistics
W
4 credits
2V
M. H. Maathuis

Abstract
This lecture covers selected advanced topics in computational statistics, including various classification methods, the EM algorithm, clustering, handling missing data, and graphical modelling.

Objective
Students learn the theoretical foundations of the selected methods, as well as practical skills to apply these methods and to interpret their outcomes.

Content
The course is roughly divided into three parts: (1) Supervised learning via (variations of) nearest neighbor methods, (2) the EM algorithm and clustering, (3) handling missing data and graphical models.

Lecture notes
Lecture notes.

Prerequisites / notice
We assume a solid background in mathematics, an introductory lecture in probability and statistics, and at least one more advanced course in statistics.

401-3627-00L
High-Dimensional Statistics
W
4 credits
2V
P. L. Bühlmann

Abstract
This lecture provides an introduction to high-dimensional statistics, including the study of methods and models for analyzing data with many variables.

Objective
Students learn about the challenges and solutions in high-dimensional data analysis, including topics such as variable selection, dimension reduction, and statistical inference.

Content
The course covers a range of advanced statistical techniques and their applications in various fields. Students will explore the theoretical foundations and practical implementation of these methods.

Prerequisites / notice
Knowledge of basic statistical concepts and proficiency in R or Python programming.

Data: 06.03.2019 12:57
Autumn Semester 2016
Page 1347 of 1571
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Semester</th>
<th>Credits</th>
<th>Type</th>
<th>Prerequisites / notice</th>
</tr>
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<tbody>
<tr>
<td>227-1033-00L</td>
<td>Particle Accelerator Physics and Modeling I</td>
<td>W</td>
<td>6</td>
<td></td>
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<tr>
<td>401-4623-00L</td>
<td>Time Series Analysis</td>
<td>W</td>
<td>6</td>
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<td>401-3901-00L</td>
<td>Mathematical Optimization</td>
<td>W</td>
<td>11</td>
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<tr>
<td>401-3640-66L</td>
<td>Mathematical Optimization</td>
<td>W</td>
<td>4</td>
<td></td>
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<tr>
<td>402-0777-00L</td>
<td>Particle Accelerator Physics and Modeling I</td>
<td>W</td>
<td>6</td>
<td></td>
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</tbody>
</table>
Neuromorphic circuits are inspired by the organizing principles of biological neural circuits. Their computational primitives are based on physics of semiconductor devices. Neuromorphic architectures often rely on collective computation in parallel networks. Adaptation, learning and memory are implemented locally within the individual computational elements. Transistors are often operated in weak inversion (below threshold), where they exhibit exponential I-V characteristics and low currents. These properties lead to the feasibility of high-density, low-power implementations of functions that are computationally intensive in other paradigms. Application domains of neuromorphic circuits include silicon retinas and cochleas for machine vision and audition, real-time emulations of networks of biological neurons, and the development of autonomous robotic systems. This course covers devices in CMOS technology (MOS transistor below and above threshold, floating-gate MOS transistor, phototransducers), static circuits (differential pair, current mirror, transconductance amplifiers, etc.), dynamic circuits (linear and nonlinear filters, adaptive circuits), systems (silicon neuron, silicon retina and cochlea) and an introduction to multi-chip systems that communicate events analogous to spikes. The lectures are accompanied by weekly laboratory sessions on the characterization of neuromorphic circuits, from elementary devices to systems.

Prerequisites: Background in basics of semiconductor physics helpful, but not required.

<table>
<thead>
<tr>
<th>Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>CRN</th>
<th>Instructor</th>
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<tbody>
<tr>
<td>227-1037-00L</td>
<td>Introduction to Neuroinformatics</td>
<td>W</td>
<td>6</td>
<td>K. A. Martin, M. Cook, V. Mante, M. Pfeiffer</td>
</tr>
<tr>
<td>327-1201-00L</td>
<td>Transport Phenomena I</td>
<td>W</td>
<td>4</td>
<td>H. C. Öttinger</td>
</tr>
<tr>
<td>151-0104-00L</td>
<td>Uncertainty Quantification for Engineering &amp; Life Sciences</td>
<td>W</td>
<td>4</td>
<td>P. Koumoutsakos</td>
</tr>
</tbody>
</table>

Abstract

151-0104-00L
Quantification of uncertainties in computational models pertaining to applications in engineering and life sciences. Exploitation of massively available data to develop computational models with quantifiable predictive capabilities. Applications of Uncertainty Quantification and Propagation to problems in mechanics, control, systems and cell biology.

Objective

The course will teach fundamental concept of Uncertainty Quantification and Propagation (UQ+P) for computational models of systems in Engineering and Life Sciences. Emphasis will be placed on practical and computational aspects of UQ+P including the implementation of relevant algorithms in multicore architectures.

Content

Topics that will be covered include: Uncertainty quantification under parametric and non-parametric modelling uncertainty, Bayesian inference with model class assessment, Markov Chain Monte Carlo simulation, prior and posterior reliability analysis.

Lecture notes

The class will be largely based on the book: Data Analysis: A Bayesian Tutorial by Devinderjit Sivia as well as on class notes and related literature that will be distributed in class.

Literature

1. Data Analysis: A Bayesian Tutorial by Devinderjit Sivia
2. Probability Theory: The Logic of Science by E. T. Jaynes
3. Class Notes

Prerequisites / notice

Fundamentals of Probability, Fundamentals of Computational Modeling
Lecture notes
A detailed manuscript is provided; this manuscript will be developed into a book entitled "A Modern Course in Transport Phenomena" by David C. Venerus and Hans Christian Öttinger.

Literature

Prerequisites / notice

see also Fields of Specialization

Case Studies

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>401-3667-66L</td>
<td>Case Studies Seminar (Autumn Semester 2016)</td>
<td>W</td>
<td>3</td>
<td>2S</td>
<td>V. C. Gradinaru, R. Hiptmair, M. Reiher</td>
</tr>
</tbody>
</table>

Abstract
In the CSE Case Studies Seminar invited speakers from ETH, from other universities as well as from industry give a talk on an applied topic. Beside of attending the scientific talks students are asked to give short presentations (10 minutes) on a published paper out of a list.

Semester Paper

There are several course units "Semester Paper" that are all equivalent. If, during your studies, you write several semester papers, choose among the different numbers in order to be able to obtain credits again.

<table>
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<tr>
<th>Number</th>
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<th>Hours</th>
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<tr>
<td>401-3740-01L</td>
<td>Semester Paper</td>
<td>W</td>
<td>8</td>
<td>11A</td>
<td>Professors</td>
</tr>
</tbody>
</table>

Abstract
Semester Papers help to deepen the students' knowledge of a specific subject area. Students are offered a selection of topics. These papers serve to develop the students' ability for independent mathematical work as well as to enhance skills in presenting mathematical results in writing.

Prerequisites / notice
There are several course units "Semester Paper" that are all equivalent. If, during your studies, you write several semester papers, choose among the different numbers in order to be able to obtain credits again.

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<th>Hours</th>
<th>Lecturers</th>
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<td>401-3740-02L</td>
<td>Semester Paper</td>
<td>W</td>
<td>8</td>
<td>11A</td>
<td>Professors</td>
</tr>
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Abstract
Semester Papers help to deepen the students' knowledge of a specific subject area. Students are offered a selection of topics. These papers serve to develop the students' ability for independent mathematical work as well as to enhance skills in presenting mathematical results in writing.

Prerequisites / notice
There are several course units "Semester Paper" that are all equivalent. If, during your studies, you write several semester papers, choose among the different numbers in order to be able to obtain credits again.

GESS Science in Perspective

see Science in Perspective: Type A: Enhancement of Reflection Capability

see Science in Perspective: Language Courses ETH/UZH

Recommended Science in Perspective (Type B) for D-MATH.

Master's Thesis

Scientific Works in Mathematics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>401-2000-00L</td>
<td>Scientific Works in Mathematics</td>
<td>O</td>
<td>0</td>
<td></td>
<td>E. Kowalski</td>
</tr>
</tbody>
</table>

Target audience:
Third year Bachelor students;
Master students who cannot document to have received an adequate training in working scientifically;
Mandatory for all Bachelor and Master students with matriculation in the autumn semester 2014 or later.

Directive

Abstract
Introduction to scientific writing for students with focus on publication standards and ethical issues, especially in the case of citations (references to works of others.)

Objective
Learn the basic standards of scientific works in mathematics.

Content
- Types of mathematical works
- Publication standards in pure and applied mathematics
- Data handling
- Ethical issues
- Citation guidelines

Lecture notes
Moodle of the Mathematics Library: https://moodle-app2.let.ethz.ch/course/view.php?id=519
This course is completed by the optional course "Recherchieren in der Mathematik" (held in German) by the Mathematics Library. For more details see: http://www.math.ethz.ch/library/services/schulungen

401-4990-01L Master's Thesis

Only students who fulfil the following criteria are allowed to begin with their master's thesis:

a. successful completion of the bachelor programme;
b. fulfilling of any additional requirements necessary to gain admission to the master programme.

For Programme Regulations 2014 there are additional requirements.

No direct enrolment to this course unit in myStudies. Please fill in the online application form. Requirements and application form under www.math.ethz.ch/intranet/students/study-administration/theses.html (Afterwards the enrolment will be done by the Study Administration.)

Abstract

The master's thesis concludes the study programme. Thesis work should prove the students' ability to independent, structured and scientific working.

Objective

Thesis work should prove the students' ability to independent, structured and scientific working.

Colloquia

Number | Title | Type | ECTS | Hours | Lecturers
---|---|---|---|---|---

Abstract

Research colloquium

Course Units for Additional Admission Requirements

The courses below are only available for MSc students with additional admission requirements.

Number | Title | Type | ECTS | Hours | Lecturers
---|---|---|---|---|---
151-0122-AAL | Fluid Dynamics for CSE | E- | 5 | 11R | T. Rösgen

Abstract

An introduction to the physical and mathematical foundations of fluid dynamics is given. Topics include dimensional analysis, integral and differential conservation laws, inviscid and viscous flows, Navier-Stokes equations, boundary layers, turbulent pipe flow. Elementary solutions and examples are presented.

Objective

An introduction to the physical and mathematical principles of fluid dynamics. Fundamental terminology/principles and their application to simple problems.

Content

Phänomene, Anwendungen, Grundfragen

Dimensionsanalyse und Ähnlichkeit; Kinematische Beschreibung; Erhaltungssätze (Masse, Impuls, Energie), integrale und differentielle Formulierungen; Reibungsfreie Strömungen: Euler-Gleichungen, Stromfadentheorie, Satz von Bernoulli; Reibungsbehaftete Strömungen: Navier-Stokes-Gleichungen; Grenzschichten; Turbulenz

Lecture notes

Eine erweiterte Formelsammlung zur Vorlesung wird elektronisch zur Verfügung gestellt.

Literature

Empfohlenes Buch: Fluid Mechanics, P. Kundu & I. Cohen, Elsevier

Prerequisites / notice

Performance Assessment: session examination

Allowed aids:

Textbook (free selection, list of assignments), list of formulars IFD, 8 Sheets (=4 Pages) own notes, calculator

406-0353-AAL | Analysis III | E- | 4 | 9R | M. Soner

Abstract

Introduction to partial differential equations. Differential equations which are important in applications are classified and solved. Elliptic, parabolic and hyperbolic differential equations are treated. The following mathematical tools are introduced: Laplace transforms, Fourier series, separation of variables, methods of characteristics.

Objective

Mathematical treatment of problems in science and engineering. To understand the properties of the different types of partial differential equations.
Laplace Transforms:
- Laplace Transform, Inverse Laplace Transform, Linearity, s-Shifting
- Transforms of Derivatives and Integrals, ODEs
- Unit Step Function, t-Shifting
- Short Impulses, Dirac's Delta Function, Partial Fractions
- Convolution, Integral Equations
- Differentiation and Integration of Transforms

Fourier Series, Integrals and Transforms:
- Fourier Series
- Functions of Any Period p=2L
- Even and Odd Functions, Half-Range Expansions
- Forced Oscillations
- Approximation by Trigonometric Polynomials
- Fourier Integral
- Fourier Cosine and Sine Transform

Partial Differential Equations:
- Basic Concepts
- Modeling: Vibrating String, Wave Equation
- Solution by separation of variables; use of Fourier series
- D'Alembert Solution of Wave Equation, Characteristics
- Heat Equation: Solution by Fourier Series
- Heat Equation: Solutions by Fourier Integrals and Transforms
- Modeling Membrane: Two Dimensional Wave Equation
- Laplacian in Polar Coordinates: Circular Membrane, Fourier-Bessel Series
- Solution of PDEs by Laplace Transform

Fourier Series, Integrals and Transforms:
- Fourier Series
- Functions of Any Period p=2L
- Even and Odd Functions, Half-Range Expansions
- Forced Oscillations
- Approximation by Trigonometric Polynomials
- Fourier Integral
- Fourier Cosine and Sine Transform

Partial Differential Equations:
- Basic Concepts
- Modeling: Vibrating String, Wave Equation
- Solution by separation of variables; use of Fourier series
- D'Alembert Solution of Wave Equation, Characteristics
- Heat Equation: Solution by Fourier Series
- Heat Equation: Solutions by Fourier Integrals and Transforms
- Modeling Membrane: Two Dimensional Wave Equation
- Laplacian in Polar Coordinates: Circular Membrane, Fourier-Bessel Series
- Solution of PDEs by Laplace Transform

Literature

For reference/complement of the Analysis I/II courses:
- Christian Blatter: Ingenieur-Analysis (Download PDF)
- http://www.math.ethz.ch/education/bachelor/lectures/hs2013/other/analysis3_itet
Abstract

The course gives an introduction into fundamental techniques and algorithms of numerical mathematics which play a central role in numerical simulations in science and technology. The course focuses on fundamental ideas and algorithmic aspects of numerical methods. The exercises involve actual implementation of numerical methods in C++.

Objective

- Knowledge of the fundamental algorithms in numerical mathematics
- Knowledge of the essential terms in numerical mathematics and the techniques used for the analysis of numerical algorithms
- Ability to choose the appropriate numerical method for concrete problems
- Ability to interpret numerical results
- Ability to implement numerical algorithms efficiently

Content

1. Direct Methods for linear systems of equations
2. Least Squares Techniques
3. Data Interpolation and Fitting
4. Filtering Algorithms
5. Approximation of Functions
6. Numerical Quadrature
7. Iterative Methods for non-linear systems of equations
8. Data Interpolation and Fitting
9. Single Step Methods for ODEs
10. Stiff Integrators

Lecture notes

Lecture materials (PDF documents and codes) will be made available to participants.

Literature

M. Hanke-Bourgeois "Grundlagen der Numerischen Mathematik und des wissenschaftlichen Rechnens", BG Teubner, 2002
P. Deuflhard and A. Hohmann, "Numerische Mathematik I", DeGruyter, 2002
M. Hanke-Bourgeois "Grundlagen der Numerischen Mathematik und des wissenschaftlichen Rechnens", BG Teubner, 2002
P. Deuflhard and A. Hohmann, "Numerische Mathematik I", DeGruyter, 2002

Prerequisites / notice

Solid knowledge about fundamental concepts and techniques from linear algebra & calculus as taught in the first year of science and engineering curricula.

The course will be accompanied by programming exercises in C++ relying on the template library EIGEN. Familiarity with C++, object oriented and generic programming is an advantage. Participants of the course are expected to learn C++ by themselves.

252-0232-AAL Software Design

Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Abstract

The course Software Design presents and discusses design patterns regularly used to solve problems in object oriented design and object oriented programming. The presented patterns are illustrated with examples from the Java libraries and are applied in a project.

Objective

The students

- know the principles of object oriented programming and can apply these.
- know the most important object oriented design patterns.
- can apply design patterns to solve design problems.
- discover in a given design the use of design patterns.

529-0483-AAL Statistical Physics and Computer Simulation

Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Abstract

Principles and applications of statistical mechanics and equilibrium molecular dynamics, Monte Carlo simulation, Stochastic dynamics.

Exercises using a MD simulation program to generate ensembles and subsequently calculate ensemble averages.

Objective

Introduction to statistical mechanics with the aid of computer simulation, development of skills to carry out statistical mechanical calculations using computers and interpret the results.

Content

Principles and applications of statistical mechanics and equilibrium molecular dynamics, Monte Carlo simulation, Stochastic dynamics.

Exercises using a MD simulation program to generate ensembles and subsequently calculate ensemble averages.

Lecture notes

available

Literature

see "Course Schedule"

additional information will be provided in the first lecture.

Computational Science and Engineering Master - Key for Type

| O | Compulsory | E- | Recommended, not eligible for credits |
| W+ | Eligible for credits and recommended | Z | Courses outside the curriculum |
| W | Eligible for credits | Dr | Suitable for doctorate |

Key for Hours

V lecture
G lecture with exercise
U exercise
S seminar
K colloquium

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
# Robotics, Systems and Control Master

## Core Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>151-0104-00L</td>
<td>Uncertainty Quantification for Engineering &amp; Life Sciences</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>P. Koumoutsakos</td>
</tr>
</tbody>
</table>

**Abstract**

Quantification of uncertainties in computational models pertaining to applications in engineering and life sciences. Exploitation of massively available data to develop computational models with quantifiable predictive capabilities. Applications of Uncertainty Quantification and Propagation to problems in mechanics, control, systems and cell biology.

**Objective**

The course will teach fundamental concept of Uncertainty Quantification and Propagation (UQ+P) for computational models of systems in Engineering and Life Sciences. Emphasis will be placed on practical and computational aspects of UQ+P including the implementation of relevant algorithms in multicore architectures.

**Content**

Topics that will be covered include: Uncertainty quantification under parametric and non-parametric modelling uncertainty, Bayesian inference with model class assessment, Markov Chain Monte Carlo simulation, prior and posterior reliability analysis.

**Lecture notes**

The class will be largely based on the book: Data Analysis: A Bayesian Tutorial by Devinderjit Sivia as well as on class notes and related literature that will be distributed in class.

**Literature**

1. Data Analysis: A Bayesian Tutorial by Devinderjit Sivia
2. Probability Theory: The Logic of Science by E. T. Jaynes
3. Class Notes

**Prerequisites / notice**

Fundamentals of Probability, Fundamentals of Computational Modeling

<table>
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<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>151-0107-20L</td>
<td>High Performance Computing for Science and Engineering (HPCSE) I</td>
<td>W</td>
<td>4 credits</td>
<td>4G</td>
<td>M. Troyer, P. Chatzidoukas</td>
</tr>
</tbody>
</table>

**Abstract**

This course gives an introduction into algorithms and numerical methods for parallel computing for multi and many-core architectures and for applications from problems in science and engineering.

**Objective**

Introduction to HPC for scientists and engineers

Fundamental of:
1. Parallel Computing Architectures
2. MultiCores
3. ManyCores

**Content**

Programming models and languages:
1. C++ threading (2 weeks)
2. OpenMP (4 weeks)
3. MPI (5 weeks)

Computers and methods:
1. Hardware and architectures
2. Libraries
3. Particles: N-body solvers
4. Fields: PDEs
5. Stochastics: Monte Carlo

**Lecture notes**

http://www.cse-lab.ethz.ch/index.php/teaching/42-teaching/classes/615-hpcse1

Class notes, handouts

<table>
<thead>
<tr>
<th>Number</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>151-0509-00L</td>
<td>Microscale Acoustofluidics</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>J. Dual</td>
</tr>
</tbody>
</table>

**Abstract**

In this lecture the basics as well as practical aspects (from modelling to design and fabrication) are described from a solid and fluid mechanics perspective with applications to microsystems and lab on a chip devices.

**Objective**

Understanding acoustophoresis, the design of devices and potential applications

**Content**

Linear and nonlinear acoustics, foundations of fluid and solid mechanics and piezoelectricity. Gorkov potential, numerical modelling, acoustic streaming, applications from ultrasonic microrobotics to surface acoustic wave devices

**Lecture notes**


**Literature**


**Prerequisites / notice**

Solid and fluid continuum mechanics. Notice: The exercise part is a mixture of presentation, lab session and hand in homework.

<table>
<thead>
<tr>
<th>Number</th>
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<tbody>
<tr>
<td>151-0563-01L</td>
<td>Dynamic Programming and Optimal Control</td>
<td>W</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>R. D’Andrea</td>
</tr>
</tbody>
</table>

**Abstract**

Introduction to Dynamic Programming and Optimal Control.

**Objective**

Covers the fundamental concepts of Dynamic Programming & Optimal Control.

**Content**

Dynamic Programming Algorithm; Deterministic Systems and Shortest Path Problems; Infinite Horizon Problems, Bellman Equation; Deterministic Continuous-Time Optimal Control.

**Literature**


**Requirements**: Knowledge of advanced calculus, introductory probability theory, and matrix-vector algebra.

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</table>

**Abstract**

This course provides a comprehensive overview of embedded control systems. The concepts introduced are implemented and verified on a microprocessor-controlled haptic device.

**Objective**

Familiarize students with main architectural principles and concepts of embedded control systems.
### Objective

The objective of this course is to expose students to the fundamental aspects of the emerging field of microrobotics. This includes a focus on physical laws that predominate at the microscale, technologies for fabricating small devices, bio-inspired design, and applications of the field.

### Content

- Scaling laws at micro/nano scales
- Electrostatics
- Electromagnetism
- Low Reynolds number flows
- Observation tools
- Materials and fabrication methods
- Applications of biomedical microrobots

### Lecture notes

The powerpoint slides presented in the lectures will be made available in hardcopy and as pdf files. Several readings will also be made available electronically.

### Prerequisites / notice

The course will be taught in English.

---

### Content

- Applications of biomedical microrobots
- Materials and fabrication methods
- Observation tools
- Low Reynolds number flows
- Electromagnetism
- Electrostatics
- Scaling laws at micro/nano scales
- Forward and inverse kinematics of multiple degree of freedom manipulators
- Velocity kinematics
- Motion planning
- Trajectory generation
- Sensing, vision, and control

### Lecture notes

Lecture notes, lab instructions, supplemental material

### Prerequisites / notice

Prerequisite courses are Control Systems I and Informatics I.

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### Theory of Robotics and Mechatronics

- Forward and inverse kinematics of multiple degree of freedom manipulators
- Velocity kinematics
- Motion planning
- Trajectory generation
- Sensing, vision, and control

### Lecture notes

Lecture notes, lab instructions, supplemental material

### Prerequisites / notice

This course is restricted to 33 students due to limited lab infrastructure. Interested students please contact Marianne Schmid (E-Mail: marianne@ethz.ch). After your reservation has been confirmed please register online at www.mystudies.ethz.ch.

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### Microrobotics

- Forward and inverse kinematics of multiple degree of freedom robots
- Microrobotics
- Biomicrofluidics
- Small animals

### Lecture notes

Lecture notes, lab instructions, supplemental material

### Prerequisites / notice

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### ETH Zurich Distinguished Seminar in Robotics, Systems, and Controls

- Students for other Master's programmes in Department of Mechanical and Process Engineering cannot use the credit in the category Core Courses
- Obtain an overview of various topics in Robotics, Systems, and Controls
- MSc students in Robotics, Systems, and Controls are required to attend every lecture
- Attendance will be monitored
- For some reason a student cannot attend one of the lectures, the student must select another ETH or University of Zurich seminar related to the field and submit a one page description of the seminar topic
- The course will be taught in English

### Lecture notes

Lecture notes, lab instructions, supplemental material

### Prerequisites / notice

Students are required to attend all seven lectures to obtain credit. If a student must miss a lecture then attendance at a related special lecture will be accepted that is reported in a one page summary of the attended lecture. No exceptions to this rule are allowed.

---

### Vision Algorithms for Mobile Robotics

- Number of participants limited to 50
- For a robot to be autonomous, it has to perceive and understand the world around it. This course introduces you to the fundamental computer vision algorithms used in mobile robotics, in particular: feature extraction, multiple view geometry, dense reconstruction, object tracking, image retrieval, event-based vision, and visual-inertial odometry (the algorithm behind Google Tango).

### Lecture notes

Lecture notes, lab instructions, supplemental material

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- Forward and inverse kinematics of multiple degree of freedom manipulators
- Velocity kinematics
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Lecture notes, lab instructions, supplemental material

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### Lecture notes

Lecture notes, lab instructions, supplemental material

### Prerequisites / notice

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Robot Dynamics

- **Abstract**: We will provide an overview on how to kinematically and dynamically model typical robotic systems such as robot arms, legged robots, rotary wing systems, or fixed wing.

- **Objective**: The primary objective of this course is that the student deepens an applied understanding of how to model the most common robotic systems. The student receives a solid background in kinematics, dynamics, and rotations of multi-body systems. On the basis of state of the art applications, he/she will learn all necessary tools to work in the field of design or control of robotic systems.

- **Content**: The course consists of three parts: First, we will refresh and deepen the student's knowledge in kinematics, dynamics, and rotations of multi-body systems. In this context, the learning material will build upon the courses for mechanics and dynamics available at ETH, with the particular focus on their application to robotic systems. The goal is to foster the conceptual understanding of similarities and differences among the various types of robots. In the second part, we will apply the learned material to classical robotic arms as well as legged systems and discuss kinematic constraints and interaction forces. In the third part, focus is put on modeling fixed wing aircraft, along with related design and control concepts. In this context, we also touch aerodynamics and flight mechanics to an extent typically required in robotics. The last part finally covers different helicopter types, with a focus on quadrotors and the coaxial configuration which we see today in many UAV applications. Case studies on all main topics provide the link to real applications and to the state of the art in robotics.

- **Prerequisites / notice**: Basics of algebra and geometry, matrix calculus.
| Objective | Over the past few decades the rapid evolution of computing, communication, and information technologies has brought about the proliferation of new dynamic systems. A significant part of activity in these systems is governed by operational rules designed by humans. The dynamics of these systems are characterized by asynchronous occurrences of discrete events, some controlled (e.g. hitting a keyboard key, sending a message), some not (e.g. spontaneous failure, packet loss). The mathematical arsenal centered around differential equations that has been employed in systems engineering to model and study processes governed by the laws of nature is often inadequate or inappropriate for discrete event systems. The challenge is to develop new modeling frameworks, analysis techniques, design tools, testing methods, and optimization processes for this new generation of systems. |
| Lecture notes | Available |
| 227-0103-00L Control Systems | W 6 credits 2V+2U F. Dörfler |
| Objective | Study of concepts and methods for the mathematical description and analysis of dynamical systems. The concept of feedback. Design of control systems for single input - single output and multivariable systems. |
| Prerequisites / notice | Prerequisites: Signal and Systems Theory II. MATLAB is used for system analysis and simulation. |
| 227-0225-00L Linear System Theory | W 6 credits 5G M. Kamgarpour |
| Objective | By the end of the class students should be comfortable with the fundamental results in linear system theory and the mathematical tools used to derive them. |
The goal of this course is understanding the stationary and dynamic problems in electrical power systems. The course includes the theory and techniques for the identification of dynamic models from experimentally obtained system input-output data.

<table>
<thead>
<tr>
<th>Code</th>
<th>Course Name</th>
<th>Credits</th>
<th>Type</th>
<th>Prerequisites / notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0247-00L</td>
<td>Power Electronic Systems I</td>
<td>W 6</td>
<td>4G</td>
<td>J. W. Kolar</td>
</tr>
<tr>
<td>Abstract</td>
<td>Basics of the switching behavior, gate drive and snubber circuits of power semiconductors are discussed. Soft-switching and resonant DC/DC converters are analyzed in detail and high frequency loss mechanisms of magnetic components are explained. Space vector modulation of three-phase inverters is introduced and the main power components are designed for typical industry applications.</td>
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<tr>
<td>Objective</td>
<td>Detailed understanding of the principle of operation and modulation of advanced power electronics converter systems, especially of zero voltage switching and zero current switching non-isolated and isolated DC/DC converter systems and three-phase voltage DC link inverter systems. Furthermore, the course should convey knowledge on the switching frequency related losses of power semiconductors and inductive power components and introduce the concept of space vector calculus which provides a basis for the comprehensive discussion of three-phase PWM converters systems in the lecture Power Electronic Systems II.</td>
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<tr>
<td>Content</td>
<td>Basics of the switching behavior and gate drive circuits of power semiconductor devices and auxiliary circuits for minimizing the switching losses are explained. Furthermore, zero voltage switching, zero current switching, zero current commutation, and resonant DC/DC converters are discussed in detail. The operating behavior of isolated full-bridge DC/DC converters is detailed for different secondary side rectifier topologies; high frequency loss mechanisms of magnetic components of converter circuits are explained and approximate calculation methods are presented; the concept of space vector calculus for analyzing three-phase systems is introduced; finally, phase-oriented and space vector modulation of three-phase inverter systems are discussed based on analytical calculations is explained.</td>
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<tr>
<td>Lecture notes</td>
<td>Lecture notes and associated exercises including correct answers, simulation program for interactive self-learning including visualization/animation features.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Prerequisites: Introductory course on power electronics.</td>
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<tbody>
<tr>
<td>227-0447-00L</td>
<td>Image Analysis and Computer Vision</td>
<td>W 6</td>
<td>3V+1U</td>
<td>L. Van Gool, O. Göksel, E. Konukoglu</td>
</tr>
<tr>
<td>Objective</td>
<td>Overview of the most important concepts of image formation, perception and analysis, and Computer Vision. Gaining own experience through practical computer and programming exercises.</td>
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<tr>
<td>Content</td>
<td>The first part of the course starts off from an overview of existing and emerging applications that need computer vision. It shows that the realm of image processing is no longer restricted to the factory floor, but is entering several fields of our daily life. First it is investigated how the parameters of the electromagnetic waves are related to our perception. Also the interaction of light with matter is considered. The most important hardware components of technical vision systems, such as cameras, optical devices and illumination sources are discussed. The course then turns to the steps that are necessary to arrive at the discrete images that serve as input to algorithms. The next part describes necessary preprocessing steps of image analysis, that enhance image quality and/or detect specific features. Linear and non-linear filters are introduced for that purpose. The course will continue by analyzing procedures allowing to extract additional types of basic information from multiple images, with motion and depth as two important examples. The estimation of image velocities (optical flow) will get due attention and methods for object tracking will be presented. Several techniques are discussed to extract three-dimensional information about objects and scenes. Finally, approaches for the recognition of specific objects as well as object classes will be discussed and analyzed.</td>
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<tr>
<td>Lecture notes</td>
<td>Course material Script, computer demonstrations, exercises and problem solutions</td>
<td></td>
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<tr>
<td>Prerequisites / notice</td>
<td>Prerequisites: Basic concepts of mathematical analysis and linear algebra. The computer exercises are based on Linux and C. The course language is English.</td>
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<tr>
<td>227-0526-00L</td>
<td>Power System Analysis</td>
<td>W 6</td>
<td>4G</td>
<td>G. Hug</td>
</tr>
<tr>
<td>Abstract</td>
<td>The goal of this course is understanding the stationary and dynamic problems in electrical power systems. The course includes the development of stationary models of the electrical network, their mathematical representation and special characteristics and solution methods of large linear and non-linear systems of equations related to electrical power networks.</td>
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<td>Objective</td>
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<tr>
<td>Content</td>
<td>The electrical power transmission system, the energy management system, requirements of the electrical power transmission (demand oriented, operationally, economically), network planning and network operation, models of N-port network components (line, cables, shunts, transformers), the p.u. computation, computer oriented network models, linear networks (solution methods - direct, iterative), algorithms for the solution of non-linear sets of equations, derived from the electrical power system (Newton-Raphson), power flow computation (problem definition, solution methods), three phase short-circuit computation, application of power flow algorithms. Introduction to power system stability.</td>
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<tr>
<td>Lecture notes</td>
<td>Lecture notes. Course is supported by WWW-teaching system.</td>
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<tr>
<td>227-0689-00L</td>
<td>System Identification</td>
<td>W 4</td>
<td>2V+1U</td>
<td>R. Smith</td>
</tr>
<tr>
<td>Abstract</td>
<td>Theory and techniques for the identification of dynamic models from experimentally obtained system input-output data.</td>
<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>To provide a series of practical techniques for the development of dynamical models from experimental data, with the emphasis being on the development of models suitable for feedback control design purposes. To provide sufficient theory to enable the practitioner to understand the trade-offs between model accuracy, data quality and data quantity.</td>
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<tr>
<td>Content</td>
<td>Predective, open-loop, black-box identification methods. Introduction to modeling: Black-box and grey-box models; Parametric and non-parametric models; ARX, ARMAX (etc.) models.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>&quot;Dynamic system identification: Experimental design and data analysis&quot;, GC Goodwin and RL Payne, Academic Press, 1977. Control systems (227-0216-00L) or equivalent.</td>
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<tr>
<td>227-0697-00L</td>
<td>Industrial Process Control</td>
<td>W 4</td>
<td>3G</td>
<td>G. Maier, A. Horch</td>
</tr>
<tr>
<td>Abstract</td>
<td>Introduction to process automation and its application in process industry and power generation. Knowledge of process automation and its application in industry and power generation.</td>
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</tbody>
</table>

Data: 06.03.2019 12:57  Autumn Semester 2016  Page 1358 of 1571
The course provides advanced knowledge in the design of complex computer systems, in particular embedded systems. Models and
material for exercises, copies of transparencies.

J. M. Buhmann
L. Thiele
Hardware/Software Codesign
P. Widmayer
No lecture notes, but slides will be made available on the course webpage.
Slides will be available as .PDF documents, see “Learning materials” (for registered students only)
The course provides advanced knowledge in the design of complex computer systems, in particular embedded systems. Models and
methods are discussed that are fundamental for systems that consist of software and hardware components.

Introduction to process automation: system architecture, data handling, communication (fieldbusses), process visualization, engineering,
etc.
Analysis and design of open loop control problems: discrete automatons, decision tables, petri-nets, drive control and object oriented function
group automation philosophy, RT-UML.
Engineering: Application programming in IEC61131-3 (function blocks, sequence control, structured text); process visualization and
operation; engineering integration from sensor, cabling, topology design, function, visualization, diagnosis, to documentation; Industry
standards (e.g. OPC, Profibus); Ergonomic design, safety (IEC61508) and availability, supervision and diagnosis.
Practical examples from process industry, power generation and newspaper production.

Prerequisites / notice
Exercises: Tuesday 15-16
Practical exercises will illustrate some topics, e.g. some control software coding using industry standard programming tools based on
IEC61131-3.

227-0778-00L Hardware/Software Codesign W 6 credits 2V+2U L. Thiele
Abstract
The course provides advanced knowledge in the design of complex computer systems, in particular embedded systems. Models and
methods are discussed that are fundamental for systems that consist of software and hardware components.

Objective
The course covers the following subjects: (a) Models for describing hardware and software components (specification), (b) Hardware-
Software Interfaces (instruction set, hardware and software components, reconfigurable computing, heterogeneous computer architectures,
System-on-Chip), (c) Application specific instruction sets, code generation and retargetable compilation, (d) Performance analysis and
estimation techniques, (e) System design (hardware/software partitioning and design space exploration).

Content
Material for exercises, copies of transparencies.

Literature

Prerequisites / notice
Prerequisites for the course is a basic knowledge in the following areas: computer architecture, digital design, software design, embedded
systems

227-0920-00L Seminar in Systems and Control Z 0 credits 1S F. Döhrer, R. D’Andrea, J. Lygeros, R. Smith
Abstract
Current topics in Systems and Control presented mostly by external speakers from academia and industry
Objective
see above

252-0535-00L Machine Learning W 8 credits 3V+2U+2A J. M. Buhmann
Abstract
Machine learning algorithms provide analytical methods to search data sets for characteristic patterns. Typical tasks include the
classification of data, function fitting and clustering, with applications in image and speech analysis, bioinformatics and exploratory data
analysis. This course is accompanied by practical machine learning projects.

Objective
Students will be familiarized with the most important concepts and algorithms for supervised and unsupervised learning; reinforce the
statistics knowledge which is indispensible to solve modeling problems under uncertainty. Key concepts are the generalization ability of
algorithms and systematic approaches to modeling and regularization. A machine learning project will provide an opportunity to test the
machine learning algorithms on real world data.

Content
The theory of fundamental machine learning concepts is presented in the lecture, and illustrated with relevant applications. Students can
deepen their understanding by solving both pen-and-paper and programming exercises, where they implement and apply famous
algorithms to real-world data.

Topics covered in the lecture include:
- Bayesian theory of optimal decisions
- Maximum likelihood and Bayesian parameter inference
- Classification with discriminant functions: Perceptrons, Fisher’s LDA and support vector machines (SVM)
- Ensemble methods: Bagging and Boosting
- Regression: least squares, ridge and LASSO penalization, non-linear regression and the bias-variance trade-off
- Non parametric density estimation: Parzen windows, nearest neighbour
- Dimension reduction: principal component analysis (PCA) and beyond

Literature

Prerequisites / notice
The course requires solid basic knowledge in analysis, statistics and numerical methods for CSE as well as practical programming
experience for solving assignments.
Students should at least have followed one previous course offered by the Machine Learning Institute (e.g., CIL or LIS) or an equivalent
course offered by another institution.

252-1407-00L Algorithmic Game Theory W 7 credits 3V+2U+1A P. Widmayer, P. Penna
Abstract
Game theory provides a formal model to study the behavior and interaction of self-interested users and programs in large-scale distributed
computer systems without central control. The course discusses algorithmic aspects of game theory.

Objective
Learning the basic concepts of game theory and mechanism design, acquiring the computational paradigm of self-interested agents, and
using these concepts in the computational and algorithmic setting.
### Content

The Internet is a typical example of a large-scale distributed computer system without central control, with users that are typically only interested in their own good. For instance, they are interested in getting high bandwidth for themselves, but don't care about others, and the same is true for computational load or download rates. Game theory provides a particularly well-suited model for the behavior and interaction of such selfish users and programs. Classic game theory dates back to the 1930s and typically does not consider algorithmic aspects at all. Only a few years back, algorithms and game theory have been considered together, in an attempt to reconcile selfish behavior of independent agents with the common good.

This course discusses algorithmic aspects of game-theoretic models, with a focus on recent algorithmic and mathematical developments. Rather than giving an overview of such developments, the course aims to study selected important topics in depth.

### Outline:
- Introduction to classic game-theoretic concepts
- Existence of stable solutions (equilibria), algorithms for computing equilibria, computational complexity
- Speed of convergence of natural game playing dynamics such as best-response dynamics or regret minimization
- Techniques for bounding the quality-loss due to selfish behavior versus optimal outcomes under central control (a.k.a. the 'Price of Anarchy')
- Design and analysis of mechanisms that induce truthful behavior or near-optimal outcomes at equilibrium.
- Selected current research topics, such as Google's Sponsored Search Auction, the U.S. FCC Spectrum Auction, Kidney Exchange.

### Literature

- "Game Theory and Strategy", Philip D. Straffin, The Mathematical Association of America, 5th printing, 2004

### Prerequisites / notice

Several copies of both books are available in the Computer Science library.

**Audience:** Although this is a Computer Science course, we encourage the participation from all students who are interested in this topic.

**Requirements:** You should enjoy precise mathematical reasoning. You need to have passed a course on algorithms and complexity. No knowledge of game theory is required.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Prerequisites / Notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>252-3110-00L</td>
<td>Human Computer Interaction</td>
<td>W 4</td>
<td>O. Hilliges, M. Norrie</td>
</tr>
<tr>
<td>252-5051-00L</td>
<td>Advanced Topics in Machine Learning</td>
<td>W 2</td>
<td>J. M. Buhmann, Hofmann,</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>A. Krause, G. Rätsch</td>
</tr>
<tr>
<td>252-5701-00L</td>
<td>Advanced Topics in Computer Graphics and Vision</td>
<td>W 2</td>
<td>M. Gross, O. Sorkine Hornung</td>
</tr>
<tr>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Number of participants limited to 24.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Prerequisites / Notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>263-5210-00L</td>
<td>Probabilistic Artificial Intelligence</td>
<td>W 4</td>
<td>S. Tschiatschek</td>
</tr>
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</tbody>
</table>

**Abstract**

This course introduces core modeling techniques and algorithms from statistics, optimization, planning, and control and study applications in areas such as sensor networks, robotics, and the Internet.

**Objective**

How can we build systems that perform well in uncertain environments and unforeseen situations? How can we develop systems that exhibit "intelligent" behavior, without prescribing explicit rules? How can we build systems that learn from experience in order to improve their performance? We will study core modeling techniques and algorithms from statistics, optimization, planning, and control and study applications in areas such as sensor networks, robotics, and the Internet. The course is designed for upper-level undergraduate and graduate students.
This course focuses on the emerging, interdisciplinary field of physical human-robot interaction, bringing together themes from robotics, camera models and calibration, invariant features, multiple-view geometry, model fitting, stereo matching, segmentation, 2D shape matching, shape from silhouettes, optical flow, structure from motion, tracking, object recognition, object category recognition.

The goal of this course is to provide students with a good understanding of computer vision and image analysis techniques. The main concepts and techniques will be studied in depth and practical algorithms and approaches will be discussed and explored through the exercises.

The objectives of this course are:
1. To introduce the fundamental problems of computer vision.
2. To introduce the main concepts and techniques used to solve these.
3. To enable participants to implement solutions for reasonably complex problems.
4. To enable participants to make sense of the computer vision literature.

Virtual Reality in Medicine

Virtual Reality has the potential to support medical training and therapy. This lecture will derive the technical principles of multi-modal (somatic, visual, haptic, tactile, etc.) input devices, displays and rendering techniques. Examples are presented in the fields of surgical training, intra-operative augmentation, and rehabilitation. The lecture is accompanied by practical courses and excursions.

Virtual Reality has the potential to provide descriptive and practical information for medical training and therapy while relieving the patient and/or the physician. Multi-modal interactions between the user and the virtual environment facilitate the generation of high-fidelity sensory impressions, by using not only visual and auditory modalities, but also kinesthetic, tactile, and even olfactory feedback. On the basis of the existing physiological constraints, this lecture will derive the technical requirements and principles of multi-modal input devices, displays, and rendering techniques. Several examples are presented that are currently being developed or already applied for surgical training, intra-operative augmentation, and rehabilitation. The lecture will be accompanied by several practical courses on graphical and haptic display devices as well as excursions to facilities equipped with large-scale VR equipment.

The course language is English. Basic experience in Information Technology and Computer Science will be of advantage. More details will be announced in the lecture.

Physical Human Robot Interaction (pHRI)

By the end of this course, you should understand the critical elements in human-robo interactions - both in terms of engineering and human factors - and use these to evaluate and de-sign safe and efficient assistive and rehabilitative robotic systems. Specifically, you should be able to:
1) identify critical human factors in physical human-robot interaction and use these to derive design requirements;
2) compare and select mechatronic components that optimally fulfill the defined design requirements;
3) derive a model of the device dynamics to guide and optimize the selection and integration of selected components into a functional system;
4) design control hardware and software and implement and test human-interactive control strategies on the physical setup;
5) characterize and optimize such systems using both engineering and psychophysical evaluation metrics;
6) investigate and optimize one aspect of the physical setup and convey and defend the gained insights in a technical presentation.

This course provides an introduction to fundamental aspects of physical human-robot interaction. After an overview of human haptic, visual and auditory sensing, neurophysiology and psychophysics, principles of human-robot interaction systems (kinematics, mechanical transmissions, robot sensors and actuators used in these systems) will be introduced. Throughout the course, students will gain knowledge of interaction control strategies including impedance/admittance and force control, haptic rendering basics and issues in device design for humans such as transparency and stability analysis, safety hardware and procedures. The course is organized into lectures that aim to bring students up to speed with the basics of these systems, readings on classical and current topics in physical human-robot interaction, laboratory sessions and lab visits.

Students will attend periodic laboratory sessions where they will implement the theoretical aspects learned during the lectures. Here the salient features of haptic device design will be identified and theoretical aspects will be implemented in a haptic system based on the haptic paddle (http://www.relab.ethz.ch/education/courses/phri/request-ethz-haptic-paddle-hardware-documentation.html), by creating simple dynamic haptic virtual environments and understanding the performance limitations and causes of instabilities (direct/virtual coupling, friction, damping, time delays, sampling rate, sensor quantization, etc.) during rendering of different mechanical properties.
Lecture notes

Will be distributed through the document repository before the lectures.

http://www.relab.ethz.ch/education/courses/phri.html

Literature


Prerequisites / notice

The registration is limited to 26 students

There are 4 credit points for this lecture.

The lecture will be held in English.

The students are expected to have basic control knowledge from previous classes.

http://www.relab.ethz.ch/education/courses/phri.html

636-0007-00L Computational Systems Biology

W 6 credits 3V+2U J. Stelling

Abstract

Study of fundamental concepts, models and computational methods for the analysis of complex biological networks. Topics: Systems approaches in biology, biology and reaction network fundamentals, modeling and simulation approaches (topological, probabilistic, stoichiometric, qualitative, linear / nonlinear ODEs, stochastic), and systems analysis (complexity reduction, stability, identification).

Objective

The aim of this course is to provide an introductory overview of mathematical and computational methods for the modeling, simulation and analysis of biological networks.

Content

Biological networks have witnessed an unprecedented increase in experimental data and, correspondingly, an increased need for computational methods to analyze this data. The explosion of sequenced genomes, and subsequently, of bioinformatics methods for the storage, analysis and comparison of genetic sequences provides a prominent example. Recently, however, an additional area of research, captured by the label "Systems Biology", focuses on how networks, which are more than the mere sum of their parts' properties, establish biological functions. This is essentially a task of reverse engineering. The aim of this course is to provide an introductory overview of corresponding computational methods for the modeling, simulation and analysis of biological networks.

We will start with an introduction into the basic units, functions and design principles that are relevant for biology at the level of individual cells. Making extensive use of example systems, the course will then focus on methods and algorithms that allow for the investigation of biological networks with increasing detail. These include (i) graph theoretical approaches for revealing large-scale network organization, (ii) probabilistic (Bayesian) network representations, (iii) structural network analysis based on reaction stoichiometrics, (iv) qualitative methods for dynamic modeling and simulation (Boolean and piece-wise linear approaches), (v) mechanistic modeling using ordinary differential equations (ODEs) and finally (vi) stochastic simulation methods.

Lecture notes

https://www.ethz.ch/content/specialinterest/bsse/computational-systems-biology/en/education/lectures/csb/LectureMaterial.html


Multidisciplinary Courses

Any courses offered by the Departments of MAVT, ITET or INFK. Your tutor must agree to this choice.

GESS Science in Perspective

see GESS Science in Perspective: Type A: Enhancement of Reflection Capability

Recommended GESS Science in Perspective (Type B) for D-MAVT.

see GESS Science in Perspective: Language Courses

ETH/UZH

Semester Project

Data: 06.03.2019 12:57  Autumn Semester 2016  Page 1362 of 1571
### Semester Project Robotics, Systems and Control

**Number** 151-1014-00L  
**Title** Semester Project Robotics, Systems and Control  
**Type** O  
**ECTS** 8 credits  
**Hours** 17A  
**Lecturers** Professors

**Abstract**
The semester project is designed to train the students in the solution of specific engineering problems. This makes use of the technical and social skills acquired during the master's program. Tutors propose the subject of the project, elaborate the project plan, and define the roadmap together with their students, as well as monitor the overall execution.

**Objective**
The semester project is designed to train the students in the solution of specific engineering problems. This makes use of the technical and social skills acquired during the master's program.

### Internship

**Number** 151-1015-00L  
**Title** Industrial Internship Robotics, Systems and Control  
**Type** O  
**ECTS** 8 credits  
**Hours** external organisers

**Abstract**
The main objective of the 12-week internship is to expose master's students to the work environment in an engineering company or in a research lab outside of the ETH domain. During this period, students have the opportunity to be involved in on-going projects at the host institution.

**Objective**
The main objective of the 12-week internship is to expose master's students to the work environment in an engineering company or in a research lab outside of the ETH domain.

### Master's Thesis

**Number** 151-1016-00L  
**Title** Master's Thesis Robotics, Systems and Control  
**Type** O  
**ECTS** 30 credits  
**Hours** 64D  
**Lecturers** Professors

**Abstract**
Students who fulfill the following criteria are allowed to begin with their Master's Thesis:

a. successful completion of the bachelor program;  
b. fulfilling of any additional requirements necessary to gain admission to the master programme;  
c. successful completion of the semester project;  
d. achievement of 28 ECTS in the category "Core Courses".

The Master's Thesis must be approved in advance by the tutor and is supervised by a professor of ETH Zurich or an adjunct faculty of RSC. To choose a titular professor as a supervisor, please contact the D-MAVT Student Administration.

**Objective**
Master's programs are concluded by the master's thesis. The thesis is aimed at enhancing the student's capability to work independently toward the solution of a theoretical or applied problem. The subject of the master's thesis, as well as the project plan and roadmap, are proposed by the tutor and further elaborated with the student.

**Objective**
The thesis is aimed at enhancing the student's capability to work independently toward the solution of a theoretical or applied problem.

---

**Robotics, Systems and Control Master - Key for Type**

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
<td>E</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
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**Key for Hours**

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<thead>
<tr>
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<th>Description</th>
<th>Type</th>
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<tr>
<td>V</td>
<td>lecture</td>
<td>P</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
<td>A</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
<td>D</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
<td>R</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
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</tr>
</tbody>
</table>

**ECTS**

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
# Science, Technology, and Policy Master

## Core Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Abstract</strong></td>
<td></td>
<td></td>
<td></td>
<td>This course introduces students to the MSc program in two ways. First, it provides a general introduction to the study of STP. Second, it exposes students to a variety of complex policy problems and ways and means of coming up with proposals for and assessments of policy options.</td>
</tr>
<tr>
<td></td>
<td><strong>Objective</strong></td>
<td></td>
<td></td>
<td></td>
<td>This course introduces students to the MSc program in two ways. First, it provides a general introduction to the study of STP. Second, it exposes students to a variety of complex policy problems and ways and means of coming up with proposals for and assessments of policy options.</td>
</tr>
</tbody>
</table>
|              | **Content**                                                         |      |      |       | Day 1: Introduction to the study of Science, Technology and Policy / getting to know each other, social event  
Day 2: Knowledge assessment in areas marked by controversy over scientific evidence  
Day 3: Challenges of urban development / Energy transition and sustainable mobility  
Day 4: Mitigating and adapting to climate change / Managing international water resources  
Day 5: Implications of digital society / Policy planning exercise |
|              | **Prerequisites / notice**                                          |      |      |       | Reserved for the ISTP’s Master students |
| 860-0004-00L | Quantitative Policy Analysis and Modeling                           | O    | 6 credits | 4G | A. Patt, T. Schmidt, E. Trutnevyte, O. van Vliet |
|              | **Abstract**                                                        |      |      |       | The lectures will introduce students to the principles of quantitative policy analysis, namely the methods to predict and evaluate the social, economic, and environmental effects of alternative strategies to achieve public objectives. A series of graded assignments will give students an opportunity for students to apply those methods to a set of case studies. |
|              | **Objective**                                                       |      |      |       | The objectives of this course are to develop the following key skills necessary for policy analysts:  
- Identifying the critical quantitative factors that are of importance to policy makers in a range of decision-making situations.  
- Developing conceptual models of the types of processes and relationships governing these quantitative factors, including stock-flow dynamics, feedback loops, optimization, sources and effects of uncertainty, and agent coordination problems.  
- Develop and program numerical models to simulate the processes and relationships, in order to identify policy problems and the effects of policy interventions.  
- Communicate the findings from these simulations and associated analysis in a manner that makes transparent their theoretical foundation, the level and sources of uncertainty, and ultimately their applicability to the policy problem.  
The course will proceed through a series of policy analysis and modeling exercises, involving real-world or hypothetical problems. The specific examples around which work will be done will concern the environment, energy, health, and natural hazards management. |
| 860-0003-00L | Bridging Science, Technology, and Policy                           | O    | 3 credits | 2S | R. S. Abhari, T. Bernauer |
|              | **Abstract**                                                        |      |      |       | This course focuses on technological innovations from the beginning of humanity through the industrial revolution up until today. It provides students with a deeper understanding of the factors that drive technological innovations, and the roles government policies, society, science, and industry play in this regard. |
|              | **Objective**                                                       |      |      |       | This course picks up on the ISTP Cornerstone Science, Technology and Policy course and goes into greater depth on issues covered in that course, as well as additional issues where science and technology are among the causes of societal challenges but can also help in finding solutions. |
|              | **Content**                                                         |      |      |       | Week 1: no class because of ISTP Cornerstone Science, Technology and Policy course  
Week 2: technology & society in historical perspective - technological innovations up to the industrial revolution  
Week 3: technology & society in historical perspective - technological innovations during the industrial revolution - engines & electricity  
Week 4: technology & society in historical perspective - from the industrial revolution to modernity - mobility and transport (railroads, ships, cars, airplanes, space)  
Week 5: food production: the green revolutions.  
Week 6: microelectronics, computing & the internet  
Week 7: life sciences: pharmaceuticals & diagnostic technology  
Week 8: energy: primary fuels, renewables, networks  
Week 9: automation: self-driving cars & trains, drones  
Week 10: communication & Big Data: semiconductors and software  
Week 11: military & security issues associated with technological innovation  
Week 12: possible futures (1): nuclear fusion, geoengineering  
Week 13: possible Future (2): information, communication, robotics, synthetic biology, nanotech, quantum computing |
|              | **Lecture notes**                                                   |      |      |       | Course materials will be given to the students prior to the start of each class |
| 860-0005-00L | Colloquium Science, Technology, and Policy (HS)                     | O    | 1 credit | 2K | T. Bernauer, R. S. Abhari |
|              | **Abstract**                                                        |      |      |       | Presentations by invited guest speakers from academia and practice/policy. Students are assigned to play a leading role in the discussion and write a report on the respective event. |
|              | **Objective**                                                       |      |      |       | Presentations by invited guest speakers from academia and practice/policy. Students are assigned to play a leading role in the discussion and write a report on the respective event. |
|              | **Content**                                                         |      |      |       | See program on the ISTP website: http://www.istp.ethz.ch/news-and-events/events.html open to anyone from ETH |
|              | **Prerequisites / notice**                                          |      |      |       | Open to anyone from ETH |
|              | **Abstract**                                                        |      |      |       | This course introduces students to key statistical methods for analyzing social science data with a special emphasis on causal inference and policy evaluation. Students learn to choose appropriate analysis strategies for particular research questions and to perform statistical analyses with the statistical Software Stata. |

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Objective

Students
- have a sound understanding of linear and logit regression
- know strategies to test causal hypotheses using regression analysis and/or experimental methods
- are able to formulate and implement a regression model for a particular policy question and a particular type of data
- are able to critically interpret results of applied statistics, in particular, regarding causal inference
- are able to critically read and assess published studies on policy evaluation
- are able to use the statistical software STATA for data analysis

Content

The topics covered in the first part of the course are a revision of basic statistics and linear and logit regression analysis. The second part of the course focuses on causal inference and introduces methods such as panel data analysis, difference-in-difference methods, instrumental variable estimation, and randomized controlled trials mostly used for policy evaluation. The course shows how the various methods differ in terms of the required identifying assumptions to infer causality as well as the data needs.

Students will apply the methods from the lectures by solving weekly assignments using statistical software and data sets provided by the instructors. These data sets will cover topics at the interface of policy, technology and society. Solving the assignments contributes to the final grade with a weight of 30%. Students are assisted in solving the assignments during the exercises session.


3 credits

J. Kingsley Galimberti, J.P. Nicolai

Abstract

This course is an introduction to the study of economics. Students will learn about the economic way of thinking, the functioning of a market economy, as well as the potentials and limitations of economic policies to govern the behavior of individuals and the economy. The course is divided into two parts, the first covering microeconomic analysis, and the second on macroeconomics.

Objective

The first part of the course focuses on microeconomic analysis, including the behavior of individuals and firms, supply and demand analysis, and market failures. Students will also be introduced to the use of microeconomic thought to influence the behavior of individuals and firms and to address market failures.

The second part focuses on macroeconomic concepts, including national production, employment, inflation, and growth theories. Students will then learn about macroeconomic policies, such as monetary and fiscal policy, often used to stabilize short-run economic fluctuations.

Lecture notes

Lecture slides will be made available by email or via course website.

Literature


860-0001-00L Public Institutions and Policy-Making Processes

3 credits

T. Bernauer, S. Bechtold, F. Schimmelfennig

Abstract

Students acquire the contextual knowledge for analyzing public policies. They learn why and how public policies and laws are developed, designed, and implemented at national and international levels, and what challenges arise in this regard.

Objective

Public policies result from decision-making processes that take place within formal institutions of the state (parliament, government, public administration, courts). That is, policies are shaped by the characteristics of decision-making processes and the characteristics of public institutions and related actors (e.g. interest groups). In this course, students acquire the contextual knowledge for analyzing public policies. They learn why and how public policies and laws are developed, designed, and implemented at national and international levels, and what challenges arise in this regard. The course is organized in three modules. The first module (Stefan Bechtold) examines basic concepts and the role of law, law-making, and law enforcement in modern societies. The second module (Thomas Bernauer) deals with the functioning of legislatures, governments, and interest groups. The third module (Frank Schimmelfennig) focuses on the European Union and international organisations.

Content

Schedule (for up-to-date information, see the syllabus that will be distributed to participants electronically):

W1: Bechtold, Bernauer: Introduction
- How are laws created and interpreted? How are they enforced?
W2: Bechtold: Why do we need laws and why do people and firms usually obey the law? What are possible goals of legal systems? What is the relationship between laws, social norms, and moral values?
W3: Bechtold: What role does scientific evidence play in the creation and enforcement of the law? How does the law deal with non-quantifiable factors or incommensurable values?
W4: no class
W5: Bernauer: How are parliaments (legislatures) elected, how do they work, and how do their characteristics and processes affect policy-making?
W6: Bernauer: Why do forms of government differ and how does this affect policy-making? Why and in what respect are public administrations efficient/effective, and why sometimes not?
W7: Bernauer: How do interest groups and social movements affect policy-making.
W8: Study week
W9: Schimmelfennig: Governance beyond the state: why and how states create international institutions.
W10: Schimmelfennig: International organizations and regimes: case studies of global governance.
W11: Schimmelfennig: Institutions and policy-making in the European Union.
W12: Schimmelfennig: International organizations and policy diffusion.
W13: End-of-semester exam

An add-on module to this course (3 ECTS) involves an essay. This part of the course is accessible only to ISTP MSc students and requires enrollment in the main course (3 ECTS). ISTP MSc students must enrol in both parts. Other students can only enrol in the main course.

3rd week of January: deadline for review essay

Lecture notes

Reading materials will be distributed electronically to the students when the semester starts.
This course discusses complex techno-socio-economic systems, their counter-intuitive behaviors, and how their theoretical understanding empowers us to solve some long-standing problems that are currently bothering the world. Particularly suitable for students of D-ITET, D-MAVT.

This course starts with a discussion of the typical and often counter-intuitive features of complex dynamical systems such as self-organization, emergence, (sudden) phase transitions at “tipping points”, multi-stability, systemic instability, deterministic chaos, and turbulence. It then discusses phenomena in networked systems such as feedback, side and cascade effects, and the problem of radical uncertainty. The course progresses by demonstrating the relevance of these properties for understanding societal and, at times, global-scale problems such as traffic jams, crowd disasters, breakdowns of cooperation, crime, conflict, social unrests, political revolutions, bubbles and crashes in financial markets, epidemic spreading, and/or “tragedies of the commons” such as environmental exploitation, overfishing, or climate change. Based on this understanding, the course points to possible ways of mitigating techno-socio-economic-environmental problems, and what data science may contribute to their solution.


The students should learn how to use MATLAB as a tool to solve various scientific problems. MATLAB is an integrated environment with a high level programming language which makes it possible to quickly find numerical solutions to a wide range of scientific problems. Furthermore, it includes a rich set of tools for graphically presenting the results.

After the students have learned the basic structure of the programming language, they should be able to implement social simulation models in MATLAB and document their skills by a seminar thesis, a coding project and finally give a short oral presentation.

### 351-0778-01L Discovering Management (Exercises)

**Objective**

Complementary exercises for the module Discovering Management.

**Prerequisite:** Participation and successful completion of the module Discovering Management (351-0778-00L) is mandatory.

**Abstract**

This course is offered complementary to the basis course 351-0778-00L, "Discovering Management". The course offers additional exercises and case studies.

**Objective**

This course is offered to complement the course 351-0778-00L. The course offers additional exercises and case studies.

**Content**

The course offers additional exercises and case studies concerning:

- Strategic Management
- Technology and Innovation Management
- Operations and Supply Chain Management
- Finance and Accounting
- Marketing and Sales

Please refer to the course website for further information on the content, credit conditions and schedule of the module: www.dm.ethz.ch

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Type</th>
<th>Credits</th>
<th>ECTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>351-0778-01L</td>
<td>Discovering Management (Exercises)</td>
<td>W</td>
<td>1 credit</td>
<td>1U</td>
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<tr>
<td>351-0778-00L</td>
<td>Discovering Management</td>
<td>W</td>
<td>3 credits</td>
<td>3G</td>
</tr>
<tr>
<td>851-0609-06L</td>
<td>Governing the Energy Transition</td>
<td>W</td>
<td>2 credits</td>
<td>2V</td>
</tr>
</tbody>
</table>

**Prerequisites / notice**

Discovering Management involves "learning by doing". The objective is to introduce the students to the relevant topics of the management literature and give them a good introduction in entrepreneurship topics too. The course is a series of lectures on the topics of strategy, innovation, corporate finance, leadership, design thinking and corporate social responsibility. While the 14 different lectures provide the theoretical and conceptual foundations, the experiential learning outcomes result from the interactive business game. The purpose of the business game is to analyse the innovative needs of a large multinational company and develop a business case for the company to grow. This business case is as relevant to someone exploring innovation within an organisation as it is if you are planning to start your own business. By discovering the key aspects of entrepreneurial management, the purpose of the course is to advance students' understanding of factors driving innovation, entrepreneurship, and company success.

Discovering Management combines in an innovate format a set of lectures and an advanced business game. The learning model for Discovering Management involves "learning by doing". The objective is to introduce the students to the relevant topics of the management literature and give them a good introduction in entrepreneurship topics too. The course is a series of lectures on the topics of strategy, innovation, corporate finance, leadership, design thinking and corporate social responsibility. While the 14 different lectures provide the theoretical and conceptual foundations, the experiential learning outcomes result from the interactive business game. The purpose of the business game is to analyse the innovative needs of a large multinational company and develop a business case for the company to grow. This business case is as relevant to someone exploring innovation within an organisation as it is if you are planning to start your own business. By discovering the key aspects of entrepreneurial management, the purpose of the course is to advance students' understanding of factors driving innovation, entrepreneurship, and company success.

Discovering Management offers an introduction to the field of business management and entrepreneurship for engineers and natural scientists. The module provides an overview of the principles of management, teaches knowledge about management that is highly complementary to the students' technical knowledge, and provides a basis for advancing the knowledge of the various subjects offered at D-MTEC.

Discovering Management aims to broaden the students' understanding of the principles of business management, emphasizing the interdependence of various topics in the development and management of a firm. The lectures introduce students not only to topics relevant for managing large corporations, but also touch upon the different aspects of starting up your own venture. The lectures will be presented by the respective area specialists at D-MTEC.

The course broadens the view and understanding of technology by linking it with its commercial applications and with society. The lectures are designed to introduce students to topics related to strategy, corporate innovation, leadership, corporate and entrepreneurial finance, value chain analysis, corporate social responsibility, and business model innovation. Practical examples from industry experts will stimulate the students to critically assess these issues. Creative skills will be trained by the business game exercise, a participant-centered learning activity, which provides students with the opportunity to place themselves in the role of Chief Innovation Officer of a large multinational company. As they learn more about the specific case and identify the challenges they face, the students will have to develop an innovative business case for this multinational corporation. Doing so, this exercise will provide an insight into the context of managerial problem-solving and corporate innovation, and enhance the students' appreciation for the complex tasks companies and managers deal with. The business game presents a realistic model of a company and provides a valuable learning platform to integrate the increasingly important development of the skills and competences required to identify entrepreneurial opportunities, analyse the future business environment and successfully respond to it by taking systematic decisions, e.g. critical assessment of technological possibilities.

Discovering Management is designed to suit the needs and expectations of Bachelor students at all levels as well as Master and PhD students not belonging to D-MTEC. By providing an overview of Business Management, this course is an ideal enrichment of the standard curriculum at ETH Zurich.

Please refer to the course website for further information on the content, credit conditions and schedule of the module: www.dm.ethz.ch

No prior knowledge of business or economics is required to successfully complete this course.

**Objective**

Primarily suited for Master and PhD level

This course addresses the role of policy and its underlying politics in the transformation of the energy sector. It covers historical, socio-economic, and political perspectives and applies various theoretical concepts to specific aspects of governing the energy transition.

**Abstract**

- To gain an overview of the history of the transition of large technical systems
- To recognize current challenges in the energy system to understand the theoretical frameworks and concepts for studying transitions
- To demonstrate knowledge on the role of policy and politics in energy transitions

**Content**

Climate change, access to energy and other societal challenges are directly linked to the way we use and create energy. Both the recent United Nations Paris climate change agreement and the UN Sustainable Development Goals make a fast and extensive transition of the energy system necessary.

This course introduces the social and environmental challenges involved in the energy sector and discusses the implications of these challenges for the rate and direction of technical change in the energy sector. It compares the current situation with historical socio-technical transitions and derives the consequences for policy-making. It then introduces theoretical frameworks and concepts for studying innovation and transitions. It then focuses on the role of policy and policy change in governing the energy transition, considering the role of policymakers, institutions and policy feedback.

The course has a highly interactive (seminar-like) character. Students are expected to actively engage in the weekly discussions and to give a presentation (15-20 minutes) on one of the weekly topics during that particular session. The presentation (30%) and participation in the discussions (20%) will form one part of the final grade, the remaining 50% of the final grade will be formed by a final exam.

**Lecture notes / Literature**

Slides and reading material will be made available via moodle.ethz.ch (only for registered students).

**Prerequisites / notice**

This course is particularly suited for students of the following programmes: MA Comparative International Studies; MSc Energy Science & Technology; MSc Environmental Sciences; MSc Management, Technology & Economics; MSc Science, Technology & Policy; ETH & UZH PhD programmes.
The course presents cost benefit analysis and related evaluation methods in transport and introduces the survey methods used to derive the monetary values of non-market goods.

Objective
Familiarity with the essential methods of project appraisal

Content
Cost-Benefit-Analysis; multi-criteria analysis; European guidelines; stated response methods; travel cost approach and others; Valuation of travel time savings; valuation of traffic safety

Lecture notes
Handouts

Literature


Abstract
We advice the students complete an internship. It is optional and not required for the master's degree.

Objective
During the course, students will learn about different design thinking methods and tools. This will enable them to:

- Generate deep insights through the systematic observation and interaction of key stakeholders.
- Engage in collaborative ideation with a multidisciplinary (student) team.
- Rapidly prototype and iteratively test ideas and concepts by using various materials and techniques.

Content
The purpose of this course is to equip the students with methods and tools to tackle a broad range of problems. Following a Design Thinking approach, the students will learn how to observe and interact with key stakeholders in order to develop an in-depth understanding of what is truly important and emotionally meaningful to the people at the center of a problem. Based on these insights, the students ideate on possible solutions and immediately validated them through quick iterations of prototyping and testing using different tools and materials. The students will work in multidisciplinary teams on a set of challenges that are organized as a one-week, a three-week, and a final six-week project with an external project partner. In this course, the students will learn about the different Design Thinking methods and tools that are needed to generate deep insights, to engage in collaborative ideation, rapid prototyping and iterative testing.

Design Thinking is a deeply human process that taps into the creative abilities we all have, but that get often overlooked by more conventional problem solving practices. It relies on our ability to be intuitive, to recognize patterns, to construct ideas that are emotionally meaningful as well as functional, and to express ourselves through means beyond words or symbols. Design Thinking provides an integrated way by incorporating tools, processes and techniques from design, engineering, the humanities and social sciences to identify, define and address diverse challenges. This integration leads to a highly productive collaboration between different disciplines.

Prerequisites / notice
Class attendance and active participation is crucial as much of the learning occurs through the work in teams during class. Therefore, attendance is obligatory for every session. Please also note that the group work outside class is an essential element of this course, so that students must expect an above-average workload.

Internship

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>860-0800-00L</td>
<td>Internship</td>
<td>W</td>
<td>0</td>
<td></td>
<td>external organisers</td>
</tr>
</tbody>
</table>

Abstract
We advice the students complete an internship. It is optional and not required for the master's degree.

Objective
The aim of the internship is to bring the future working environment closer and to give them a chance to work on projects in which the institute is involved. More details can be found in Art. 33.

Content
Dem Praktikum werden keine KP zugeordnet.

Das Praktikum wird auf Antrag der Studierenden im Zeugnis aufgeführt, wenn alle der folgenden Bestimmungen erfüllt sind:

a. Das Praktikum dauert mindestens acht Wochen und kann in einem Industrie- Unternehmen, bei einer nationalen oder internationalen Organisation oder bei der öffentlichen Hand im Inland oder Ausland absolviert werden.

b. Das Praktikum muss während der ETH-Studienzeit absolviert werden.

c. Das Praktikum darf nicht bereits für einen Studienabschluss angerechnet worden sein.

d. Der Nachweis über das Praktikum erfolgt über eine schriftliche Bestätigung des Unternehmens oder der Institution, in welcher das Praktikum absolviert worden ist (Praktikumsbestätigung).


Prerequisites / notice
If the student request internship must be completed, the student is granted to prolong their study duration for maximum one semester. The extension doesn't happen automatically and is soely looked upon when handing in a application on time, at the vice principal office.

Master's Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>860-0900-00L</td>
<td>Master's Thesis</td>
<td>O</td>
<td>30</td>
<td>64</td>
<td>Professors</td>
</tr>
</tbody>
</table>

Only students who fulfill the following criteria are allowed to begin with their master thesis:

a. successful completion of the bachelor programme;

b. fulfilling of any additional requirements necessary to
Abstract
The thesis should demonstrate the students ability to conduct independent research on the basis of the theoreticel and methodological knowledge acquired during the MSc program.

Objective
The thesis should demonstrate the students ability to conduct independent research on the basis of the theoreticel and methodological knowledge acquired during the MSc program.

▶ Complementary Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>860-0020-00L</td>
<td>Winter School: Low-Carbon Energy and Development Strategies □</td>
<td>Z</td>
<td>4 credits</td>
<td>8S</td>
<td>T. Schmidt</td>
</tr>
</tbody>
</table>

Does not place this semester. Limited number of spaces. Registration with ETH Global E4D Winter School.

Abstract
Open for master and doctoral students of all departments with a background in energy, development and public policy.

Objective
Students will understand the multi-faceted challenges of developing and implementing a low-carbon energy development strategy (LCEDS) and how to address them. During the three weeks, they will develop LCEDS for specific countries in interdisciplinary teams, as if they were consultants to the national governments of these countries. They will integrate technical, socio-economic, and policy knowledge. The students' LCEDS proposals will be evaluated at the end of the three weeks by a team of experts.

Content
The correlation between consumption of modern forms of energy and long-term economic growth and development is well documented. Yet so too is the historic correlation between economic growth and adverse environmental impacts, such as climate change. Low-carbon energy and development strategies (LCEDS) that decouple energy use from greenhouse gas emissions and therefore enable green economic development are therefore becoming an important new paradigm for national policymakers. In this winter school, students will develop LCEDS which could support national policy decisions.

Prerequisites / notice
The winter school will take place outside of Switzerland and during the exam session. You cannot register if you need to take important exams during the session.

The following ETH Master courses are relevant: MEST, ISTP, MA CIS, MTEC, all engineering types (esp. BAUG, ITET, MAVT

4 credits

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>051-0821-1SL</td>
<td>Summer School: Learning from Havana □</td>
<td>Z</td>
<td>4 credits</td>
<td>4G</td>
<td>H. Klumpner, A. Brillembourg, M. Menendez, C. Schmid</td>
</tr>
</tbody>
</table>

Abstract
The course will function as an inter-disciplinary think-tank exploring the requisites for sustainable urban development of the Old Havana Port (UNESCO World Heritage site) through the lens of architectural engineering, and social sciences. The challenge is to work in an intensive cross-cultural setting and develop solutions in a complex, real-life context with local practitioners and stakeholders.

Objective
You will receive full support on-site from the Polytechnic University José Antonio Echeverría, La Habana (PUJAE) and ETH tutors from your discipline. In developing the scenarios you will work side by side with young professionals with a grounded knowledge of the field, and be joined by a wide variety of local stakeholders.

The program will combine site visits, expert lectures and workshops to allow you to develop the following skills:
- The capacity to work to address urban challenges in an inter-disciplinary team;
- Conduct your own research within a limited time frame and through quantitative and qualitative analysis;
- Apply Scenario Analysis technique to structure and integrate knowledge from various fields;
- Cross cultural understanding and skills in an international collaboration;
- Mechanisms to collaborate and communicate with practitioners and stakeholders;
- Developing integrated and sustainable urban development strategies.

Content
Cities on the border or an outpost of Western European influence, struggling between globalization, modernization and local traditions, are characterized by great social and spatial disparity. Havana is a characteristic case of such a city, which is currently undergoing rapid urbanization and experiences a critical moment of transition.

At this very moment, the political and economical situation is changing rapidly, with a contradictory process of economic and social opening that becomes more and more visible in the streets of Havana, with new businesses, restaurants and street activities, announcing further changes in everyday life. How can such fragmented conditions within cities be tackled by integrated and inclusive solutions, rather than fragmented interventions that exclude the challenged local communities?

Moreover, the lack of resources in cities of the Global South often prevents the gathering of modern, digitalized data, while the unstable political structures prevent the implementation of durable planning strategies. These cities need a rapid assessment procedure, in order to identify relevant priorities and potentials. How can we create a comprehensive understanding of the system and propose appropriate solutions, while using quantitative and qualitative data?

The summer school will build on the current "Atlas Urbano de La Havana - Urban Atlas of Havana" and on the project SeDUT (Seminario Internacional de Desarrollo Urbano y Transporte), a three-year Swiss-Cuban cooperative research project on the urban development of Havana and its mobility potentials. The SeDUT project involved many academic, governmental and private stakeholders, such as the Politecnico University José Antonio Echeverría, the Centro de Estudios Urbanos de La Habana, the Instituto de Planificación Física, the Dirección Provincial de Planificación Física de la Ciudad de La Habana and the design office of Metron AG. Together they represent an important expertise and a high degree of accumulated knowledge.

In a team, you will produce alternative urban scenarios for the planned redevelopment of the Old Port of Havana. You will contribute your expertise and unpack the realities of sustainable development in a tropical climate. How can knowledge from the ETH be combined with Cuban research and translated to a Caribbean context? Through debate, controversy and collaboration it is expected you produce scenarios that integrate your different disciplines and question the preconceptions of sustainable urban development.

This immersive summer school will be structured in three interlocking modules:
- In the first module you will investigate the Old Port and gain a strong understanding of the social, environmental and built context in Havana. You will employ analytical mapping to integrate and synthesize different disciplinary knowledge, ranging from quantitative data to subjective observation.
- In the second module, you will develop a series of scenarios for the Old Port, proposing alternatives for its sustainable future. You will build on the research from the first module, and explore the potential of your ideas with local stakeholders and professionals from your field. You will document these scenarios using creative and varied representational methods.
- In the final module you will pitch your scenarios to decision makers. During this event you will measure their preferences, debate the associated trade-offs, and provide a series of orientations for those planning the future of Havana.

Literature
More information on: http://u-tt.com/teaching/havana-summer-school/
Who should apply?

Enthusiastic students currently enrolled in a masters program in ETH Zurich and PUJAE Havana. A balanced group of 15 ETH master students from the D-ARCH, D-BAUG, D-GESS and D-USYS departments will be selected. They will be joined by 15 Cuban students from our partner university.

Applicants should have a strong interest in sustainable urban development and transdisciplinary collaborative research. They should be able to demonstrate their academic strength, motivation, interest and expertise. Knowledge of Spanish is welcome but not obligatory.

Dates in Cuba: 21 August to 1st of September.
Contact: Marie Grob at grob@arch.ethz.ch, enrollment procedure on our webpage.

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### Science, Technology, and Policy Master - Key for Type

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>Suitable for doctorate</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
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<tr>
<td>O</td>
<td>Compulsory</td>
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</table>

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### Key for Hours

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
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</tbody>
</table>

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**ECTS**

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
### Educational Science

Course offerings in the category Educational Science are listed under "Programme: Educational Science for Teaching Diploma and TC".

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0240-15L</td>
<td>Designing Educational Environments in Physical Education (EW2 Sport)</td>
<td>O</td>
<td>4</td>
<td>2S</td>
<td>H. Gubelmann, R. Scharpf</td>
</tr>
<tr>
<td></td>
<td>Compulsory course requirements for EW2 Sport: This course is required to be taken prior to EW4 Sport</td>
<td></td>
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<tr>
<td></td>
<td>&quot;Outdoor Education: Concepts and Practice&quot; (851-0242-02L)</td>
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<tr>
<td>Abstract</td>
<td>Students learn principles of teaching beyond classroom and regular PE-Lessons :</td>
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<tr>
<td></td>
<td>- Planning and organizing camps and events</td>
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<td></td>
<td>- Teaching the &quot;Ergänzungsfach Sport&quot;</td>
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<td></td>
<td>- Long-term-curricula in PE</td>
<td></td>
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<tr>
<td>Objective</td>
<td>Students know</td>
<td></td>
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<tr>
<td></td>
<td>- How to plan events and camps</td>
<td></td>
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<tr>
<td></td>
<td>- To assess curricula critically and to use them properly</td>
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<tr>
<td></td>
<td>- How to combine theoretical and practical issues in the ‘Ergänzungsfach’</td>
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</tr>
<tr>
<td>Content</td>
<td>1. LV Semestereinführung</td>
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<tr>
<td></td>
<td>2. LV Planung Outdoor-Weekend</td>
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<tr>
<td></td>
<td>3. LV Auswertung Outdoor-Event</td>
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<tr>
<td></td>
<td>4. LV Planung Event</td>
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<tr>
<td></td>
<td>5. LV Event-Präsentationen / Schlussveranstaltung</td>
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</tbody>
</table>

**Prerequisites / notice**

EW2 is compulsory requirement for EW4 Sport

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0240-00L</td>
<td>Human Learning (EW1)</td>
<td>O</td>
<td>2</td>
<td>2G</td>
<td>E. Stern</td>
</tr>
<tr>
<td></td>
<td>This course is only apt for students who intend to enrol in the programs &quot;Teaching Diploma&quot; or &quot;Teaching Certificate&quot;. It is about learning in childhood and adolescence.</td>
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<tr>
<td>Abstract</td>
<td>This course looks into scientific theories and also empirical studies on human learning and relates them to the school.</td>
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<tr>
<td>Objective</td>
<td>Anyone wishing to be a successful teacher must first of all understand the learning process. Against this background, theories and findings on the way humans process information and on human behaviour are prepared in such a manner that they can be used for planning and conducting lessons. Students additionally gain an understanding of what is going on in learning and behavioural research so that teachers are put in a position where they can further educate themselves in the field of research into teaching and learning.</td>
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</tr>
<tr>
<td>Content</td>
<td>Thematische Schwerpunkte:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Lernen als Verhaltensänderung und als Informationsverarbeitung: Das menschliche Gedächtnis unter besonderer Berücksichtigung der Verarbeitung symbolischer Information; Lernen als Wissenskonstruktion und Kompetenzerwerb unter besonderer Berücksichtigung des Wissenstransfers; Lernen durch Instruktion und Erklärungen; Die Rolle von Emotion und Motivation beim Lernen; Interindividuelle Unterschiede in der Lernfähigkeit und ihre Ursachen; Intelligenztheorien, Geschlechtsunterschiede beim Lernen</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lecture notes</td>
<td>Folien werden zur Verfügung gestellt.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Prerequisites / notice</td>
<td>This lecture is only apt for students who intend to enrol in the programs &quot;Lehrdiplom&quot; or &quot;Didaktisches Zertifikat&quot;. It is about learning in childhood and adolescence.</td>
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<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0242-08L</td>
<td>Research Methods in Educational Science</td>
<td>W</td>
<td>1</td>
<td>1S</td>
<td>P. Edelsbrunner, B. Rutsche</td>
</tr>
<tr>
<td></td>
<td>Number of participants limited to 30</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>This course unit can only be enrolled after successful participation in, or during enrollment in the course &quot;Human Learning (EW 1)&quot;.</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Abstract</td>
<td>Literature from the learning sciences is critically discussed with a focus on research methods.</td>
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<tr>
<td></td>
<td>At the first meeting, working groups will be assembled and meetings with those will be set up.</td>
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</tr>
<tr>
<td></td>
<td>In the small groups students will write critical essays about the read literature. At the third meeting, we will discuss the essays and develop research questions in group work.</td>
<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>- Understand research methods used in the empirical educational sciences</td>
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<tr>
<td></td>
<td>- Understand and critically examine information from scientific journals and media</td>
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<tr>
<td></td>
<td>- Understand pedagogically relevant findings from the empirical educational sciences</td>
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</table>

### Subject Didactics in Sport

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>557-0203-00L</td>
<td>Mentored Work Subject Didactics Sport A</td>
<td>O</td>
<td>2</td>
<td>4A</td>
<td>R. Scharpf, O. Graf</td>
</tr>
<tr>
<td></td>
<td>Only for Sport Teaching Diploma students</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Simultaneous enrolment in Mentored Work Subject Didactics Sport A and B is compulsory</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abstract</td>
<td>In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Objective</td>
<td>planning and organization of a longer period of instruction in school.</td>
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</tbody>
</table>

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Data: 06.03.2019 12:57  
Autumn Semester 2016  
Page 1371 of 1571
connection of educational goals and instruction

see moodle 00 - Lehreldiplom Sport https://moodle-app2.let.ethz.ch/auth/shibboleth/login.php


Disher P., Dida-Methodische Modelle in der Ausbildung, Dissertation in 2004, 152


Loosch E., Allgemeine Bewegungsolehre, Limpert Verlag Weiiebelstein 1999

Roth K. & K. Willecmziz, Bewegungsswissenschaft, Rowohl Verlag Reinbek 1999

Röthig P. Sportwissenschaftliches Lexikon, Schorndorf Verlag 2003

Röthig P. & s. Grössing (Hrsg.) Bewegungsolehre, Kurssbuch 3, Wiesbaden 1990/3

557-0204-00L Mentored Work Subject Didactics Sport B

Only for Sport Teaching Diploma students.

Simultaneous enrolment in Mentored Work Subject Didactics Sport A and B is compulsory.

Abstract
In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.

Objective
connection of educational goals and instruction

Content
see moodle 00 - Lehreldiplom Sport

https://moodle-app2.let.ethz.ch/auth/shibboleth/login.php


Disher P., Dida-Methodische Modelle in der Ausbildung, Dissertation in 2004, 152


Loosch E., Allgemeine Bewegungsolehre, Limpert Verlag Weiiebelstein 1999

Roth K. & K. Willecmziz, Bewegungsswissenschaft, Rowohl Verlag Reinbek 1999

Röthig P. Sportwissenschaftliches Lexikon, Schorndorf Verlag 2003

Röthig P. & s. Grössing (Hrsg.) Bewegungsolehre, Kurssbuch 3, Wiesbaden 1990/3

557-0315-00L Sport Didactics I

Only for Sport Teaching Diploma students.

Simultaneous enrolment in Introductory Internship Sport - course 557-0210-00L - is compulsory.

Abstract
Practical implementation in sports of general didactics, with the planning, implementation and evaluation of topics from all the sports-specific areas of tuition in secondary school Level II.

Objective
The students:
- Implement the objectives of general didactics in respect of the different types of sport at school.
- master the planning, implementation and evaluation of topics from all the sports-specific areas of tuition.
- gain an overview of the preparation necessary for the different requirements placed on a sports teacher at secondary school Level II.
- try out different teaching structures, such as the lesson, teaching unit, block periods and extra units in sport in addition to those on the timetable.

Content
Implementation of practical sport into general teacher training with planning, execution and evaluation of the topics from all sport-specific areas of the education at this level in Section II.

Lecture notes
Skript unter: https://moodle-app2.let.ethz.ch/course/view.php?id=117>

Literature
Lehrmittel Sporterziehung, ESK 1997/98.

Lehreldiplom-Studierende müssen die Fachdidaktik Sport I zusammen mit dem Einführungspraktikum Sport - LE 557-0210-00 - belegen.

Professional Training

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>557-0210-00L</td>
<td>Introductory Internship Sport</td>
<td>O</td>
<td>3 credits</td>
<td>6P</td>
<td>O. Graf, R. Scharpf</td>
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</table>

Simultaneous enrolment in Introductory Internship Sport - course 557-0210-00L - is compulsory.

Abstract
During the introductory teaching practice, the students sit in on five lessons given by the teacher responsible for their teaching practice, and teach five lessons themselves. The students are given observation and reflection assignments by the teacher responsible for their teaching practice.

Objective
Right at the start of their training, students acquire initial experience with the observation of teaching, the establishment of concepts for teaching and the implementation of teaching. This early confrontation with the complexity of everything that teaching involves helps students decide whether they wish to and, indeed, ought to, continue with the training. It forms a basis for the subsequent pedagogical and subject-didactics training.

Content
Students observe and teach 5 lessons, supervised by experienced teachers

Lecture notes
see moodle 00 - Lehreldiplom Sport

https://moodle-app2.let.ethz.ch/auth/shibboleth/login.php
Students are involved in teaching courses they lead, and the examination lessons take place in 4-6 week periods. The teaching practice lasts 17 weeks. The students apply teaching methods they learned in Didactics I and II in practical lessons in the gym hall. They also supervise their fellow students and give feedback.

**Prerequisites / Literature**

**557-0208-00L** Teaching Internship Sport

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<tr>
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<th>17P</th>
<th>O. Graf, R. Scharpf</th>
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</thead>
</table>

**Abstract**

The teaching practice takes place in 50 lessons: 30 are taught by the students, and the students sit in on 20 lessons. The teaching practice lasts 4-6 weeks. It gives students the opportunity to implement the contents of their specialist-subject, educational science and subject-didactics training in the classroom. Students also conduct work assignments in parallel to their teaching practice.

**Objective**

Students use their disciplinary skills and educational knowledge for teaching. They know how to judge topics of their subject and can present them in class.

Teaching and classroom management in practice is the main target of this course; students have to find a balance between instruction and self-determined activity of their pupils.

Together with their supervisors they learn to assess their tasks and achievements.

**Content**

Students apply their theoretical background in practice. By teaching sports lessons they improve their teaching skills and classroom management and learn how to interact with pupils. Together with their supervisor they develop an ability of critical reflection of their tasks.

**Prerequisites / Literature**

557-0215-00L, 557-0211-01L

- Die Studierenden leiten nach sorgfältiger Planung Lektionen in verschiedenen schulrelevanten Sportarten.

- The didaktischen und methodischen Kompetenzen werden durch das Unterrichten und Analysieren der Lektionen erweitert und vertieft.

**557-0211-01L** Examination Lesson I Sport

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<tr>
<th>O</th>
<th>1 credit</th>
<th>2P</th>
<th>R. Scharpf, O. Graf</th>
</tr>
</thead>
</table>

**Abstract**

In the context of an examination lesson conducted and graded at a high school, the candidates provide evidence of the subject-matter based and didactic skills they have acquired in the course of their training.

**Content**

The didaktischen und methodischen Kompetenzen werden durch das Unterrichten und Analysieren der Lektionen erweitert und vertieft.

**Prerequisites / Literature**

- Die Lektionen werden anhand von Videoanalysen reflektiert.

- Die Lehrenden erfahren das Lektionsthema in der Regel eine Woche vor dem Prüfungstermin. Von der zuständigen Lehrperson erhalten sie Informationen über den Wissensstand der zu unterrichtenden Klasse und können sie vor dem Prüfungstermin besuchen.

- Sie erstellen eine Vorbereitung gemäss Anleitung und reichen sie bis am Vortag um 12 Uhr den beiden Prüfungsexperten ein.

- Die Lektionen werden anhand von Videoanalysen reflektiert.

- Die Lehrenden erfahren das Lektionsthema in der Regel eine Woche vor dem Prüfungstermin. Von der zuständigen Lehrperson erhalten sie Informationen über den Wissensstand der zu unterrichtenden Klasse und können sie vor dem Prüfungstermin besuchen.

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- Sie erstellen eine Vorbereitung gemäss Anleitung und reichen sie bis am Vortag um 12 Uhr den beiden Prüfungsexperten ein.

- Die Lehrenden erfahren das Lektionsthema in der Regel eine Woche vor dem Prüfungstermin. Von der zuständigen Lehrperson erhalten sie Informationen über den Wissensstand der zu unterrichtenden Klasse und können sie vor dem Prüfungstermin besuchen.

- Sie erstellen eine Vorbereitung gemäss Anleitung und reichen sie bis am Vortag um 12 Uhr den beiden Prüfungsexperten ein.
Sport and social change: developments and trends


These lectures deal with the current changes in society and sport and provide an overview of the many different problems and perspectives of sport sociology.

The lectures set out to:
- present the different dimensions, functions and interrelationships of present-day sport
- provide an introduction to the central theories and models of (sport) sociology
- show how far sport reflects society and how it changes and becomes more differentiated in the process
- take current examples from newspapers, magazines and television to highlight the sociological view of sport.

The economy and the media: dependencies, consequences, scandals
Social inequalities and distinctions: gender differences and group behavior
Conflicts and politics: sports organizations, doping, violence


At least 6 CPs must be obtained in this category.

Sport Pedagogy

Abstract
Central aspects of Sport related pedagogy will be handled in these lectures. These aspects cover, amongst others, the subject and tasks of Sport related pedagogy. Furthermore, the general and sports relevant foundations of Sport related pedagogy will be covered.

Objective
To gain basic knowledge of sport pedagogy and to recognize starting points for applied sports pedagogical intervention in schools.

Content
Inhaltliche Schwerpunkte der Vorlesung sind:
- Einführung in die Sportpädagogik und die pädagogische Psychologie des Sportunterrichts
- Bedeutung des Sports im Jugendalter
- Zeitgemässer Sportunterricht
- Sport und Leistung
- Heterogenität im Sportunterricht
- Sport und Gesundheit
- Geschlechterfragen im Sport
- Soziale und moralische Entwicklung im Sportunterricht

Sport Psychology

Abstract
This lecture is intended as an introduction to sport psychology and imparts knowledge on selected areas of the subject.

Objective
Students are given insight into different areas of sport psychology. In order to understand what «sport psychology» is, it is necessary to explain the essence and tasks of sport psychology and what it relates to, and to work out an underlying basis for key topics, such as cognition and emotions. Students' expertise is furthered by presenting and providing more in-depth treatment of additional topics of sport psychology. Selected intervention forms are intended to provide insight into applied sport psychology and ensure that mental processes and their impact in sport can be recognised. Case studies and practical exercises (e.g. objective training) are intended to prompt students to reflect to a greater extent on the forms in which sport psychology can be applied in their practice of sports and to integrate these in their teaching.

Content
Main Topics
- Introduction to sport psychology
- Cognitions in sports: mental rehearsal and mental training
- Emotions and stress
- Motivation: goal-setting in sports
- Career and career transition in elite sport
- Coach-Athlete-Interaction
- Psychological aspects of sport-injury rehabilitation
- Group dynamics in sport

Sociology of Sport

Abstract
These lectures deal with the current changes in society and sport and provide an overview of the many different problems and perspectives of sport sociology.

Objective
The lectures set out to:
- present the different dimensions, functions and interrelationships of present-day sport
- provide an introduction to the central theories and models of (sport) sociology
- show how far sport reflects society and how it changes and becomes more differentiated in the process
- take current examples from newspapers, magazines and television to highlight the sociological view of sport.

Content
Sport and social change: developments and trends
The economy and the media: dependencies, consequences, scandals
Social inequalities and distinctions: gender differences and group behavior
Conflicts and politics: sports organizations, doping, violence

Data: 06.03.2019 12:57 Autumn Semester 2016 Page 1374 of 1571
ECTS

The students combine and apply general educational aims with a general and specific background of research projects.

4A

Title

Lecturers

Mentored Work Specialised Courses in the Respective Subject with an Educational Focus in Sport A

R. Scharpf, O. Graf

557-0205-00L

2 credits

Subject with an Educational Focus in Sport for Teaching Diploma.

Mentored Work Specialised Courses in the Respective Subject with an Educational Focus in Sport for Teaching Diploma.

Pedagogical application of research projects for schools

Abstract

Introduction of sports pedagogical oriented research projects. Competency to a youth friendly movement and sports education. Competent 'pedagogical application' of research projects in the field of movement and sport. Feed in of scientific findings to school lesson settings.

Objective

The students combine and apply general educational aims with a general and specific background of research projects. They know different educational concepts of the above mentioned, recognise its strengths and weaknesses and are able to apply concepts appropriate to the situation. They are interested in the (thought-) processes of education and research in sports in Switzerland. They use their knowledge of research matters to guide educational thought-processes. They are interested in processes of research in sports. They approach the research interest of their pupils with the knowledge of sports psychology, sports sociology, sports pedagogy, and sports history.

Content


Lecture notes

Literaturverweise erfolgen jeweils in den gewählten Fachbereichen

Prerequisites / notice

Literatur

Skript unter: https://moodle-app2.let.ethz.ch/course/view.php?id=117

Mentorated paper in selected sports disciplines.

R. Scharpf, O. Graf

Compulsory Elective Courses

At least 6 CP's must be obtained in this category.

Further courses must be chosen from the "Sport Practical: Major Education and Specialized Education".

Number

557-0206-00L

Title

Mentored Work Specialised Courses in the Respective Subject with an Educational Focus in Sport B

2 credits

Type

4A

ECTS

Subject with an Educational Focus in Sport for Teaching Diploma.

Only for Sport Teaching Diploma students.

Mentored Work Specialised Courses in the Respective Subject with an Educational Focus in Sport for Teaching Diploma.

Abstract

Refurbishment of research projects dealing with motor competencies in sport and professional scientific content related to this area. Competent "didactical implementation" of research content. The Fachwissenschaftliche Vertiefung II orientates itself to the guiding principles of cognitive, conditional and coordination aspects of movement.

Objective

Scientific principles of sports disciplines in order to improve instruction

Content

Lecture notes

Skript unter: https://moodle-app2.let.ethz.ch/course/view.php?id=117

see specific subjects

Literature

see specific subjects

Prerequisites / notice

Mentorated paper in selected sports disciplines.

see Sport Teaching Diploma, Sport Practical: Major Education

Compulsory Elective Courses

At least 6 CP's must be obtained in this category.

Further courses must be chosen from the "Sport Practical: Major Education and Specialized Education".

Sport Practical

The Teaching Diploma in Sport will only be granted to students holding a Master, Diploma or Licentiate degree in Sport. Additionally, a Sport Practical encompassing 56 CP's is required. The Sport Practical can be partly conducted during the Bachelor and Master programmes in Sport.
Assessments

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<tr>
<td>557-0103-00L</td>
<td>Assessment II</td>
<td>O</td>
<td>2</td>
<td>2G</td>
<td>A. Krebs, S. Nüssli</td>
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<td>Only for Health Sciences and Technology BSc and</td>
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<tr>
<td>Abstract</td>
<td>The assessment II 'achievement' allows students</td>
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<td>to continue their studies in the basic subjects</td>
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<td>of athletics, fitness, swimming, ice sports</td>
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<td>and trend sports. Aim is to acquire the basic</td>
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<td></td>
<td>skills for the respective sports discipline.</td>
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<td>Objective</td>
<td>The assessment monitors both the physical fit-</td>
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<td>ness of the students and their skills in the</td>
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<td>fields of athletics and fitness, which forms</td>
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<td>the basis for a successful rounding off of the</td>
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<td>respective direction of study.</td>
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<td>Content</td>
<td>Im Assessment II Leisten werden einige Elemente</td>
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<td>der Sportarten Fitness und Leichtathletik</td>
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<td>erworben. Unter anderem Grundschritte Aerobic,</td>
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<td>wesentliche Übungen zur Körperrkraftigung,</td>
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<td>Gewandtheit, Hochsprung, Kugelstossen und</td>
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<td>Ausdauer.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Kenntnisse (Schulniveau) in den Sportfächern Fitness und Leichtathletik werden ebenso vorausgesetzt wie angemessene konditionelle Fähigkeiten.</td>
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Basic Education

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<td>O</td>
<td>2</td>
<td>2G</td>
<td>B. Mattli Baur, M. M. Jaeggi, C. König</td>
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<td>Only for Health Sciences and Technology BSc and</td>
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<tr>
<td>Abstract</td>
<td>To acquire basic movements on various apparatuses</td>
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<td>and in acrobatics as well as to create individual</td>
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<td>and cooperative combinations according to</td>
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<td>qualitative criteria.</td>
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<td>- acquire and consolidate apparatus related</td>
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<td>core movements as well as apply and create</td>
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<td>such combinations</td>
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<td>- utilize their own strength as well as the</td>
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<td>resulting impact in a differentiate way in</td>
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<td>order to precisely move the swinging, flying,</td>
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<td>falling and twisting body</td>
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<td>- gain orientation safety and equilibrium</td>
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<td>while twisting and flying</td>
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<td>Content</td>
<td>- Rhythmised attainment of specific acrobatic</td>
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<td>requirements with music</td>
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<td>- Change of positions on the trampoline</td>
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<td>respecting coordinative aspects</td>
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<td>- Accomplishment of an Indoor Parkour</td>
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<tr>
<td>Lecture notes</td>
<td>During the semester the documents are steadily</td>
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<td>available electronically</td>
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</tbody>
</table>
Literature
- Trampolinschule nach der Part-Methode, BASPO 2013

557-0503-01L  Basketball - Basics
Prerequisites: Practical course Movement Sciences I-III (BSc HMS) or Assessment III (BSc HST).

Abstract
Basketball - Basics: Basic technical skills: shooting, passing, dribbling / ballhandling, related to the specific Basketball rules.

Objective
Basics of Basketball (technical and tactical skills) up to level 3 vs. 3. With these learnings the game 5 vs. 5 can be played easily, though it is not a primary topic of this event.

Content
Basic technical skills: shooting, passing, dribbling / ballhandling, related to the specific Basketball rules.
Tactical skills: from 1 : 0 through 3 : 3, preparing 5 : 5

Lecture notes
no specific script

Literature
- manual for monitors of the Swiss Youth & Sports program (available through the "Jugend & Sport" office, german / french / italian)
- Chervet, Michel: Basektball. Fundamental skills for offensive play. Video (german / french). Magglingen, BASPO, 2003 (CHF 34.-). Order at video@baspo.admin.ch

557-0514-03L  Soccer I
Prerequisites: Practical course Movement Sciences -III (BSc HMS) or Assessment III (BSc HST).

Abstract
Acquisition/consolidation basic skills for soccer.

Objective
Support and development the individual conditions/talent/skill and introduction of basic methods will be treated.
Acquisition/consolidation basiscles in soccer
Support and development the individual conditions/talent/skill and introduction of basic methods want to be at the centre of attention.

Content
Technique:
Indvidual tactics:
offensive/defensive 1vs1; keep ball in own rows
various contests in support of different techniques and tactics
- Bucher, Walter (Hrsg.) 1020 Spiel- und Übungsformen im Kinderfussball, 7. unveränderte Auflage 2011, Hofmann-Verlag, Schorndorf

Prerequisites / notice
1. Prerequisites:
Small being able in soccer.
Readines to train.
2. After this course you can get the licence "manager for children".
Prerequisites: Only 1 absence from the lessons "football for children", the book "Kinderfussball" can be bought in the course

557-0533-01L  Floorball I
Prerequisites: Practical course Movement Sciences I-III (BSc HMS) or Assessment III (BSc HST).

Abstract
Experiencing Unihockey/Floorball as an indoor sportsgame
Learning by doing to improve personal sport skills and widening personal abilities in ball sports
Learning by practising/playing and linking that knowledge to theories of motor learning
Practising unihockey to improve personal sport skills and widening personal abilities in ball sports
Improvement of personal unihockey-skills
Learning by practising/playing and linking that knowledge with theories of motor learning
Transfer of ideas into motor movements and motor skills
Personal improvement by practising different motor skills as moving the ball/ballcontrol, passing, shooting
Training of personal sports abilities in ballgames
Analysis of play-situations and corresponding motor movement
Understanding, learning and applying the rules of the game
Practical test of skills and in game activities at the end of the semester

Lecture notes
Classes are based on insights from the book "unihockey basics" by B.Beutler, M.Wolf.
ISBN 3-03700-043-0

Literature

Prerequisites / notice
Please bring your personal hockey stick with you to class.

557-0603-00L  Snowsport I
Prerequisites: Assessment I+II (BSc HST) passed.

Abstract
Experiencing Unihockey/Floorball as an indoor sportsgame
Learning by doing to improve personal sport skills and widening personal abilities in ball sports
Learning by practising/playing and linking that knowledge to theories of motor learning
Practising unihockey to improve personal sport skills and widening personal abilities in ball sports
Improvement of personal unihockey-skills
Learning by practising/playing and linking that knowledge with theories of motor learning
Transfer of ideas into motor movements and motor skills
Personal improvement by practising different motor skills as moving the ball/ballcontrol, passing, shooting
Training of personal sports abilities in ballgames
Analysis of play-situations and corresponding motor movement
Understanding, learning and applying the rules of the game
Practical test of skills and in game activities at the end of the semester

Literature
Classes are based on insights from the book "unihockey basics" by B.Beutler, M.Wolf.
ISBN 3-03700-043-0

Prerequisites / notice
Please bring your personal hockey stick with you to class.
Compulsory for Sport Teaching Diploma, new Programme Regulations.

**Abstract**
Education in the disciplines of winter sports (ski or snowboard)

**Objective**
The students:
- experience the different winter sports
- gain an understanding of how to ski off-piste

**Content**
To apply and vary personal technique of alpine skiing
To apply and vary personal technique of snowboarding
To acquire and vary personal technique of cross-country skiing
Competition in ski-jumping, and giant slalom
To gain an understanding in how to ski off-piste

**Prerequisites / notice**
Requirement: Assessment I + II (BSc HST)

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**557-0609-00L**

**Trendsports**

Number of participants limited to 72.

**Prerequisites:** Assessment II passed (BSc HST) or enrolled in Teaching Diploma Sport.

**Abstract**
Students learn basic skills of a wide range of well-known and new sports

**Objective**
Participants know how to play and exercise new sports and are able to teach them to pupils.

**Content**
Introduction of new and established sports like Badminton, Flagball, Touch, contact games, Icehockey, a.s.o.

**Prerequisites / notice**
Students need to be inscribed in LD Sport or must have passed assessment II.

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**557-0522-01L**

**Handball I**

**Prerequisites:** Practical course Movement Sciences III (BSc HMS) or Assessment III (BSc HST).

**Abstract**
Learn by playing - from three-a-side to four-a-side games.
Game development takes place over the zone play of the game (2/1) or 3/2 to the game 4/4 or (6/6).

The introduced technical elements form the requirements for the tactically-orientated zone plays and are exclusively trained in the execution and formation steps.

**Objective**
The students improve their personal skills and demonstrate the game in teams as well as groups of 4 against 4.
They deepen the development of the game
They improve their personal skills with an individual emphasis on game and practice.

**Content**
Spieldend Handball lernen - Über das Spiel zum Spiel (Vom Spiel 3/3 zum Spiel 4/4)
Techniktraining ist Sache der Studierenden.
Die individuelle Grundschulung wird mit Lernkontrollen überprüft (Kontrollblätter).
Alle ausgewählten Formen müssen als Lernkontrolle durchführbar sein.

**Lecture notes**
Lehrunterlagen können von der Homepage abgerufen werden.

**Literature**

- Obligatorisch Spielerziehung O. Buholzer SHV Kosten Fr. 15.
- Obligatorisch Spielend Handball lernen A. Emrich Limpert Kosten Fr. 20.
- Freiwillig Spielen lernen M. Ochsenbein/ O. Buholzer SHV Kosten Fr. 15.
- Freiwillig Technik lernen O. Buholzer SHV

Muss selbständig erworben oder bei Semesterbeginn bestellt werden.

**Prerequisites / notice**

Maximale Abwesenheiten (3 entschuldigte und 3 unentschuldigte Absenzen)
Teststunden: Im Rahmen der Ausbildung werden Zonenspiele und Fertigkeiten erarbeitet. Für das Testat (Bewegungswissenschafter) müssen insgesamt 6 Teststübungen aus mind. 4 praktischen Bereichen abgegeben werden.

Prüfungen Inhalte: Die Prüfungsinhalte werden während des Semesters erarbeitet und am Ende des Semesters schriftlich abgegeben.

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**557-0601-00L**

**Badminton I**

**Prerequisites:** Assessment III (BSc HST).

**Abstract**
To learn and to deepen technical and tactical abilities and skills of the game; to show methodical learning- and structural series

**Objective**
to learn all the basic strokes
to learn the basic foot work
to get to know single and double tactics
to try out different game variations

**Content**
Erwerben des "Shuttle-Time Teaching Certificate" (Lehrzertifikat der Badminton World Federation and Swiss Badminton)

**Lecture notes**
Die Skriptunterlagen können auf moodle heruntergeladen werden

**Literature**
Lehrunterlagen von Shuttle Time
Prerequisites: Basic course completed

Abstract
Support and development the individual conditions/talent/skill and introduction of basic methods will be treated.

Objective
Acquisition/consolidation skills in soccer basics.

Content
Technique:
Dribble, pass the ball, get the ball under control, shot, throw-in, header

Literature
- J+S Ordner Fussball

557-0650-00L
Snowsport II
Prerequisite: Basic education Snowsport I completed.

Abstract
Specialization training: Acquisitions of special skills, getting to know the performance factors and training methods in the areas of Snowsports.

Objective
- To deepen and expand experience and skills in snow sports and in the personal competency of technique of the chosen snow sport.
- To expand skills to the area of telemark and competition

Content
Snow sports (skiing/snowboarding):
- To acquire knowledge and experience in planning and realization of back-country skiing and consider the environment

Literature
- PAPAGEORGIOU/CZIMEK: "Volleyball Spielerisch Lernen"
- PAPAGEORGIOU/SPITZLEY: "Volleyball Grundlagenausbildung"
- PAOLINI M.: "Volleyball from young player to champions"
- MEYNDT/BEUTELSTAHL: "Richtig Volleyball - Halle und Beach"
### Fitness II

**Prerequisites:** successful completion of Basic Education in Fitness.

**Abstract**
A consolidation of fitness education; relevant performance factors in the training of physical fitness. Acquisition of skills, methodology in fitness coaching and the area of group fitness. Getting to know current and prophylactic training aspects and the training thereof.

**Objective**
A consolidation of fitness education; relevant performance factors in the training of physical fitness. Acquisition of skills, methodology in fitness coaching and the area of group fitness. Getting to know current and prophylactic training aspects and the training thereof.

**Content**
- Anamnese und Trainingsplanung
- Trainingsmittel im Fitnessbereich
- Methoden im Kraft und Ausdauerbereich
- Einführung von Personen an Fitnessgeräten, Instruktion und Korrektur
- Funktionelle Anatomiekennnisse im Fitnessbereich
- Sicherheits- und Trainingsregeln im Group Fitness
- verbales & visuelles Cuing
- Funktionelles Training im Group Fitness
- Training der Tiefenmuskulatur ohne/mit instabiler Unterlage
- Intervalltraining als Stundenformat
- Koordinationstraining ohne/mit Hilfsmittel
- Dehnmethoden
- Zielgruppenangepasste Stundenformate

**Lecture notes**
Wird im Unterricht abgegeben oder auf Moodle bereitgestellt

**Literature**
- Skript und Unterlagen Fitness I
- Training fundiert erklärt, J. Hegner, 5. Auflage 2012
- Der neue Muskelguide, F. Delavier, 13. Auflage
- Core Performance, M. Verstegen, 8. Auflage 2010
- Taschenatlas Anatomie: Bewegungsapparat, von W. Platzer, 11. Auflage 2013

**Prerequisites / notice**

**Group Fitness:**
Fragen über Inhalte des Group Fitness-Vorlesungsskriptes und Praxissequenzen beantworten, Präsentation eines Trends (schriftliche Arbeit und Präsentation), Unterrichten einer Kleingruppe (vorgegebene Sequenz)

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### Acrobatics II

**Prerequisites:** successful completion of Basic Education.

**Abstract**
To get to know and understand the basics of movement (core movements) and its respective actions and functions on the floor, in acrobatics and partner acrobatics as well as in Parkour to create individual and cooperative combinations according to qualitative criteria.

**Objective**
The students should be able to:
- acquire and consolidate core movements as well as to apply and create such combinations
- utilize their own strength as well as the resulting impact in a differentiate way in order to precisely and economically move the swinging, flying, falling and twisting body
- gain orientation safety and room orientation while twisting and flying
- gain sensitivity for social competences (e.g. to assist, to observe, to advise) within a small group
- compose and present within a group of three a creative performance

**Content**
- Freerunning
- creative and cooperative composition in a threesome accompanied by music
- core movements and combinations on the floor, the tumbing-track (airtrack) and the wall
- vault springs and touching down springs (stuetz springs) to overcome obstacles in a artful way
- methodical didactical inputs

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### Education Acquired Outside ETH

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>557-0450-00L</td>
<td><strong>Life Saving Rescue Test Plus Pool SLRG</strong></td>
<td>O</td>
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<td>external organisers</td>
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<td></td>
<td>Only for Sport Teaching Diploma students.</td>
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<td></td>
<td>Confirmation of course attendance Brevet Basis Pool and Brevet Plus Pool SLRG.</td>
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<td>External education! Credit points only for Sport Teaching Diploma!</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<tr>
<td></td>
<td>To recognize danger in, on and around water</td>
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<tr>
<td></td>
<td>Knowledge and handling of life saving equipment</td>
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<td></td>
<td>Rescue and towing techniques</td>
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<td></td>
<td>Orientation under water</td>
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<tr>
<td></td>
<td>To rescue a person</td>
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<tr>
<td></td>
<td>Basis knowledge in anatomy and first aid</td>
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</tbody>
</table>

| 557-0451-00L | **Samariterausweis**                          | O    | 2    |       | external organisers     |
|              | Only for Sport Teaching Diploma students.     |      |      |       |                         |
|              | Confirmation of course attendance "Samariterausweis". | | | | |
|              | More information: www.samariter.ch.            |      |      |       |                         |
|              | **Abstract**                                  |      |      |       |                         |
Inhaltliche Schwerpunkte der Vorlesung sind:

- To be able to judge an injured person and to apply life saving actions
- To carry out wound treatment with actual bandage
- To list the characteristics of a sprain, strain, dislocation and to apply first-aid interventions
- To carry out fixed bandages with common material
- To explain the function of the cardiovascular system
- To name the symptoms of poisoning
- To list the signs of acute illness
- To put together the content of a first-aid box
- To carry out safety interventions in daily situations.

Content

* Hautverletzungen
* Wundinfektion / Blutvergiftung
* Stürze im Alltag (Verstauchungen, Prellungen, Quetschungen)
* Sportverletzungen, Knochenbrüche
* Herzkreislaufstörungen
* Alltagserkrankungen in der Familie

Prerequisites / notice
Fremdausbildung; Dauer 7x2h

▶ Additional Requirements in Sports Science

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>376-0203-00L</td>
<td>Movement and Biomechanics</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>B. Taylor, R. List, S. Lorenzetti</td>
</tr>
<tr>
<td>376-0207-00L</td>
<td>Exercise Physiology</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>C. Spengler</td>
</tr>
<tr>
<td>376-1033-00L</td>
<td>History of Sports</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>M. Gisler</td>
</tr>
<tr>
<td>376-1107-00L</td>
<td>Sport Pedagogy</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>D. Seiler Hubler</td>
</tr>
<tr>
<td>376-1117-00L</td>
<td>Sport Psychology</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>H. Gubelmann</td>
</tr>
</tbody>
</table>

Objective

- To be able to judge an injured person and to apply life saving actions
- To carry out wound treatment with actual bandage
- To list the characteristics of a sprain, strain, dislocation and to apply first-aid interventions
- To carry out fixed bandages with common material
- To explain the function of the cardiovascular system
- To name the symptoms of poisoning
- To list the signs of acute illness
- To put together the content of a first-aid box
- To carry out safety interventions in daily situations.

Content

* Hautverletzungen
* Wundinfektion / Blutvergiftung
* Stürze im Alltag (Verstauchungen, Prellungen, Quetschungen)
* Sportverletzungen, Knochenbrüche
* Herzkreislaufstörungen
* Alltagserkrankungen in der Familie

Prerequisites / notice
Fremdausbildung; Dauer 7x2h

Abstract

Learning to view the human body as a (bio-) mechanical system. Making the connections between everyday movements and sports activity with injury, discomfort, prevention and rehabilitation.

Objective

Students are able to describe the human body as a mechanical system.

They analyse and describe human movement according to the laws of mechanics.

Content

Movement- and sports biomechanics deals with the attributes of the human body and their link to mechanics. The course includes topics such as functional anatomy, biomechanics of daily activities (gait, running, etc.) and looks at movement in sport from a mechanical point of view. Furthermore, simple reflections on the loading analysis of joints in various situations are discussed. Additionally, questions covering the statics and dynamics of rigid bodies, and inverse dynamics, relevant to biomechanics are investigated.

Abstract

This course provides an overview over molecular and systemic aspects of neuromuscular, cardiovascular and respiratory adaptations to acute and chronic exercise as well as the interactions of the different systems influencing factors, e.g. genetics, gender, age, altitude/depth, heat/cold, with respect to performance and health.

Objective

The aim of this course is to understand molecular and systemic aspects of neuromuscular, cardiovascular and respiratory adaptations to acute and chronic exercise as well as the interaction of the different systems regarding health-relevant aspects and performance in healthy people and persons with selected diseases. Furthermore, students will understand the influence of genetics, gender, age, altitude/depth, heat and cold on the named factors.

Content

History of Exercise Physiology, research methods, fibertype heterogeneity and its functional significance, neural control of muscle force, molecular nad cellular mechanisms of muscle adaptation to resistance, endurance and stretching exercise, interindividual variability in the response to training, cardiorespiratory and metabolic responses to acute and chronic exercise, sexi differences relevant to exercise performance, exercise in hot and cold environment, children and adolescents in sport and exercise, exercise at altitude and depth, aging and exercise performance, exercise for health, exercise in the context of disease.

Lecture notes

Online material is provided during the course.

Literature

Recommended textbooks:

William D. McArdle, Frank I. Katch, Victor L. Katch
ISBN/ISSN: 9781451191554

W.L. Kenney, J.H. Wilmore, D.L. Costill
Physiology of Sport and Exercise

Prerequisites / notice

Anatomy and Physiology I + II

Abstract

Comprehension for development and changes of sports from the ancient world to the presence. Description of sports in services of national idea, from education and health promotion from the middle of the 18th century till this day.

Objective

Understanding for the development and adaptation of sports from the ancient world to present times.

Content


Lecture notes

Ein Skript für die aktuelle Veranstaltung wird abgegeben.

Literature


Abstract

Central aspects of Sport related pedagogy will be handled in these lectures. These aspects cover, amongst others, the subject and tasks of Sport related pedagogy. Furthermore, the general and sports relevant foundations of Sport related pedagogy will be covered.

Objective

To gain basic knowledge of sports pedagogy and to recognize starting points for applied sports pedagogical intervention in schools.

Content

Inhaltliche Schwerpunkte der Vorlesung sind:
- Einführung in die Sportpädagogik und die pädagogische Psychologie des Sportunterrichts
- Bedeutung des Sports im Jugendalter
- Zeitgemäßer Sportunterricht
- Sport und Leistung
- Heterogenität im Sportunterricht
- Sport und Gesundheit
- Gesichterfragen im Sport
- Soziale und moralische Entwicklung im Sportunterricht

Lecture notes

Unterrichtsmaterialien zu den einzelnen Veranstaltungen werden den Studierenden zur Verfügung gestellt.
### Tutorial on Laboratory Experiments in Exercise Physiology

These lectures deal with the current changes in society and sport and provide an overview of the many different problems and perspectives in sport sociology.

- Schmidt/Lang/Heckmann: Physiologie des Menschen, Springer-Verlag, Heidelberg

**Main Topics**
- Introduction to sport psychology
- Cognitions in sports: mental rehearsal and mental training
- Emotions and stress
- Motivation: goal-setting in sports
- Career and career transition in elite sport
- Coach-Athlete-Interaction
- Psychological aspects of sport-injury rehabilitation
- Group dynamics in sport

**Literature**

### Laboratory Course in Exercise Physiology

- **Course Code:** 376-1127-00L
- **Module:** Sociology of Sport
- **Objective:**
  - To observe athletes in case studies, make judgments and conclusion
  - To develop the basics of talent training in theory and practice
  - To develop competencies of training with youth and talents

- **Content:**
  - Konkrete Athletenbeobachtung
  - Praxisbeispiele erarbeiten und planen
  - Praxisinput zum Thema Koordination, motorische Grundbedürfnisse, Kraft und Gesundheit
  - Projekte aus der Praxis (Talent- und Nachwuchstraining)
  - Das Nachwuchs- und Talenttraining (Sichtung, Selektion, Förderung)
  - Folgerungen für die Athletenauswahl, Athletenbeobachtung und -betreuung
  - Folgerungen für das Nachwuchstraining
  - Folgerungen für das Training und Coaching in der Sportart
  - Das Modell der Wettkampfanalyse
  - Folgerungen für das Nachwuchstraining
  - Folgerungen für die Athletenauswahl, Athletenbeobachtung und -betreuung
  - Das Nachwuchs- und Talenttraining (Sichtung, Selektion, Förderung)
  - Projekte aus der Praxis (Talent- und Nachwuchstraining)

**Literature**

A detailed program with additional references will be delivered at the beginning of the lecture.

### Exercise Physiology Lecture

- **Course Code:** 376-0130-00L
- **Module:** Laboratory Course in Exercise Physiology
- **Objective:**
  - To conduct physical performance tests and measurements that are typically used to assess performance of athletes and/or patients and that deepen the understanding of physiological processes in response to physical exertion.

- **Content:**

A detailed program with additional references will be delivered at the beginning of the lecture.

### Training and Coaching I

- **Course Code:** 376-1665-00L
- **Module:** Training and Coaching I
- **Objective:**
  - To combine and coaching as in the example of sport analysis, which has an effect on youth training and athlete development
  - To develop basics for a differentiates analyses of sports (model)
  - To develop a profile of requirements for specific sports
  - To develop competencies of training with youth and talents
  - To develop the basics of talent training in theory and practice
  - To observe athletes in case studies, make judgments and conclusion

- **Content:**
  - Exploration of the different fields of intervention
  - The relevance of different Leistungs faktoren
  - The Modell der Wettkampfanalyse
  - Folgerungen für das Training und Coaching in der Sportart
  - Folgerungen für das Nachwuchstraining
  - Folgerungen für die Athletenauswahl, Athletenbeobachtung und -betreuung
  - Das Nachwuchs- und Talenttraining (Sichtung, Selektion, Förderung)
  - Projekte aus der Praxis (Talent- und Nachwuchstraining)
  - Praxisinput zum Thema Koordination, motorische Grundbedürfnisse, Kraft und Gesundheit

**Notice**
- Exercise Physiology Lecture (concomitantly or passed; is selection criterion in case of more applications than lab spaces)
### Lecture notes
Die Skript- (Lektionsunterlagen) werden im Rahmen des Semesters abgeben und auf Homepage veröffentlicht.

### Literature
- Struktur sportlicher Leistung (Modellansatz von Gundlach; (Trainingswissenschaften S. 45 - 49; Stiehler/Konzag/Döbler)
- Leistungsdiagnostische Verfahren, Stiehler/Konzag/Döbler
- Training fundiert erklärt, Handbuch der Trainingslehre, Ingold Verlag 2006
- Das sportliche Talent, W. Joch, Meyer&Meyer Verlag, 2002
- Das neue Konditionstraining, Grosser/Starischka/Zimmermann, blv 2002

### Prerequisites / notice
Für die Kreditvergabe sind die vorgeschriebenen Semesterarbeiten und die Präsenz zwingend. Die Benotung erfolgt durch eine schriftliche Arbeit.

Die Planungsunterlagen werden zu Semesterbeginn abgegebenen, sind provisorisch und können vom Dozenten geändert werden. Die Praxislektionen werden jeweils am Mittwoch von 13.00 - 15.00 abgehalten. Die Termine werden in Absprache festgelegt.

Die Semesterarbeit ist 4 Wochen nach Semesterende abzugeben.


### 376-2019-00L Applied Movement Analysis

<table>
<thead>
<tr>
<th>Abstract</th>
<th>Students are able to assess human movement using different methods of movement analysis.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective</td>
<td>Students are able to assess human movement using different methods of movement analysis.</td>
</tr>
<tr>
<td>Content</td>
<td>Based on practical examples, these methods are used and compared. The examples range from sport, everyday movement and therapy, such as hockey, gymnastics, acrobatics, badminton, gait / running and strength training. In the first phase of the class, the different approaches are applied. In the second phase, small teams are working on individual projects. These will be discussed and presented in plenum.</td>
</tr>
</tbody>
</table>

### Sport Teaching Diploma - Key for Type

| W+       | Eligible for credits and recommended       | E-       | Recommended, not eligible for credits |
| W        | Eligible for credits                       | Z        | Courses outside the curriculum        |
| O        | Compulsory                                 | Dr       | Suitable for doctorate                |

### Key for Hours

| V         | lecture                                   | P        | practical/laboratory course           |
| G         | lecture with exercise                     | A        | independent project                   |
| U         | exercise                                  | D        | diploma thesis                        |
| S         | seminar                                  | R        | revision course / private study       |
| K         | colloquium                                |          |                                      |

### ECTS
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Introduction to Torts, Contracts and Insurance Law.

This course shall make sure that the participants are fit to make the adequate decisions when encountering legal questions and issues in their career.

In order to achieve this goal, legal problems and issues will be presented to the participants and then discussed in class.

The course touches upon relevant topics of Contract Law (formation of contract and contract performance), Tort Law (including liability limitation), corporate law (types of corporations, formation of LLC), civil procedure (jurisdiction and applicable law, costs, when and how to engage a lawyer) and insurance law (duty to disclose relevant facts, gross negligence).

The course 'Introduction au Droit civil' (851-0709-00) provides an introduction to the law of Contracts and Torts in French.

This course covers the basic questions, concepts, theories, methods, and empirical findings of political science.

The aim of this lecture is to give students an introductory overview of relevant topics regarding leadership research and practice, thus enabling them to gain a deeper understanding of the leadership phenomenon. Students should understand different concepts of leadership in the complex interaction between individuals, groups, organisation, context and situation. They should be informed about the evolution of the understanding of mankind in relation to working processes and its impact on organizations and the understanding of leadership theory in the past 100 years. They should grasp the concept of leadership responsibility (leadership ethics) and be able to derive consequences for leadership in practical situations. They should recognize the fundamental importance of communication in leadership situations and receive input which enables them to communicate adequately in specific situations.

The 1-hour written exam will take place during the last lecture in the semester.

Students are free to take the exam either in German or in French. They may choose between 853-0723-00L 'Introduction to Torts, Contract and Insurance Law' or 851-0709-00L 'Introduction to Civil Law' (French).

### Examination Block 1

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Lecturers</th>
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<tr>
<td>853-0723-00L</td>
<td>Introduction to Torts, Contracts and Insurance Law</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>C. von Zedwitz</td>
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<tr>
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<td>Introduction to Torts, Contracts and Insurance Law.</td>
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### Examination Block 2

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<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>351-1034-00L</td>
<td>Microeconomics</td>
<td>O</td>
<td>3</td>
<td>2V</td>
<td>A. Fetz, M. Gysler</td>
</tr>
</tbody>
</table>
Introduction to the economic decisions of households and firms, and their coordination through markets. Analysis of different market structures and of situations in which markets may lead to socially undesirable outcomes.

Understanding of basic microeconomic models. Ability to apply these models to real world economic situations.

Economics as a science, division of labour and welfare (concept of comparative advantage), supply and demand (market equilibrium, elasticity), households (preferences, demand), firms (technology, cost analysis, profit maximisation, supply), perfect competition, monopoly and oligopoly, externalities, public goods, information, factor markets and income distribution

via email


Course macroeconomics in the summer term
Abstract
Beside of the most important terms of sociology, demographic changes and the related value and structure change will be analysed. The second part focuses on organizational sociology. Thirdly, the course examines to which extent armed forces can be considered as organizations like any other and to which extent they constitute a special case from an organizational and normative point of view.

Objective
Recognize and explain current changes (social change) in modern society (individualisation, pluralisation); describe demographic changes in Switzerland; explain the structures of societies; define issues and fields of research in modern military sociology and explain the foundations of organisational sociology; explain the military in terms of organisational sociology and identify specific traits of the military as an organisation.

Content
Societal change; organizations as societal phenomena; aims, structures, environments of organizations; specifics of the military as an organization; impacts of technological and societal changes on the armed forces in modern societies.

Literature
A reader with a set of texts will be handed out.

Languages
First Foreign Language

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>853-0405-00L</td>
<td>English, Part I Only for Public Policy BA</td>
<td>O</td>
<td>3 credits</td>
<td>2G</td>
<td>O. Gwerder</td>
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<tr>
<td></td>
<td>Abstract</td>
<td></td>
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<td>Teaching is focused on the acquisition of general English in the four classical skills, i.e. speaking, listening comprehension, reading comprehension and writing. The goal is to reach level B2 or C1 depending on the linguistic proficiency of the students.</td>
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<td></td>
<td>Objective</td>
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<td>This three-semester English course should enable the participants to successfully use the English language in an international military setting.</td>
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<td>Content</td>
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<td>Read, analyse and write military and civilian documents Listening comprehension using current radio or TV reports Practise speaking through group discussions and short presentations Systematic revision and extension of key grammar points Systematic acquisition of general and military vocabulary</td>
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3. Semester
Remaining Core Courses of the Bachelor Programme

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<tr>
<th>Number</th>
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<th>Type</th>
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<td>853-0015-00L</td>
<td>Conflict Research I: Causes of War in Historical Context Only for Public Policy BA.</td>
<td>O</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>S. Rüegger, G. Schvitz</td>
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<tr>
<td></td>
<td>Abstract</td>
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<td>This course offers an introduction to research on causes of wars. War as a social phenomenon is covered from the pre-state world to today's state system after the end of the Cold War. Topics include state formation and collapse, nationalism, decolonization, democracy, and ethnic conflict. Exercises complete the Lectures.</td>
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<td></td>
<td>Objective</td>
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<td>Developing an understanding for causes of war and their development over the last 500 years. Knowledge of fundamental concepts in research on causes of war.</td>
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<td>Prerequisites / notice</td>
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<td>Weitere Literatur wird im Kurs bekanntgegeben.</td>
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<td>Lehrangebot im Studiengang Berufsoffizier</td>
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<td>853-0046-00L</td>
<td>Social Psychology of Groups Only applied social psychosocial topics will be discussed.</td>
<td>O</td>
<td>3 credits</td>
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<td>T. Heilmann</td>
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<td></td>
<td>Abstract</td>
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<td>You have got the chance 1. To learn about basic fields of social psychology. 2. To apply the lessons learned to your own (military) situation/daily life. 3. To think about daily social psychological pitfalls 4. To connect theory and application based on case studies.</td>
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<tr>
<td>853-0047-00L</td>
<td>World Politics Since 1945: The History of International Relations Only for Public Policy BA and DAS Military Sciences</td>
<td>O</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>A. Wenger</td>
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<tr>
<td></td>
<td>Abstract</td>
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<td>This lecture series provides students with an overview of the development of international relations since the end of World War II. The first part of the series deals with the development of and changes in Cold War security policy structures. The second part deals with the period after the transformation of 1989/91; the focus here is on current issues in international security policy.</td>
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<td></td>
<td>Objective</td>
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<td>By the end of the semester, participants should have a solid knowledge of the history and theoretical foundations of International Relations since the end of the Second World War.</td>
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<td>cf. &quot;Diploma Supplement&quot;</td>
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<td>&quot;Military Revolution&quot; and starts</td>
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<td>European armed forces after the</td>
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<td>Oranian Army reform in the 17th</td>
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<td>- Based on the &quot;Military Revolution&quot;</td>
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<td>approach, the lecture examines</td>
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<td>the structural changes regarding the</td>
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<td></td>
<td>- Peter Brown: The Changing Nature</td>
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<td>- MacGregor Knox/Williamson Murray:</td>
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<td>The Dynamics of Military Revolution</td>
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<td>present day, London 2005.</td>
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<td>- The lecture series treats high-impact</td>
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<td>- The participants know in what ways</td>
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<td>components: ends, ways and means.</td>
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<td>implementation of strategies.</td>
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<td>- The two-term lecture series treats</td>
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<td>Term 1 covers the theories up until</td>
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<td>primary sources and a list of further</td>
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<td>reading are accessible electronically</td>
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<td>Literature</td>
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<td></td>
<td>- Peter Paret, Makers of Modern</td>
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<td>Strategy, From Machiavelli to the</td>
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<td>Nuclear Age, Princeton 1986</td>
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<td>Literature</td>
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<td></td>
<td>- Martin van Creveld, A History of</td>
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<td>Strategy: from Sun Tzu to William S.</td>
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<td></td>
<td>Lind, Kouvola 2015</td>
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</table>

Data: 06.03.2019 12:57 Autumn Semester 2016 Page 1387 of 1571
A reading list will be distributed at the beginning of the semester. Students should:

1. Introduction to Constitutional Law in Security Policy
2. Theories of European integration
3. The development of European integration
4. Internal market and monetary union
5. Internal and external security policies
6. Constitutionalization
7. Widening and differentiation
8. Switzerland, the EEA, and EU neighbourhood policies
9. Identity, trust, and solidarity
10. Public spheres, parties, and elections
11. Decision-making and policy development in the EU
12. Statehood and democracy in the EU
13. European integration in crisis

Lecture notes: Schimmelfennig, Frank: Europäische Integration (erhältlich zu Beginn des Kurses)


Prerequisites / notice: The Leistungskontrolle findet durch eine Seminarpräsentation und einen schriftlichen Schlusstest statt.

Languages

First Foreign Language

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>853-0416-00L</td>
<td>English, Part III</td>
<td>O</td>
<td>3 credits</td>
<td>2G</td>
<td>O. Gwerder</td>
</tr>
</tbody>
</table>

Abstract: The knowledge and skills acquired in the second semester serve as a basis for further improvements in the areas of speaking, listening, reading and writing, which will enable students to enroll for the Cambridge exams. The goal is to reach Council of Europe (CEFR) level C1 or C2 depending on the linguistic proficiency of the students.

Objective: Participants should gain a solid understanding of security challenges stemming from the use and control of dual-use technologies. In addition, the students should become aware of how researchers can deal with sensitive knowledge regarding research transparency and control.

Content:
- Read, analyse and write military and civilian documents
- Listening comprehension using current radio or TV reports
- Practise speaking with group discussions and short presentations
- Systematic revision and extension of key grammar points
- Systematic acquisition of general and military vocabulary

5. Semester

Remaining Core Courses of the Bachelor's Programme

<table>
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<tr>
<th>Number</th>
<th>Title</th>
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<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>853-0049-00L</td>
<td>Introduction to Constitutional Law in Security Policy</td>
<td>O</td>
<td>3 credits</td>
<td>2V</td>
<td>P. Sutter</td>
</tr>
</tbody>
</table>

Abstract: The knowledge and skills acquired in the second semester serve as a basis for further improvements in the areas of speaking, listening, reading and writing, which will enable students to enroll for the Cambridge exams. The goal is to reach Council of Europe (CEFR) level C1 or C2 depending on the linguistic proficiency of the students.

Objective: Participants should gain a solid understanding of security challenges stemming from the use and control of dual-use technologies. In addition, the students should become aware of how researchers can deal with sensitive knowledge regarding research transparency and control.

Content:
- Read, analyse and write military and civilian documents
- Listening comprehension using current radio or TV reports
- Practise speaking with group discussions and short presentations
- Systematic revision and extension of key grammar points
- Systematic acquisition of general and military vocabulary

Literature: The basic sources of the lectures are:
- Patrick Sutter, Recht der militärischen Operationen, Sicherheit & Recht 1/2008, S. 19-32

These articles and further sources are part of the Reader mentioned above.

- 853-0050-00L | Current Issues in Security Policy | O    | 3 credits | 2V    | A. Wenger, O. Thränert

Abstract: This course provides an overview of the security implications of so-called “dual-use” technologies, i.e. technologies that can be used for both peaceful and military aims. The course will also cover various policies - in particular arms control - that are discussed and applied by the international community in dealing with such dual-use technologies.

Objective: Participants should gain a solid understanding of security challenges stemming from the use and control of dual-use technologies. In addition, the students should become aware of how researchers can deal with sensitive knowledge regarding research transparency and control.

Content:
- The aim of the course is to provide participants with an overview of international security politics with a special focus on dual-use technologies.
- Students will analyze the character of dual-use security risks and of risk-based security strategies and instruments.
- Thematic areas include the nuclear non-proliferation regime, biological and chemical weapons conventions, missile proliferation, the nuclear programs of Iran and North Korea, cyber and space technologies, as well as robotics and nanotechnology.

Literature: An online learning platform serves as a supplement to the course.

Notice: Participants are expected to study the compulsory texts provided at the beginning of the semester via the online platform Moodle.
Students should acquire a sound understanding of Swiss foreign policy and the relevant academic and political debates associated with it.

This two-semester course is divided into several groups. A core question relating to the topic of the seminar paper is being developed (I),

Seminar II builds on the findings of seminar I. Within the broader framework of the overall theme of the seminar (Foreign Policies and Security Strategies of the Great Powers) and based on the approved research design of seminar I, participants write their term paper (in close consultation with the lecturer).

The course will be supported by an e-learning environment.

Languages

Second Foreign Language

Bachelor's Colloquium and Bachelor's Thesis
Understanding for the development and adaptation of sports from the ancient world to present times. This lecture is intended as an introduction to sport psychology and imparts knowledge on selected areas of the subject.

The BA Colloquium prepares students for their BA thesis with regard to content, administration, and methodology. During the colloquium, students are being prepared administratively and methodologically to write their BA-thesis after completing the course. The BA Colloquium prepares students for their BA thesis with regard to content, administration, and methodology. During the colloquium, each student has to choose a topic for his/her BA-thesis. The students also choose their supervisors, whereas the goal is an even distribution of the supervisors. Finally, the methodological competences which were acquired during the first four semesters will be complemented.

If you have questions, please contact Lukas Meyer, lukas.meyer@sipo.gess.ethz.ch.

### Electives

#### Recommended Elective Courses

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<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>853-0102-00L</td>
<td>Military Business Administration II - Case Examples</td>
<td>W+</td>
<td>3</td>
<td>2V</td>
<td>M. Keupp</td>
</tr>
</tbody>
</table>

The elective course Military Business Administration II builds on the mandatory course Military Business Administration I and adds to it. It deals with in-depth case studies from international security and economic policy with a special emphasis on the economic and practical relevance of these issues for the Swiss Armed Forces.

Students who are intrinsically interested in business-related issues will be provided with a big picture that transcends the micro view of business administration. Students learn how to integrate security and resource-related issues into a global economic analysis and how to derive relevant consequences, particularly economic ones, for Switzerland.

The program of the course is organized into 14 units of 90 minutes each. The units combine the elements of lecture (where analytical concepts are taught) and application (where these concepts as applied). Additionally, guest lecturers will hold talks on selected issues.

- Swiss economic autarchy - madness or option?
- Global resource positions and world trade: Implications for the Swiss Armed Forces I
- Global resource positions and world trade: Implications for the Swiss Armed Forces II
- Economic causes of military instability
- Aggressive emerging economies: Economic growth and rearmament
- The process of an arms deal
- Costs and financing of a military conflict
- Economic analysis of terrorism
- Economic analysis of cyberwar
- Economic analysis of the present GSOA initiative: Compulsory military service vs. voluntary militia
- Global arms production and international arms trade
- The privatisation of military security
- Standardisation and interoperability: Does NATO membership increase Swiss military efficiency
- Written exam

As this course has been completely redesigned and is being offered for the first time in the fall semester of 2013, a script is not yet available. However, the lecturer will distribute all necessary course material in time and directly to the students, either in the classroom or by uploading files to a public server.

Examination:**Military Business Administration I** passed successfully or profound basic knowledge of business administration and economics. The course is open to external participants.

#### Additional Elective Courses

*These Electives may be chosen from the start of the Bachelor Study Programme.*

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<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
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<tbody>
<tr>
<td>376-1033-00L</td>
<td>History of Sports</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>M. Gisler</td>
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</tbody>
</table>

Comprehension for development and changes of sports from the ancient world to the presence. Description of sports in services of national idea, from education and health promotion from the middle of the 18th century till this day.

Understanding for the development and adaptation of sports from the ancient world to present times.


Ein Skript für die aktuelle Veranstaltung wird abgegeben.


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<th>Number</th>
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<tbody>
<tr>
<td>376-1107-00L</td>
<td>Sport Pedagogy</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>D. Seiler Hubler</td>
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</table>

Central aspects of Sport related pedagogy will be handled in these lectures. These aspects cover, amongst others, the subject and tasks of Sport related pedagogy. Furthermore, the general and sports relevant foundations of Sport related pedagogy will be covered.

To gain basic knowledge of sports pedagogy and to recognize starting points for applied sports pedagogical intervention in schools.

Inhaltliche Schwerpunkte der Vorlesung sind:
- Einführung in die Sportpädagogik und die pädagogische Psychologie des Sportunterrichts
- Bedeutung des Sports im Jugendalter
- Zeitgemässer Sportunterricht
- Sport und Leistung
- Heterogenität im Sportunterricht
- Sport und Gesundheit
- Geschlechterfragen im Sport
- Soziale und moralische Entwicklung im Sportunterricht

Unterrichtsmaterialien zu den einzelnen Veranstaltungen werden den Studierenden zur Verfügung gestellt.

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<tr>
<td>376-1117-00L</td>
<td>Sport Psychology</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>H. Gubelmann</td>
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</table>

This lecture is intended as an introduction to sport psychology and imparts knowledge on selected areas of the subject.
Sociology of Sport

376-1127-00L

WebClass Introductory Course History of Technology

W 2 credits 2V M. Lamprecht

- to recognize the challenges and opportunities of technological change in terms of sustainable development
- to improve understanding of political decision-making processes in the regulation of science & technology
- to become familiar with policy instruments to promote innovation
- to provide an introduction to the central theories and models of (sport) sociology
- to show how far sport reflects society and how it changes and becomes more differentiated in the process
- to take current examples from newspapers, magazines and television to highlight the sociological view of sport.

Sport and social change: developments and trends

The economy and the media: dependencies, consequences, scandals
Social inequalities and distinctions: gender differences and group behavior
Conflicts and politics: sports organizations, doping, violence

Selected materials for the lecture are available under www.LSSFB.ch --> Lehre

Selected materials for the lecture are denoted in the lecture notes.

Additional references will be delivered at the beginning of the course.

Further information can be found at https://www.tg.ethz.ch/de/programme/
Lecture notes

Reader with issue-specific articles. E-version is partly available under https://www.ethz.ch/content/specialinterest/gess/cis/international-relations/en/teaching/materials/tech.html


The 2-hour course (5-7 p.m.) will be held as a series of lectures. The course materials will be available in form of an electronic Reader at the beginning of the semester.

The class will be taught in English.

Students will be asked to give a (a) presentation (15 Minutes) or write a review paper based on an article selected from the electronic script, and (b) they will have to pass a written test at the end of the course in order to obtain 3 credit points in the ECTS System. In the final mark (a) will have a weight of 40% and (b) 60%.

851-0594-00L International Environmental Politics W 3 credits 2V T. Bernauer

Particularly suitable for students of D-ITET, D-USYS

This course focuses on the conditions under which cooperation in international environmental politics emerges and the conditions under which such cooperation and the respective public policies are effective and/or efficient.

The objectives of this course are to (1) gain an overview of relevant questions in the area of international environmental politics from a social sciences viewpoint; (2) learn how to identify interesting/innovative questions concerning this policy area and how to answer them in a methodologically sophisticated way; (3) gain an overview of important global and regional environmental problems.
We develop a ‘systemic’ view of organizations. This course is an introduction to the critical management skills involved in planning, structuring, controlling and leading an organization.

The content of the course will rely on the book: 

Selected readings from the book and additional learning materials will be available on the course Moodle: 
https://moodle-app2.let.ethz.ch/course/view.php?id=2209

The final exam of the present course is in written form. The final exam is requested for all types of students (BSc, MSc, MA, PhD, and Exchange students). It is not possible to retake the exam within the same term or academic year.

We strongly recommend Exchange students to take it into consideration when selecting the courses to attend.

After passing an end-of-semester test (requirement: grade 4.0 or higher) students will receive 3 ECTS credit points. The workload is around 90 hours (meetings, reading assignments, preparation of test).

None

Basic Concepts of Management

This course deals with fundamental and proven management concepts. The lecturers emphasize the practical applicability of concepts. The course was designed in close cooperation with practitioners; e.g. will Mr. S. Baldenweg, mechanical engineer ETH, MBA Insead, share his experience in several guest lectures.

Students: will be familiar with basic general management concepts. 
will learn about the fundamental concepts of strategy development with practical examples. 
will get to know the basic organisational issues and the essential types of organisations. 
get a rough overview on the concepts of financial management. 
will learn about the strategic positioning of small departments within larger organisations. 
will learn about the fundamental mechanisms for handling change, and will be able to recognise these situations. 
will learn the basic principles of project management and of successful self-management.

Schwarzenbach

The course is open to all ETH students. Participation does not require previous coursework in the social sciences.

Lecture notes

Assigned reading materials and slides will be available at http://www.ib.ethz.ch/teaching.html (select link ‘Registered students, please click here for course materials’ at top of that page). Log in with your nethz name and password. Questions concerning access to course materials can be addressed to Mike Hudecheck (Mike Hudecheck <micheahu@student.ethz.ch>). All assigned papers must be read ahead of the respective meeting. Following the course on the basis of on-line slides and papers alone is not sufficient. Physical presence in the classroom is essential. Many books and journals covering international environmental policy issues can be found at the D-GESS library at the IFW building, Haldeneggsteig 4, B-floor, or in the library of D-USYS.

Literature

Assigned reading materials and slides will be available at http://www.ib.ethz.ch/teaching.html (select link ‘Registered students, please click here for course materials’ at top of that page). Log in with your nethz name and password. Questions concerning access to course materials can be addressed to Mike Hudecheck (Mike Hudecheck <micheahu@student.ethz.ch>).
Abstract
The students shall obtain a basic knowledge about business law. They shall be able to recognize and evaluate issues in the area of business law and suggest possible solutions.

Objective
The students shall obtain the following competence:
- They shall obtain a working knowledge on the legal aspects involved in setting up and managing an enterprise.
- They shall be acquainted with corporate functions as contracting, negotiation, claims management and dispute resolution.
- They shall be familiar with the issues of corporate compliance, i.e. the system to ascertain that all legal and ethical rules are observed.
- They shall be able to contribute to the legal management of the company and to discuss legal issues.
- They shall have an understanding of the law as a part of the corporate strategy and as a valuable resource of the company.

Lecture notes
A comprehensive script will be made available online on the moodle platform.

Project Management
W 2 credits 2G M. Kersting

Abstract
General introduction to the development, the life cycle and the characteristics of projects. Introduction to, and experience with, the methods and tools to help with the preparation, evaluation, organisation, planning, controlling and completion of projects.

Objective
To introduce the methods and tools of project management. To impart knowledge in the areas of project organisation and structure, project planning, resource management, project controlling and on team leadership and team work.

Content
- From strategic planning to implementation (Project phases, goals, constraints, and feasibility)
- Project leadership (Leadership, Teams)
- Project organization (Structure)
- Project planning (Schedule, cost and resource planning)
- Project controlling
- Risk and Quality Management
- Project completion

Lecture notes
Yes
The transparencies will be available for download from the website at least one week before each class.
Copies of all necessary documents will be distributed at appropriate times.

Complexity and Global Systems Science
W 3 credits 2V D. Helbing, N. Antulov-Fantulin

Abstract
This course discusses complex techno-socio-economic systems, their counter-intuitive behaviors, and how their theoretical understanding empowers us to solve some long-standing problems that are currently bothering the world.

Objective
Participants should learn to get an overview of the state of the art in the field, to present it in a well understandable way to an interdisciplinary scientific audience, to develop models for open problems, to analyze them, and to defend their results in response to critical questions. In essence, participants should improve their scientific skills and learn to think scientifically about complex dynamical systems.

Content
This course starts with a discussion of the typical and often counter-intuitive features of complex dynamical systems such as self-organization, emergence, (sudden) phase transitions at "tipping points", multi-stability, systemic instability, deterministic chaos, and turbulence. It then discusses phenomena in networked systems such as feedback, side and cascade effects, and the problem of radical uncertainty. The course progresses by demonstrating the relevance of these properties for understanding societal and, at times, global-scale problems such as traffic jams, crowd disasters, breakdowns of cooperation, crime, conflict, social unrests, political revolutions, bubbles and crashes in financial markets, epidemic spreading, and/or "tragedies of the commons" such as environmental exploitation, overfishing, or climate change. Based on this understanding, the course points to possible ways of mitigating techno-socio-economic-environmental problems, and what data science may contribute to their solution.

Prerequisites / notice
Mathematical skills can be helpful

Basic Management Skills
W 3 credits 8G R. Specht

Abstract
With the aim of preparing the students to take on managerial responsibility, this 2x5 days-seminar teaches basic and practical management skills.

Objective
To convey management behaviour based on practical examples, own experiences and team discussions complemented by short theory sessions (subsidized from the donation for promotion and training in enterprise sciences at the ETHZ).

Content
1 Fundamentals of Communication Psychology
2 Communication in Business-Life
3 Fundamentals of Leadership
4 Self-Management and Life Balance
5 Leadership Tools
6 Problem Solving and Decision Making Techniques
7 Performance Coaching
8 Conflict Management
9 Personality
10 Summary-Day, Domino-Examination

Lecture notes
Will be provided as electronic version at www.entrepreneurship.ethz.ch at least one week before the seminar starts
### Prerequisites / notice

Special permission from lecturers required

Limited number of participants: Mandatory registration required.

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### IMPORTANT NOTICE

Preliminary announcement: Seminar 2 is offered in Spring Semester 2017. Students can only register and participate in "Seminar 1" OR "Seminar 2".

Seminar 1: 2 x 5 days

Limited number of participants: Mandatory registration required for "Seminar 1" until 30.06.2016 by E-Mail: bms@ethz.ch

Block I: 15.-19.08.2016, 9-17 h
Block II: 05.-09.09.2016, 9-17 h

where: tba

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Seminar 2: 2 x 5 days

Limited number of participants: Mandatory registration required for "Seminar 2" until 26.09.2016 by E-Mail: bms@ethz.ch

Block I: 30.01.-03.02.2017, 9-17 h
Block II: 13.02.-17.02.2017, 9-17 h

where: tba

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### 751-1551-00L Ressourcen- und Umweltökonomie

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<tr>
<th>W</th>
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<th>2V</th>
<th>L. Bretschger, A. Müller</th>
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</thead>
</table>

**Abstract**

Relationship between economy and environment, market failure, external effects and public goods, contingent valuation, internalisation of externalities; economics of non-renewable resources, economics of renewable resources, cost-benefit analysis, sustainability, and international aspects of resource and environmental economics.

**Objective**

Understanding of the basic issues and methods in resource and environmental economics; ability to solve typical problems in the field using the appropriate tools, which are concise verbal explanations, diagrams or mathematical expressions.

Topics are:

- Introduction to resource and environmental economics
- Importance of resource and environmental economics
- Main issues of resource and environmental economics
- Normative basis
- Utilitarianism
- Fairness according to Rawls
- Economic growth and environment
- Externalities in the environmental sphere
- Governmental internalisation of externalities
- Private internalisation of externalities: the Coase theorem
- Free rider problem and public goods
- Types of public policy
- Efficient level of pollution
- Tax vs. permits
- Command and Control Instruments
- Empirical data on non-renewable natural resources
- Optimal price development: the Hotelling-rule
- Effects of exploration and Backstop-technology
- Effects of different types of markets.
- Biological growth function
- Optimal depletion of renewable resources
- Social inefficiency as result of over-use of open-access resources
- Cost-benefit analysis and the environment
- Measuring environmental benefit
- Measuring costs
- Concept of sustainability
- Technological feasibility
- Conflicts sustainability / optimality
- Indicators of sustainability
- Problem of climate change
- Cost and benefit of climate change
- Climate change as international ecological externality
- International climate policy: Kyoto protocol
- Implementation of the Kyoto protocol in Switzerland

**Content**

Economy and natural environment, welfare concepts and market failure, external effects and public goods, measuring externalities and contingent valuation, internalising external effects and environmental policy, economics of non-renewable resources, renewable resources, cost-benefit-analysis, sustainability issues, international aspects of resource and environmental problems, selected examples and case studies.

**Lecture notes**

The script and lecture material are provided at:

https://moodle-app2.let.ethz.ch/course/view.php?id=140

**Literature**


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### 376-1685-00L Training and Coaching I

<table>
<thead>
<tr>
<th>W</th>
<th>3 credits</th>
<th>2G</th>
<th>O. Buholzer</th>
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</table>

**Abstract**

The combining of training and coaching as in the example of sport analysis, which has an effect on youth training and athlete development

**Objective**

- To develop basics for a differentiate analyses of sports (model)
- To develop a profile of requirements for specific sports
- To develop competencies of training with youth and talents
- To develop the basics of talent training in theory and practice
- To observe athletes in case studies, make judgments and conclusion
Das Modell der Sportartenanalyse
Die Relevanz der einzelnen Leistungsfaktoren
Das Modell der Wettkampfanalyse
Folgerungen für das Training und Coaching in der Sportart
Folgerungen für das Nachwuchstraining
Folgerungen für die Athletenauswahl, Athletenbeobachtung und -betreuung
Das Nachwuchs- und TalenteTraining (Sichtung, Selektion, Förderung)
Projekte aus der Praxis (Talent- und Nachwuchstraining)
Praxisinput zum Thema Koordination, motorische Grundbedürfnisse, Kraft und Gesundheit
Praxisbeispiele erarbeiten und planen
Konkrete Athletenbeobachtung

Lecture notes
Die Skript- (Lektionsunterlagen) werden im Rahmen des Semesters abgeben und auf Homepage veröffentlicht.

Literature
Struktur sportlicher Leistung (Modellsansatz von Gundlach; (Trainingswissenschaften S. 45 - 49; Stiehler/Konzag/Döbler)

Leistungsdiagnostische Verfahren, Stiehler/Konzag/Döbler
Training fundiert erklärt, Handbuch der Trainingslehre, Ingold Verlag 2006
Das sportliche Talent, W. Joch, Meyer&Meyer Verlag, 2002
Das neue Konditionstraining, Grosser/Starischka/Zimmermann, blv 2002

Prerequisites / notice
Für die Kreditvergabe sind die vorgeschriebenen Semesterarbeiten und die Präsenz zwingend. Die Benotung erfolgt durch eine schriftliche Arbeit.

Die Planungsunterlagen werden zu Semesterbeginn abgegebenen, sind provisorisch und können vom Dozenten geändert werden. Die Praxislektionen werden jeweils am Mittwoch von 13.00 - 15.00 abgehalten. Die Termine werden in Absprache festgelegt.

Die Semesterarbeit ist 4 Wochen nach Semesterende abzugeben.

851-0588-00L Introduction to Game Theory. Models and Experimental Studies
Particularly suitable for students of D-MAVT, D-MATL

Abstract
This course introduces the foundations of game theory. It focuses on models of social interaction, conflict and cooperation, the emergence of cooperation and concepts of strategic decision-making behaviour. Examples, applications and the contrast between theory and empirical results are particularly emphasized.

Objective
Learn the fundamentals, models, and logic of thinking about game theory. Apply game theory models to strategic interaction situations and critically assess game theory's capabilities through a wide array of experimental results.

Content


In der Vorlesung wird Wert darauf gelegt, Modelle an Beispielen zu demonstrieren und empirische Untersuchungen ("experimentelle Spieltheorie") vorzustellen.

Lecture notes
Die folgenden Einführungen unterscheiden sich nach Anwendungen und Grad der Formalisierung. Zur Einführung kann man sich eines der folgenden Bücher ansehen, die ab Januar im Handapparat der D-GESS-Bibliothek stehen werden:


Weitere Literatur und Übungsaufgaben zum Download unter:
http://www.socio.ethz.ch/publications/spieltheorie

### Literature

**Prerequisites / Notice**

Um Missverständnisse zu vermeiden: Die Vorlesung ist für Hörerinnen und Hörer aller Departemente geeignet. (Nicht nur für D-MATL, D-MAVT)

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<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
<th>Type</th>
<th>Author</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0585-43L</td>
<td>Experimental Game Theory</td>
<td>W 2 credits 2S</td>
<td></td>
<td>A. Diekmann</td>
</tr>
</tbody>
</table>

**Abstract**
The course addresses principles and methods of experimental game theory. It focuses on experiments about social interaction, conflict and cooperation, emergence of cooperation and experimental validity of concepts for strategic behaviour in decision-making situations.

**Objective**
Learn the fundamentals and logic of thinking about experimental methods and experimental game theory. Learn to read critically the scientific literature on experimental game theory. Apply experimental game theory methods to strategic interaction situations.

**Content**

**Lecture notes**
Folien der Spieltheorie-Vorlesung und Literatur (Fachartikel, Kapitel aus Lehrbüchern) können auf der Webseite des Seminar eingesehen und heruntergeladen werden.

**Literature**

(Ein Handapparat dieser und weiterer Literatur wird in der D-GESS-Bibliothek bereitgestellt.)

Literatur zum Download befindet sich auch auf der Webseite:
http://www.socio.ethz.ch/publications/spieltheorie

**Prerequisites / Notice**
Interesse am Thema und Motivation zur Mitarbeit. Der Besuch der Vorlesung "Spieltheorie" (851-0588-00 V, Dienstag, 15-17 Uhr) ist hilfreich.

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<th>Code</th>
<th>Title</th>
<th>Credits</th>
<th>Type</th>
<th>Author</th>
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<tbody>
<tr>
<td>701-0985-00L</td>
<td>Social Intercourse with Current Environmental Risks</td>
<td>W 1 credit 1V</td>
<td></td>
<td>B. Nowack, C. M. Som-Koller</td>
</tr>
</tbody>
</table>

**Abstract**
The lecture treats the social intercourse with risks of technical systems. The notion of risk and the perception of risk are discussed by case studies (e.g. nanotechnology) and socio-political instruments for decision-making are presented. Methods are presented that can be applied to deal with environmental risks and how they can be used for sustainable innovation.

**Objective**
- Getting acquainted to the extended risk concept
- Evaluation of the risks caused by technical systems within the societal context
- Knowledge about the mode science and society handle current environmental risks (examples gene- and nanotechnology)
- Knowledge about handling risks (e.g. precautionary principle, protection goal, damage definition, ethics)

**Content**
- Risks and technical systems (risk categories, risk perception, risk management)
- Illustration with case studies (nanotechnology)
- Implementation (politics, science, media, etc.)
- Decision making (technology assessment, cost/benefit analysis etc.)
- The role of the media
- prospects for future developments

**Lecture notes**
Copies of slides and selected documents will be distributed.

**Prerequisites / Notice**
The lecture is held biweekly (for 2 hours). The dates are 26.9., 3.10. (out of schedule), 24.10, 7.11, 21.11, 5.12, 19.12

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<th>Code</th>
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<th>Author</th>
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<tbody>
<tr>
<td>701-0703-00L</td>
<td>Environmental Ethics</td>
<td>W 2 credits 2V</td>
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<td>M. Huppenbauer</td>
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</tbody>
</table>

**Abstract**
The lecture begins with an introduction to applied ethics in general. The main focus is on environmental ethics. Students learn to handle important concepts and positions of environmental ethics. They achieve a deeper understanding of these concepts and positions in applying them to ecological problems and discussing them in case studies.

**Objective**
On completion of this lecture course you will have acquired the ability to identify and process general and environmental ethical problems.

**Content**
- Introduction to general and applied ethics.
- Overview and discussion of ethical theories relevant to the environment.
- Familiarisation with various basic standpoints within environmental ethics.
- Cross-section topics, such as sustainability, intergenerational justice, protection of species, etc.
- Practising of newly acquired knowledge in case studies (protection of species, climate change, etc.)

**Lecture notes**
Summaries of the individual sessions will be distributed, including the most important theories and keywords; reading list.

In the part of the course serving as an introduction to general and applied ethics, we shall be using the following textbook: Barbara Bleisch/Markus Huppenbauer: Ethische Entscheidungsfindung. Ein Handbuch für die Praxis, 2nd Edition Zürich 2014
Literature
- Andrew Light/Holmes Rolston III, Environmental Ethics. An Anthology, 2003
- John O’Neill et al., Environmental Values, 2008
- Klaus Peter Rippe, Ethik im ausserhumanen Bereich, Paderborn (mentis) 2008

General introductions:
- Marcus Düwell et. al (Hrg.), Handbuch Ethik, 2. Auflage, Stuttgart (Metzler Verlag), 2006
- Johann S. Ach et. al (Hrg.), Grundkurs Ethik 1. Grundlagen, Paderborn (mentis) 2008

Prerequisites / notice
The procedure for accumulating CP will be explained at the start of term.
I expect participants to be motivated and contribute to discussions, keeping the course interesting and lively.

151-0757-00L Environmental Management W 2 credits 2G R. Züst
Abstract
An environmental management system has the objective to continuously improve the environmental performance of the activities, products and services of a company. The company has to introduce different management procedures. The goal of this lecture is to provide basics and specific procedure to implement the environmental dimension in the planning and decision making processes of an organisation.

Objective
Overview on environmental management and environmental management systems, general methods and principles.

Content
Introduction to environmental management / environmental management systems, energy and material flows; economical and ecological problems in industry; charakterisation of an enterprise (incl. management handbook); structur and contents of an environmental management system; overview on the ISO 14001 ff. series; methods for environmental evaluation and assessment; integrated management systems; planning methodology and life-cycle-design design; planning exampl

Lecture notes
Information about environmental management and environmental management systems will be provided by a CD or mail.

Literature
a list with literatures and links will be provided

Prerequisites / notice
Delivery of a case study, worked out in groups. Language: Teaching in English on request.

Public Policy Bachelor - Key for Type

<table>
<thead>
<tr>
<th>Letter</th>
<th>Compulsory</th>
<th>Eligible for credits and recommended</th>
<th>Eligible for credits</th>
<th>Recommended, not eligible for credits</th>
<th>Courses outside the curriculum</th>
<th>Suitable for doctorate</th>
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Key for Hours

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<tr>
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<th>Description</th>
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<th>European Credit Transfer and Accumulation System</th>
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<tbody>
<tr>
<td>V</td>
<td>lecture</td>
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<td>Special students and auditors need special permission from the lecturers.</td>
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<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<td>S</td>
<td>seminar</td>
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<td>K</td>
<td>colloquium</td>
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<td>P</td>
<td>practical/laboratory course</td>
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<td>A</td>
<td>independent project</td>
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<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
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Statistics Master
The following courses belong to the curriculum of the Master's Programme in Statistics. The corresponding credits do not count as external credits even for course units where an enrolment at ETH Zurich is not possible.

► Core Courses
In each subject area, the core courses offered are normally mathematical as well as application-oriented in content. For each subject area, only one of these is recognised for the Master degree.

►► Regression

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>401-0649-00L</td>
<td>Applied Statistical Regression</td>
<td>W</td>
<td>5 credits</td>
<td>2V+1U</td>
<td>M. Dettling</td>
</tr>
</tbody>
</table>

Abstract
This course offers a practically oriented introduction into regression modeling methods. The basic concepts and some mathematical background are included, with the emphasis lying in learning “good practice” that can be applied in every student's own projects and daily work life. A special focus will be laid in the use of the statistical software package R for regression analysis.

Objective
The students acquire advanced practical skills in linear regression analysis and are also familiar with its extensions to generalized linear modeling.

Content
The course starts with the basics of linear modeling, and then proceeds to parameter estimation, tests, confidence intervals, residual analysis, model choice, and prediction. More rarely touched but practically relevant topics that will be covered include variable transformations, multicollinearity problems and model interpretation, as well as general modeling strategies.

The last third of the course is dedicated to an introduction to generalized linear models: this includes the generalized additive model, logistic regression for binary response variables, binomial regression for grouped data and poisson regression for count data.

Lecture notes
A script will be available.

Literature
Faraway (2005): Linear Models with R
Faraway (2006): Extending the Linear Model with R
Draper & Smith (1998): Applied Regression Analysis
Fox (2008): Applied Regression Analysis and GLMs
Montgomery et al. (2006): Introduction to Linear Regression Analysis

Prerequisites / notice
In the Mathematics Bachelor and Master programmes, the two course units 401-0649-00L "Applied Statistical Regression" and 401-3622-00L "Regression" are mutually exclusive. Registration for the examination of one of these two course units is only allowed if you have not registered for the examination of the other course unit.

►► Analysis of Variance and Design of Experiments

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>401-0625-01L</td>
<td>Applied Analysis of Variance and Experimental Design</td>
<td>W</td>
<td>5 credits</td>
<td>2V+1U</td>
<td>L. Meier</td>
</tr>
</tbody>
</table>

Abstract

Objective
Participants will be able to plan and analyze efficient experiments in the fields of natural sciences. They will gain practical experience by using the software R.

Content

Literature

Prerequisites / notice
The exercises, but also the classes will be based on procedures from the freely available, open-source statistical software package R, for which an introduction will be held.

►► Multivariate Statistics

►► Time Series and Stochastic Processes

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>401-4623-00L</td>
<td>Time Series Analysis</td>
<td>W</td>
<td>6 credits</td>
<td>3G</td>
<td>N. Meinhausen</td>
</tr>
</tbody>
</table>

Abstract
Statistical analysis and modeling of observations in temporal order, which exhibit dependence. Stationarity, trend estimation, seasonal decomposition, autocorrelations, spectral and wavelet analysis, ARIMA-, GARCH- and state space models. Implementations in the software R.

Objective
Understanding of the basic concepts and techniques used in time series analysis and their implementation in the statistical software R.

Content
This course deals with modeling and analysis of variables which change randomly in time. Their essential feature is the dependence between successive observations. Applications occur in geophysics, engineering, economics and finance. Topics covered: Stationarity, trend estimation, seasonal decomposition, autocorrelations, spectral and wavelet analysis, ARIMA-, GARCH- and state space models. The models and techniques are illustrated using the statistical software R.

Lecture notes
Not available

Literature
A list of references will be distributed during the course.

Basic knowledge in probability and statistics

►► Mathematical Statistics

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<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>401-3621-00L</td>
<td>Fundamentals of Mathematical Statistics</td>
<td>W</td>
<td>10 credits</td>
<td>4V+1U</td>
<td>F. Balabdaoui</td>
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</table>

Abstract
The course covers the basics of inferential statistics.

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>401-8623-00L</td>
<td>Likelihood Inference (University of Zurich)</td>
<td>W</td>
<td>5 credits</td>
<td>3G</td>
<td>University lecturers</td>
</tr>
</tbody>
</table>

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.

UZH Module Code: STA402

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Abstract

An overview of the basics of likelihood inference.

### Specialization Areas and Electives

#### Statistical and Mathematical Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>401-3601-00L</td>
<td>Probability Theory</td>
<td>W</td>
<td>10</td>
<td>4V+1U</td>
<td>A.S. Sznitman</td>
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<tr>
<td></td>
<td>This course counts as a core course in the Bachelor's degree programme in Mathematics. Holders of an ETH Zurich Bachelor's degree in Mathematics who didn't use credits from none of the three course units 401-3601-00L Probability Theory, 401-3642-00L Brownian Motion and Stochastic Calculus resp. 401-3622-00L Applied Stochastic Processes for their Bachelor's degree still can have recognised this course for the Master's degree. Furthermore, at most one of the three course units 401-3661-00L Functional Analysis I 401-3531-00L Differential Geometry I 401-3601-00L Probability Theory can be recognised for the Master's degree in Mathematics or Applied Mathematics.</td>
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<td></td>
<td>Basics of probability theory and the theory of stochastic processes in discrete time</td>
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<td>This course presents the basics of probability theory and the theory of stochastic processes in discrete time. The following topics are planned: Basics in measure theory, random series, law of large numbers, weak convergence, characteristic functions, central limit theorem, conditional expectation, martingales, convergence theorems for martingales, Galton Watson chain, transition probability, Theorem of Ionescu Tulcea, Markov chains.</td>
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<td>This course covers the basics of probability theory and the theory of stochastic processes in discrete time. The following topics are planned: Basics in measure theory, random series, law of large numbers, weak convergence, characteristic functions, central limit theorem, conditional expectation, martingales, convergence theorems for martingales, Galton Watson chain, transition probability, Theorem of Ionescu Tulcea, Markov chains.</td>
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<td>Lecture notes available, will be sold in the course</td>
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<tr>
<td>401-3627-00L</td>
<td>High-Dimensional Statistics</td>
<td>W</td>
<td>4</td>
<td>2V</td>
<td>P. L. Bühlmann</td>
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<td>&quot;High-Dimensional Statistics&quot; deals with modern methods and theory for statistical inference when the unknown parameters is of much larger order than sample size. Statistical estimation and algorithms for complex models and aspects of multiple testing will be discussed.</td>
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<td></td>
<td>Knowledge of methods and basic theory for high-dimensional statistical inference</td>
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<td></td>
<td>Non-convex loss functions and l1-regularization; Stability selection, multiple testing and construction of p-values; Undirected graphical modeling</td>
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<td>Lecture notes available, will be sold in the course</td>
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<td>Prerequisites / notice Knowledge of basic concepts in probability theory, and intermediate knowledge of statistics (e.g. a course in linear models or computational statistics).</td>
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<tr>
<td>401-3612-00L</td>
<td>Stochastic Simulation</td>
<td>W</td>
<td>5</td>
<td>3G</td>
<td>F. Sigrist</td>
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<td></td>
<td>This course provides an introduction to statistical Monte Carlo methods. This includes applications of simulations in various fields (Bayesian statistics, statistical mechanics, operations research, financial mathematics), algorithms for the generation of random variables (accept-reject, importance sampling), estimating the precision, variance reduction, introduction to Markov chain Monte Carlo.</td>
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<td>Stochastic simulation (also called Monte Carlo method) is the experimental analysis of a stochastic model by implementing it on a computer. Probabilities and expected values can be approximated by averaging simulated values, and the central limit theorem gives an estimate of the error of this approximation. The course shows examples of the many applications of stochastic simulation and explains different algorithms used for simulation. These algorithms are illustrated with the statistical software R.</td>
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<td>Lecture notes A script will be available in English.</td>
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<td>Prerequisites / notice Familiarity with basic concepts of probability theory (random variables, joint and conditional distributions, laws of large numbers and central limit theorem) will be assumed.</td>
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<tr>
<td>401-3611-00L</td>
<td>Advanced Topics in Computational Statistics</td>
<td>W</td>
<td>4</td>
<td>2V</td>
<td>M. H. Maathuis</td>
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<td>This course covers selected advanced topics in computational statistics, including various classification methods, the EM algorithm, clustering, handling missing data, and graphical modelling.</td>
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Students learn the theoretical foundations of the selected methods, as well as practical skills to apply these methods and to interpret their outcomes.

The course is roughly divided in three parts: (1) Supervised learning via (variations of) nearest neighbor methods, (2) the EM algorithm and clustering, (3) handling missing data and graphical models.

We assume a solid background in mathematics, an introductory lecture in probability and statistics, and at least one more advanced course in statistics.

**401-4633-00L**  
**Data Analytics in Organisations and Business**  
W  5 credits  2+1U  1. Flückiger

**Abstract**  
On the end-to-end process of data analytics in organisations & business and how to transform data into insights for fact based decisions.

**Objective**  
The goal of this course is to give the students the understanding of the data analytics process in the business world, with special focus on the skills and techniques used besides the technical skills. The student will become familiar with the “business language”, current problems and thinking in organisations and business and tools used.

**Lecture notes**  
Lecture notes.

**Prerequisites / notice**  
Lecture Notes will be available.

**401-6217-00L**  
**Using R for Data Analysis and Graphics (Part II)**  
W  1 credit  1G  A. Drewek, A. J. Papritz

**Abstract**  
The course provides the second part an introduction to the statistical software R for scientists. Topics are data generation and selection, graphical functions, important statistical functions, types of objects, models, programming and writing functions.

**Objective**  
The students will be able to use the software R efficiently for data analysis.

**Content**  
- Framing the Business Problem
- Framing the Analytics Problem
- Data
- Methodology
- Model Building
- Deployment
- Model Lifecycle

**Lecture notes**  
Lecture Notes will be available.

**Prerequisites / notice**  
Basic knowledge of R equivalent to "Using R... (Part I)” (= 401-6215-00L) is a prerequisite for this course.

**401-0627-00L**  
**Smoothing and Nonparametric Regression with Examples**  
W  4 credits  2G  S. Beran-Ghosh

**Abstract**  
Starting with an overview of selected results from parametric inference, kernel smoothing (including local polynomials) will be introduced along with some asymptotic theory, optimal bandwidth selection, data driven algorithms and some special topics. Examples from environmental research will be used for motivation, but the methods will also be applicable elsewhere.

**Objective**  
The students will learn about methods of kernel smoothing and application of concepts to data. The aim will be to build sufficient interest in the topic and intuition as well as the ability to implement the methods to various different datasets.

**Content**  
- Parametric estimation methods: selection of important results
  - Maximum likelihood
  - Least squares: regression & diagnostics
- Nonparametric curve estimation
  - Density estimation, Kernel regression, Local polynomials, Bandwidth selection
  - Selection of special topics (as time permits, we will cover as many topics as possible) such as rapid change points, mode estimation, robust smoothing, partial linear models, etc.
- Applications: potential areas of applications will be discussed such as, change assessment, trend and surface estimation, probability and quantile curve estimation, and others.

**Lecture notes**  
Brief summaries or outlines of some of the lecture material will be posted at http://www.wsl.ch/info/mitarbeiternde/ghosh/index_EN (click on "ETH Course" in the left panel).

**NOTE:** The posted notes will tend to be just sketches whereas only the in-class lessons will contain complete information.

**LOG IN:** In order to have access to the posted notes, you will need the course user id & the password. These will be given out on the first day of the lectures.
Nonparametric and Resampling Methods

Does not take place this semester.

Special Students "University of Zurich (UZH)" in the Master Program in Biostatistics at UZH cannot register for this course unit electronically. Forward the lecturer's written permission to attend to the Registrar's Office. Alternatively, the lecturer may also send an email directly to registrar@ethz.ch. The Registrar's Office will then register you for the course.

Abstract

Nonparametric tests, randomization tests, jackknife and bootstrap, as well as asymptotic properties of estimators.

Objective

For classical parametric models there exist optimal statistical estimators and test statistics whose distributions can often be determined exactly. The methods covered in this course allow for finding statistical procedures for more general models and to derive exact or approximate distributions of complicated estimators and test statistics.

Content

Nonparametric tests, randomization tests, jackknife and bootstrap, as well as asymptotic properties of estimators.

Prerequisites / notice

This course is part of the programme for the certificate and diploma in Advanced Studies in Applied Statistics. It is given every second year in the winter semester break.

Nonparametric Regression

Special Students "University of Zurich (UZH)" in the Master Program in Biostatistics at UZH cannot register for this course unit electronically. Forward the lecturer's written permission to attend to the Registrar's Office. Alternatively, the lecturer may also send an email directly to registrar@ethz.ch. The Registrar's Office will then register you for the course.

Abstract

This course focusses on nonparametric estimation of probability densities and regression functions. These recent methods allow modelling without restrictive assumptions such as 'linear function'. These smoothing methods require a weight function and a smoothing parameter.

Objective

Knowledge on estimation of probability densities and regression functions via various statistical methods. Understanding of the choice of weight function and of the smoothing parameter, also done automatically. Practical application on data sets at the computer.

Spatial Statistics

Special Students "University of Zurich (UZH)" in the Master Program in Biostatistics at UZH cannot register for this course unit electronically. Forward the lecturer's written permission to attend to the Registrar's Office. Alternatively, the lecturer may also send an email directly to registrar@ethz.ch. The Registrar's Office will then register you for the course.

Abstract

In many research fields, spatially referenced data are collected. When analysing such data the focus is either on exploring their structure (dependence on explanatory variables, autocorrelation) and/or on spatial prediction. The course provides an introduction to geostatistical methods that are useful for such purposes.

Objective

The course will provide an overview of the basic concepts and stochastic models that are commonly used to model spatial data. In addition, the participants will learn a number of geostatistical techniques and acquire some familiarity with software that is useful for analysing spatial data.

Content

After an introductory discussion of the types of problems and the kind of data that arise in environmental research, an introduction into linear geostatistics (models: stationary and intrinsic random processes, modelling large-scale spatial patterns by regression, modelling autocorrelation by variogram; kriging: mean-square prediction of spatial data) will be taught. The lectures will be complemented by data analyses that the participants have to do themselves.

Lecture notes

Slides, descriptions of the problems for the data analyses and worked-out solutions to them will be provided.

Data Mining: Learning from Large Data Sets

Many scientific and commercial applications require insights from massive, high-dimensional data sets. This course introduces principled, state-of-the-art techniques from statistics, algorithms and discrete and convex optimization for learning from such large data sets. The course both covers theoretical foundations and practical applications.

Abstract

Many scientific and commercial applications require us to obtain insights from massive, high-dimensional data sets. In this graduate-level course, we will study principled, state-of-the-art techniques from statistics, algorithms and discrete and convex optimization for learning from such large data sets. The course will both cover theoretical foundations and practical applications.

Objective

Topics covered:
- Dealing with large data (Data centers; Map-Reduce/Hadoop; Amazon Mechanical Turk)
- Fast nearest neighbor methods (Shingling, locality sensitive hashing)
- Online learning (Online optimization and regret minimization, online convex programming, applications to large-scale Support Vector Machines)
- Multi-armed bandits (expansion-exploitation tradeoffs, applications to online advertising and relevance feedback)
- Active learning (uncertainty sampling, pool-based methods, label complexity)
- Dimension reduction (random projections, nonlinear methods)
- Data streams (Sketches, coresets, applications to online clustering)
- Recommender systems

Content

Prerequisites / notice

Prerequisites: A background in Linear Algebra, Calculus, Probability & Statistical Inference including Estimation and Testing.

References:
- Statistical Inference, by S.D. Silvey, Chapman & Hall.
- Density Estimation, by B.W. Silverman, Chapman and Hall.
- Kernel Smoothing, by M.P. Wand and M.C. Jones, Chapman and Hall.
- Nonparametric Simple Regression, by J. Fox, Sage Publications.

Additional references will be given out in the lectures.

Prerequisites / notice

Prerequisites: A background in Linear Algebra, Calculus, Probability & Statistical Inference including Estimation and Testing.

References:

Prerequisites: A background in Linear Algebra, Calculus, Probability & Statistical Inference including Estimation and Testing.

References:

Prerequisites: A background in Linear Algebra, Calculus, Probability & Statistical Inference including Estimation and Testing.

References:
Block course only on prediction problems, aka “supervised learning”.

Bayes Methods

“Data Mining” is a large field from which in this block course, we only treat so called prediction problems, aka “supervised learning”.

Bayes statistics is attractive, because it allows to make decisions under uncertainty where a classical frequentist statistical approach fails.

Part 2, Flexible Prediction (of continuous or “class” response/target) contains additive models, MARS, Y-Transformation models (ACE, AVAS); Projection Pursuit Regression (PPR), neural nets.

The course provides an introduction into bayesian methods. It is moderately mathematically technical, but demands a flexibility of mind, which should not underestimated.

Knowledge of the Elements and the process of a sample survey. Understanding of the paradigm of random samples. Knowledge of simple random sampling and stratified random sampling and capability to apply the corresponding methods. Knowledge of further methods of sampling and estimation as well as data preparation and analysis.

Bayes statistics is attractive, because it allows to make decisions under uncertainty where a classical frequentist statistical approach fails. The course provides an introduction into bayesian methods. It is moderately mathematically technical, but demands a flexibility of mind, which should not underestimated.

Knowledge of the Elements and the process of a sample survey. Understanding of the paradigm of random samples. Knowledge of simple random sampling and stratified random sampling and capability to apply the corresponding methods. Knowledge of further methods of sampling and estimation as well as data preparation and analysis.

This course gives a first introduction to the main modelling ideas and mathematical tools from mathematical finance. It aims at a double audience: mathematicians who want to learn the modelling ideas and concepts for finance, and non-mathematicians who need an introduction to the main tools from stochastics used in mathematical finance. The main emphasis will be on ideas, but important results will be given with (sometimes partial) proofs.

Special Students "University of Zurich (UZH)" in the Master Program in Biostatistics at UZH cannot register for this course unit electronically. Forward the lecturer's written permission to attend to the Registrar's Office. Alternatively, the lecturer may also send an email directly to registrar@ethz.ch. The Registrar's Office will then register you for the course.
Abstract
Mathematical treatment of diverse optimization techniques.

Objective
Advanced optimization theory and algorithms.

Content
1. Linear optimization: The geometry of linear programming, the simplex method for solving linear programming problems, Farkas’ Lemma and infeasibility certificates, duality theory of linear programming.


3. Integer optimization: Ties between linear and integer optimization, total unimodularity, complexity theory, cutting plane theory.

4. Combinatorial optimization: Network flow problems, structural results and algorithms for matchings, matchings and, more generally, independence systems.

401-6282-00L Statistical Analysis of High-Throughput Genomic and Transcriptional Data (University of Zurich)
No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.
UZH Module Code: STA405

Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

Abstract
A range of topics will be covered, including basic molecular biology, genomics technologies and in particular, a wide range of statistical and mathematical treatment of diverse optimization techniques.

Objective
- Understand the fundamental "scientific process" in the field of Statistical Bioinformatics
- Be equipped with the skills/tools to preprocess genomic data (Unix, Bioconductor, mapping, etc.) and ensure reproducible research (Sweave)
- Have a general knowledge of the types of data and biological applications encountered with microarray and sequencing data
- Gain the ability to apply statistical methods/knowledge/software to a collaborative biological project
- Gain the ability to critically assess the statistical bioinformatics literature
- Write a coherent summary of a bioinformatics problem and its solution in statistical terms

Content
Lectures will include: microarray preprocessing; normalization; exploratory data analysis techniques such as clustering, PCA and multidimensional scaling; Controlling error rates of statistical tests (FPR versus FDR versus FWER); limma (linear models for microarray analysis); mapping algorithms (for RNA/ChIP-seq); RNA-seq quantification; statistical analyses for differential count data; isoform switching; epigenomics data including DNA methylation; gene set analyses; classification

Lecture notes
Lecture notes, published manuscripts

Prerequisites / notice
Prerequisites: Basic knowledge of the programming language R, sufficient knowledge in statistics

Former course title: Statistical Methods for the Analysis of Microarray and Short-Read Sequencing Data

401-8625-00L Statistical Methods in Clinical Research (University of Zurich)
No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.
UZH Module Code: STA404

Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

Abstract
Discussion of the different statistical methods that are used in clinical research.

Objective
Discussion of the different statistical methods that are used in clinical research. Among other subjects the following will be introduced: sample size calculation, randomization and blinding, analysis of clinical trials (parallel groups design, analysis of covariance, crossover design, equivalence studies), intention-to-treat analysis, multiple testing, group sequential methods, adaptive designs, diagnostic studies, and agreement studies.

Content
Discussions will include: sample size calculation, randomization and blinding, analysis of clinical trials (parallel groups design, analysis of variance, crossover design, equivalence studies), intention-to-treat analysis, multiple testing, group sequential methods, adaptive designs, diagnostic studies, and agreement studies.

Literature

Prerequisites / notice
Basic knowledge of the programming language R, sufficient knowledge in calculus, linear algebra, probability, statistics

252-0535-00L Machine Learning

Abstract
Machine learning algorithms provide analytical methods to search data sets for characteristic patterns. Typical tasks include the classification of data, function fitting and clustering, with applications in image and speech analysis, bioinformatics and exploratory data analysis. This course is accompanied by practical machine learning projects.

Objective
Students will be familiarized with the most important concepts and algorithms for supervised and unsupervised learning; reinforce the statistics knowledge which is indispensible to solve modeling problems under uncertainty. Key concepts are the generalization ability of algorithms and systematic approaches to modeling and regularization. A machine learning project will provide an opportunity to test the machine learning algorithms on real world data.

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Content

The theory of fundamental machine learning concepts is presented in the lecture, and illustrated with relevant applications. Students can deepen their understanding by solving both pen-and-paper and programming exercises, where they implement and apply famous algorithms to real-world data.

Topics covered in the lecture include:

- Bayesian theory of optimal decisions
- Maximum likelihood and Bayesian parameter inference
- Classification with discriminant functions: Perceptrons, Fisher’s LDA and support vector machines (SVM)
- Ensemble methods: Bagging and Boosting
- Regression: least squares, ridge and LASSO penalization, non-linear regression and the bias-variance trade-off
- Non-parametric density estimation: Parzen windows, nearest neighbour
- Dimension reduction: principal component analysis (PCA) and beyond

Lecture notes

No lecture notes, but slides will be made available on the course webpage.

Literature


Prerequisites / notice

The course requires solid basic knowledge in analysis, statistics and numerical methods for CSE as well as practical programming experience for solving assignments.

Students should at least have followed one previous course offered by the Machine Learning Institute (e.g., CIL or LIS) or an equivalent course offered by another institution.

Statistical and Mathematical Courses: not eligible for credits

Number | Title | Type | ECTS | Hours | Lecturers
---|---|---|---|---|---
401-6215-00L | Using R for Data Analysis and Graphics (Part I) | E- | 1 credit | 1G | A. Drewek, A. J. Papritz

Abstract

The course requires solid basic knowledge in analysis, statistics and numerical methods for CSE as well as practical programming experience for solving assignments. Students should at least have followed one previous course offered by the Machine Learning Institute (e.g., CIL or LIS) or an equivalent course offered by another institution.

The course provides the first part of an introduction to the statistical software R for scientists. Students can deepen their understanding by solving both pen-and-paper and programming exercises, where they implement and apply famous algorithms to real-world data.

Topics covered in the lecture include:

- What is R?
- R Basics: reading and writing data from/to files, creating vectors & matrices, selecting elements of dataframes, vectors and matrices, arithmetics;
- Types of data: numeric, character, logical and categorical data, missing values;
- Simple (statistical) functions: summary, mean, var, etc., simple statistical tests;
- Writing simple functions;
- Introduction to graphics: scatter-, boxplots and other high-level plotting functions, embellishing plots by title, axis labels, etc., adding elements (lines, points) to existing plots.

Part I of the course covers the following topics:

- R Basics: reading and writing data from/to files, creating vectors & matrices, selecting elements of dataframes, vectors and matrices, arithmetics;
- Types of data: numeric, character, logical and categorical data, missing values;
- Simple (statistical) functions: summary, mean, var, etc., simple statistical tests;
- Writing simple functions;
- Introduction to graphics: scatter-, boxplots and other high-level plotting functions, embellishing plots by title, axis labels, etc., adding elements (lines, points) to existing plots.

The course focuses on practical work at the computer. We will make use of the graphical user interface RStudio: www.rstudio.org

Prerequisites / notice

The course requires solid basic knowledge in analysis, statistics and numerical methods for CSE as well as practical programming experience for solving assignments. Students should at least have followed one previous course offered by the Machine Learning Institute (e.g., CIL or LIS) or an equivalent course offered by another institution.

The course focuses on practical work at the computer. We will make use of the graphical user interface RStudio: www.rstudio.org

Application Areas

Students select one area of application and look for suitable courses in which quantitative methods and modeling play a role. They need the consent by the Advisor (http://stat.ethz.ch/~kalisch/) that the chosen courses are eligible in the category "Application Areas".

For the category assignment of eligible courses keep the choice "no category" and take contact with the Study Administration Office (www.math.ethz.ch/studiensekretariat/staff/ekuenti) after having received the credits. The Study Administration Office needs the Advisor's consent.

Seminar or Semester Paper

Number | Title | Type | ECTS | Hours | Lecturers
---|---|---|---|---|---
401-3630-06L | Semester Paper | W | 6 credits | 9A | Professors

Abstract

Semester papers serve to delve into a problem in statistics and to study it with the appropriate methods or to compile and clearly exhibit a case study of a statistical evaluation.

401-3630-04L | Semester Paper | W | 4 credits | 6A | Professors

Abstract

Semester papers serve to delve into a problem in statistics and to study it with the appropriate methods or to compile and clearly exhibit a case study of a statistical evaluation.
Semester papers serve to delve into a problem in statistics and to study it with the appropriate methods or to compile and clearly exhibit a case study of a statistical evaluation.

**Abstract**

In this seminar, recent papers of the pattern recognition and machine learning literature are presented and discussed. Possible topics cover statistical models in computer vision, graphical models and machine learning.

**Objective**

The seminar "Advanced Topics in Machine Learning" familiarizes students with recent developments in pattern recognition and machine learning. Original articles have to be presented and critically reviewed. The students will learn how to structure a scientific presentation in English which covers the key ideas of a scientific paper. An important goal of the seminar presentation is to summarize the essential ideas of the paper in sufficient depth while omitting details which are not essential for the understanding of the work. The presentation style will play an important role and should reach the level of professional scientific presentations.

**Content**

The seminar will cover a number of recent papers which have emerged as important contributions to the pattern recognition and machine learning literature. The topics will vary from year to year but they are centered on methodological issues in machine learning like new learning algorithms, ensemble methods or new statistical models for machine learning applications. Frequently, papers are selected from computer vision or bioinformatics - two fields, which relies more and more on machine learning methodology and statistical models.

**Literature**

The papers will be presented in the first session of the seminar.

**GESS Science in Perspective**

Recommended GESS Science in Perspective (Type B) for D-MATH.

see GESS Science in Perspective: Type A: Enhancement of Reflection Capability

see GESS Science in Perspective: Language Courses ETH/UZH

**Master's Thesis**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-2000-00L</td>
<td>Scientific Works in Mathematics</td>
<td>O</td>
<td>0</td>
<td></td>
<td>E. Kowalski</td>
</tr>
<tr>
<td>401-4990-02L</td>
<td>Master's Thesis</td>
<td>O</td>
<td>30</td>
<td>57D</td>
<td>Professors</td>
</tr>
</tbody>
</table>

**Statistics Master - Key for Type**

| Dr     | Suitable for doctorate          | E-   | Recommended, not eligible for credits |
| W+     | Eligible for credits and recommended | Z   | Courses outside the curriculum |
| W      | Eligible for credits            | O    | Compulsory |

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<table>
<thead>
<tr>
<th>Key for Hours</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
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<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<td>S</td>
<td>seminar</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
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</tbody>
</table>

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>401-0241-00L</td>
<td>Analysis I</td>
<td>O</td>
<td>7 credits</td>
<td>5V+2U</td>
<td>M.h. Akka Ginosar</td>
</tr>
<tr>
<td>Abstract</td>
<td>Mathematical tools for the engineer</td>
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<tr>
<td>Objective</td>
<td>Mathematics as a tool to solve engineering problems.</td>
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<tr>
<td>Content</td>
<td>Complex numbers.</td>
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<tr>
<td>License notes</td>
<td>Die Vorlesung folgt weitgehend</td>
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<td></td>
<td>Urs Stammbach, &quot;Analysis III/II&quot; (erhältlich im ETH Store); <a href="https://people.math.ethz.ch/~stammb/analysisskript.html">https://people.math.ethz.ch/~stammb/analysisskript.html</a></td>
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<tr>
<td>401-0141-00L</td>
<td>Linear Algebra and Numerical Analysis</td>
<td>O</td>
<td>5 credits</td>
<td>3V+1U</td>
<td>V. C. Gradinaru, R. Käppeli</td>
</tr>
<tr>
<td>Abstract</td>
<td>Introduction to Linear Algebra and Numerical Analysis with emphasis on both abstract concepts and algorithms.</td>
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<tr>
<td>Objective</td>
<td>To acquire basic knowledge of Linear Algebra and Numerical Methods. Enhanced capability for abstract and algorithmic thinking based on mathematical concepts and models. Ability to select appropriate numerical linear algebra methods, to apply them properly and to implement them efficiently in MATLAB.</td>
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<tr>
<td>Content</td>
<td>1. Linear systems of equations</td>
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<td></td>
<td>2. Vector and matrix calculus</td>
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<td>3. Subspaces and bases</td>
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<td>4. The Euclidean space Rn</td>
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<td></td>
<td>5. Numerical linear algebra with MATLAB</td>
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<td></td>
<td>6. Linear mappings [optional]</td>
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<td>7. Diagonalization (eigenproblems)</td>
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<tr>
<td>Literature</td>
<td>K. Nipp, D. Stoffer, Lineare Algebra, vdf Hochschulverlag ETH</td>
<td></td>
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<tr>
<td></td>
<td>G. Strang, Lineare Algebra, Springer</td>
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<tr>
<td>252-0845-00L</td>
<td>Computer Science I</td>
<td>O</td>
<td>5 credits</td>
<td>2V+2U</td>
<td>M. Hirt</td>
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<tr>
<td>Abstract</td>
<td>The course covers the basic concepts of computer programming.</td>
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<tr>
<td>Objective</td>
<td>Basic understanding of programming concepts. Students will be able to write and read simple programs and to modify existing programs.</td>
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<tr>
<td>Content</td>
<td>Variablen, Typen, Kontrollanweisungen, Prozeduren und Funktionen, Scoping, Rekursion, dynamische Programmierung, vektorisierte Programmierung, Effizienz. Als Lernsprachen werden Pascal und Matlab verwendet.</td>
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<tr>
<td>Lecture notes</td>
<td>Script and transparencies as well as additional material via Moodle.</td>
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<tr>
<td>Literature</td>
<td>The transparencies will be provided via Moodle two days before the respective class.</td>
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<tr>
<td>101-0031-01L</td>
<td>Systems Engineering</td>
<td>O</td>
<td>4 credits</td>
<td>3G</td>
<td>B. T. Adee, C. Richmond</td>
</tr>
<tr>
<td>Abstract</td>
<td>An introduction to system development, analysis and optimization, and decision making, with focus on linear programming, networks, formal decision methods and economic analysis.</td>
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<tr>
<td>Objective</td>
<td>- to gain competency in methods used to plan and analyse systems</td>
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<td></td>
<td>- to gain the ability to formulate, analyse and solve complex problems</td>
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<tr>
<td>Content</td>
<td>- Introduction</td>
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<td>- System development</td>
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<td>- System analysis</td>
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<td></td>
<td>- Networks</td>
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<td>- Decision theory</td>
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<td>- Economic analysis</td>
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<td>- Cost-benefit analysis</td>
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<td>Lecture notes</td>
<td>Script and transparencies as well as additional material via Moodle.</td>
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<tr>
<td>Literature</td>
<td>The transparencies will be provided via Moodle two days before the respective class.</td>
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<tr>
<td>651-0032-00L</td>
<td>Geology and Petrography</td>
<td>O</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>C. A. Heinrich, S. Löw, K. Rauchenstein</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course gives an overview of the basic concepts of geology and petrography and shows some links to the application of these concepts. The course consists of lectures and exercises in groups. The lectures cover all aspects of the dynamic earth, from the history of the earth, to the formation of rocks, mountains, and oceans, and the degradation processes shaping the uppermost earth's crust.</td>
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<tr>
<td>Objective</td>
<td>This course gives an overview of the basic concepts of geology and petrography and shows some links to the application of these concepts.</td>
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<tr>
<td>Lecture notes</td>
<td>Übungen zum Gesteinsbestimmen und Lenen von geologischen, tektonischen und geotechnischen Karten, einfache Konstruktionen.</td>
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<tr>
<td>Literature</td>
<td>The course is based on the book Dynamic Earth from Press &amp; Siever</td>
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</tbody>
</table>
This course will cover the basic topics in Physics and will show/display/explain with a variety of experiments the most important physical effects. The course will address classical as well as modern physics, and the interplay between basic research and applications. This goal is achieved through lectures with demonstration experiments and exercises in the lecture hall.

The course will address classical as well as modern physics, and the interplay between basic research and applications. Effects of the course include explaining the power and beauty of modern and classical physics, fostering scientific thinking in the natural-scientific-technical field, and introducing students to physics experiments.

Effects of the course include explaining the power and beauty of modern and classical physics, fostering scientific thinking in the natural-scientific-technical field, and introducing students to physics experiments. Effects of the course include explaining the power and beauty of modern and classical physics, fostering scientific thinking in the natural-scientific-technical field, and introducing students to physics experiments.

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Teaching of basic knowledge in microbiology.


Interzeption: Messung und Schätzung.

Evaporation und Evapotranspiration: Prozesse, Messung, Schätzung, potentielle und effektive Evapotranspiration, Energiebilanzmethode, empirische Methode.

Infiltration: Messung, Horton-Gleichung, empirische und konzeptionelle Methoden, F-index und Prozentuale Methode, SCS-CN Methode.

Einzugsgebietseigenschaften: Morphologie des Einzugsgebietes, topografische und unterirdische Wasserscheide, hysométrische Kurve, Gefälle, Dichte des Entwässerungssnetzes.


Schnee und Eis: Schneeeigenschaften und -messungen Schätzung des Schneeschmelzprozesses durch die Energiebilanzmethode, Abfluss aus Schneemelze, Temperatur-Index- und Grad-Tag-Verfahren.


Lecture notes
Ein internes Skript steht zur Verfügung (kostenpflichtig, nur Herstellungskosten)

Prerequisites / notice
Die Kopie der Foliens zu Vorlesung können auf den Webseiten der Professur für Hydrologie und Wasserwirtschaft herunterladen werden


Prerequisites / notice


Abstract
This lecture presents an introduction to ecology. It includes basic ecological concepts and the most important levels of complexity in ecological research. Corresponding methods for studying the systems will be presented.

Objective
The objective of this lecture is to teach basic ecological concepts and the different levels of complexity in ecological research: the individual, the population, the community and the ecosystem level.

Content
- Einfluss von Umweltfaktoren (Temperatur, Strahlung, Wasser, Nährstoffe etc.) auf Organismen; Anpassung an bestimmte Umweltbedingungen
- Populationsdynamik: Ursachen, Beschreibung, Vorhersage und Regulation
- Interaktionen zwischen Arten (Konkurrenz, Koexistenz, Prädation, Parasitismus, Nahrungsnetze)
- Lebensgemeinschaften: Struktur, Stabilität, Sukzession
- Ökosysteme: Kompartimente, Stoff- und Energieflüsse
- Biodiversität: Variation, Ursachen, Gefährdung und Erhaltung
- Aktuelle Naturschutzprobleme und -massnahmen
- Evolutionäre Ökologie: Methodik, Spezialisierung, Koevolution

Lecture notes
Unterlagen, Vorlesungsvorlagen und relevante Literatur sind in der Lehrdokumentenablage abrufbar. Die Unterlagen für die nächste Vorlesung stehen jeweils spätestens am Freitagmorgen zur Verfügung.

Literature
Generelle Ökologie:
Aquatische Ökologie:
Lampert & Sommer 1999. Limnökologie. Thieme, 2. Aufl., ca. Fr. 55.-;
Bohle 1995. Limnische Systeme. Springer, ca. Fr. 50.-
Naturschutzbioologie:

Examination Block 2

Number Title Type ECTS Hours Lecturers
752-4001-00L Microbiology O 2 credits 2V M. Schuppler, S. Schlegel, J. Vorholt-Zambelli

Abstract
Teaching of basic knowledge in microbiology.

Objective
Teaching of basic knowledge in microbiology.

Wird von den jeweiligen Dozenten ausgegeben.

Die Behandlung der Themen erfolgt auf der Basis des Lehrbuchs Brock, Biology of Microorganisms

Biochemistry

- 2 credits
- 2V
- H.P. Kohler

Building on the biology courses in the 1st and 2nd semesters, this course covers basic biochemical knowledge in the areas of enzymology and metabolism. Those completing the course are able to describe and understand fundamental cellular metabolic processes.

Students are able to understand
- the structure and function of biological macromolecules
- the kinetic bases of enzyme reactions
- thermodynamic and mechanistic basics of relevant metabolic processes

Students are able to describe the relevant metabolic reactions in detail

Introduction, basics, composition of cells, biochemical units, repetition of relevant organic chemistry
Structure and function of proteins
Carbohydrates
Lipids an biological membranes
Enzymes and enzyme kinetics
Catalytic strategies
Metabolism: Basic concepts and design. Repetition of basic thermodynamics
Glycolysis, fermentation
The citric acid cycle
Oxidative phosphorylation
Fatty acid metabolism

Abstract

Building on the biology courses in the 1st and 2nd semesters, this course covers basic biochemical knowledge in the areas of enzymology and metabolism. Those completing the course are able to describe and understand fundamental cellular metabolic processes.

Students are able to understand
- the structure and function of biological macromolecules
- the kinetic bases of enzyme reactions
- thermodynamic and mechanistic basics of relevant metabolic processes

Students are able to describe the relevant metabolic reactions in detail

Introduction, basics, composition of cells, biochemical units, repetition of relevant organic chemistry
Structure and function of proteins
Carbohydrates
Lipids an biological membranes
Enzymes and enzyme kinetics
Catalytic strategies
Metabolism: Basic concepts and design. Repetition of basic thermodynamics
Glycolysis, fermentation
The citric acid cycle
Oxidative phosphorylation
Fatty acid metabolism

Program

Introduction, basics, composition of cells, biochemical units, repetition of relevant organic chemistry
Structure and function of proteins
Carbohydrates
Lipids an biological membranes
Enzymes and enzyme kinetics
Catalytic strategies
Metabolism: Basic concepts and design. Repetition of basic thermodynamics
Glycolysis, fermentation
The citric acid cycle
Oxidative phosphorylation
Fatty acid metabolism

5. Semester

Compulsory Courses 5. Semester

Examination Block 3

As of examination session winter 2015, examination block 3 will be implemented in its new structure (i.e. new, Earth Observation will be examined within examination block 3 instead of within examination block 4). The new structure is valid for those students NOT having taken exams of examination block 3 nor of examination block 4 for the first time. All other students take the exams of examination block 3 as well as of examination block 4 in the present structure, including repetition where applicable.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>102-0215-00L</td>
<td>Urban Water Management II</td>
<td>O</td>
<td>3 credits</td>
<td>2G</td>
<td>M. Maurer, P. Staufer</td>
</tr>
<tr>
<td>Objective</td>
<td>Consolidation of the basic procedures for design and operation of technical networks in water engineering.</td>
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<tr>
<td>Lecture notes</td>
<td>Written material and copies of the overheads will be available. Prerequisite: Introduction to Urban Water Management</td>
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</tr>
<tr>
<td>Prerequisites / notice</td>
<td>Basic knowledge in biology and chemistry is a precondition.</td>
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<tr>
<td>102-0455-01L</td>
<td>Groundwater I</td>
<td>O</td>
<td>3 credits</td>
<td>2G</td>
<td>M. Willmann</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course provides an introduction into quantitative analysis of groundwater flow and transport. It is focussed on formulating flow and transport problems in groundwater, which are to be solved analytically or numerically.</td>
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<tr>
<td>Objective</td>
<td>a) Students understand the basic concepts of flow and contaminant transport processes and boundary conditions in groundwater.</td>
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<td>b) Students are able to formulate simple practical flow and transport problems.</td>
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<td>c) Students are able to understand and apply simple analytical solutions to simple flow and transport problems.</td>
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<td></td>
<td>d) Students are able to use simple numerical codes to adequately solve simple flow (and transport) problems.</td>
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</tr>
</tbody>
</table>
Introdiction, aquifers, groundwater use, sustainability, porosity.

Properties of porous media.
Exercises: Groundwater use, porosity, grain size analysis.

Flow properties, Darcy’s law, filter.

Flow equations, stream function.
Exercises: Darcy’s law.

Analytical solutions, confined aquifers, steady-state flow.
Exercises: Head isolines.

Use of superposition principles, transient flow, free surface flow.
Exercises: Analytical solutions to flow problems.

Finite difference solutions to flow problems I.
Exercises: Analytical solutions to flow problems.

Finite difference solutions to flow problems II.
Exercises: Finite difference formulations to flow problems.

Transport processes.
Exercises: Computer workshop using PMWIN.

Analytical solutions to transport problems I.
Exercises: Computer workshop using PMWIN.

Analytical solutions to transport problems II.
Exercises: Analytical solutions to transport problems.

Path lines, groundwater protection.
Exercises: Analytical solutions to transport problems.

Groundwater remediation, groundwater management.
Exercises: Groundwater remediation.

Lecture notes
Folien auf Internet unter www.ihw.ethz.ch/GWH/education/index
Altes Skript auf Internet www.ihw.ethz.ch/GWH/education/index
Weitere Texte auf Internet www.ihw.ethz.ch/GWH/education/index
Didaktische Software auf Internet unter www.ihw.ethz.ch/GWH/education/index

Literature
W. Kinzelbach, R. Rausch, Grundwassermodellierung, Gebrüder Bornträger, Stuttgart, 1995
Kruusemann, de Ridder, Untersuchung und Anwendung von Pumpversuchen, Verl. R. Müller, Köln, 1970
G. de Marsily, Quantitative Hydrogeology, Academic Press, 1986

Air Pollution Control
O 6 credits 4G B. Buchmann, P. Hofer

Abstract
The lecture provides in the first part an introduction to the formation of air pollutants by technical processes, the emission of these chemicals into the atmosphere and their impact on air quality. The second part covers different strategies and techniques for emission reduction. The basic knowledge is deepened by the discussion of specific air pollution problems of today's society.

Objective
The students gain general knowledge of the factors resulting in air pollution and the techniques used for air pollution control. The students can identify major air pollution sources and understand the methods for measurement, data collection and analysis. The students can evaluate possible control methods and equipment, design a control system and estimate the efficiency and cost. The students know the different techniques of air pollution control and their scientific bases. They are able to incorporate goals concerning the air quality into their engineering work.

Content
Part 1 Emission, Immission, Transmission
- Flues of pollutants and their environmental impact
  - Physical and chemical processes leading to emission of pollutants
  - Mass and energy of processes
  - Emission measurement techniques and concepts
  - Quantification of emissions from individual and aggregated sources
  - Extent and development of the emissions (Switzerland and global)
  - Propagation and transport of pollutants (transmission)
  - Meteorological parameters influencing air pollution dispersion
  - Deterministic and stochastic models, describing the air pollution dispersion
  - Dispersion models (Gaussian model, box model, receptor model)
  - Measurement concepts for ambient air (immission level)
  - Extent and development of ambient air mixing ratios
  - Goal and instrument of air pollution control

Part 2 Air Pollution Control Technologies
- The reduction of the formation of pollutants is done by modifying the processes (process-integrated measures) and by different engineering operations for the cleaning of waste gas (downstream pollution control). It will be demonstrated, that the variety of these procedures can be traced back on the application of a few basic principles of physical chemistry.
  - Procedures for the removal of particles (inertial separator, filtration, electrostatic pre-cipitators, scrubbers) with their different mechanisms (field forces, impaction and diffu-sion processes) and the modelling of these mechanisms.
  - Procedures for the removal of gaseous pollutants and the description of the driving forces involved, as well as the equilibrium and the kinetics of the relevant processes (absorption, adsorption as well as thermal, catalytic and biological conversions).
  - Discussion of the technical possibilities to solve the actual air pollution problems.
Lecture notes
- Brigitte Buchmann, Air pollution control, Part I
- Peter Hofer, Air pollution control, Part II
- Lecture slides and exercises

Literature
List of literature included in scrip

Prerequisites / notice
College lectures on basic physics, chemistry and mathematics

<table>
<thead>
<tr>
<th>102-0675-00L</th>
<th>Earth Observation</th>
<th>O</th>
<th>4 credits</th>
<th>3G</th>
<th>I. Hajnsek, E. Baltisavias</th>
</tr>
</thead>
</table>

Abstract
The aim of the course is to provide the fundamental knowledge about earth observation sensors, techniques and methods for bio/geophysical environmental parameter estimation.

Objective
Students should know at the end of the course:
1. Basics of measurement principle
2. Fundamentals of image acquisition
3. Basics of the sensor-specific geometries
4. Sensor-specific determination of environmental parameters

Content
Die Lehrveranstaltung gibt einen Einblick in die heutige Erdbeaobachtung mit dem folgenden skizzierten Inhalt:

- Einführung in die Fernerkundung von Luft- und Weltraum gestützen Systemen
- Einführung in das Elektromagnetische Spektrum
- Einführung in optische Systeme (optisch und hyperspektral)
- Einführung in Mikrowellen-Technik (aktiv und passiv)
- Einführung in atmosphärische Systeme (meteo und chemisch)
- Techniken und Methoden zur Bestimmung von Umweltparametern
- Einführung in die Anwendungen zur Bestimmung von Umweltparametern in der Hydrologie, Glaziologie, Forst und Landwirtschaft, Geologie und Topographie

Lecture notes
Folien zu jeden Vorlesungsblock werden zur Verfügung gestellt.

Literature
Ausgewählte Literatur wird am Anfang der Vorlesung vorgestellt.

Examination Block 4
In place of the German course 851-0703-03L Introduction to Law for Civil Engineering students can take the French course 851-0709-00L Droit civil.

As of examination session summer 2015, examination block 4 will be implemented in its new structure (i.e. new, Earth Observation will be examined within examination block 3 instead of within examination block 4). The new structure is valid for those students NOT having taken exams of examination block 3 nor of examination block 4 for the first time. All other students take the exams of examination block 3 as well as of examination block 4 in the present structure, including repetition where applicable.

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<th>ECTS</th>
<th>Hours</th>
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<tbody>
<tr>
<td>101-0031-02L</td>
<td>Business Administration</td>
<td>O</td>
<td>2 credits</td>
<td>2V</td>
<td>M. Passardi</td>
</tr>
</tbody>
</table>

Remark: Students BSc Civil Engineering (StR2014) are not allowed to assign to 101-0031-02, but have to assign 101-0031-04 in spring semester (2. Sem).

Abstract
Introduction to business administration
Principles of accounting and financial management
Financial planning and capital budgeting of projects
Costing systems by corporations

Objective
Prepare and analyze the financial statements of organizations
Establish budget and determine profitability of investment
Understand the major costing systems
Perform some product calculations

Content
Overview in business administration

Financial Accounting
- Balance sheet, income statement
- Accounts, double-entry bookkeeping
- Year-end closing and financial statements

Financial Management
- Financial statement analysis
- Financial planning
- Investment decisions

Management Accounting
- Full costing and marginal costing
- Product costing
- Management decisions

851-0703-03L | Introduction to Law for Civil Engineering | W | 2 credits | 2V | G. Hertig |

Only for Civil Engineering BSc, Geomatic Engineering and Planning BSc, Environmental Engineering BSc and Spatial Development and Infrastructure Systems MSc

Students who have attended or will attend the lecture "Introduction to Law for Architecture " (851-0703-01L) cannot register for this course unit.

Abstract
This class introduces students to basic features of the legal system. Questions of constitutional and administrative law, contract law, tort law, corporate law, as well as litigation are covered.

Objective
Introduction to fundamental questions of public and private law which serves as a foundation for more advanced law classes.

Content
1. Public Law
   Constitutional law: sources of law, organization of the state, fundamental rights. Administrative law: administrative decisions, organization of the administration, enforcement of administrative decisions, procedural law, basics of police, environmental and zoning law.

2. Private law

Lecture notes
There are 'Lecture Notes' (in German) for this course.

Literature
Further information is available at http://www.hertig.ethz.ch/education/grundzuege-des-rechts-fuer-baug-und-arch.html
### Elective Blocks

#### Elective Block: Environmental Planning

**Number** | **Title** | **Type** | **ECTS** | **Hours** | **Lecturers**
--- | --- | --- | --- | --- | ---
102-0535-00L | Noise Abatement | W | 5 credits | 4G | K. Eggenschwiler, J. M. Wunderli

**Abstract**

**Objective**
The students will understand the basics of noise abatement: acoustics, impact of noise, measure-ment techniques and legislation. The students will be able to analyze different noise prob-lems and they will be able to solve simple problems of noise abatement.

**Content**

**Lecture notes**
Skript "Lärmbekämpfung" erhalten zu Beginn der Vorlesung.

**Prerequisites**
1 - 2 Exkursionen

---

#### Elective Block: Soil Protection

**Number** | **Title** | **Type** | **ECTS** | **Hours** | **Lecturers**
--- | --- | --- | --- | --- | ---
701-0501-00L | Pedosphere | W | 3 credits | 2V | R. Kretzschmar

**Abstract**
Introduction to the formation and properties of soils as a function of parent rock, landscape position, climate, and soil organisms. Complex relationships between soil forming processes, physical and chemical soil properties, soil biota, and ecological soil properties are explained and illustrated by numerous examples.
Objective

Introduction to the formation and properties of soils as a function of parent rock, landscape position, climate, and soil organisms. Complex relationships between soil forming processes, physical and chemical soil properties, soil biota, and ecological soil properties are explained and illustrated by numerous examples.

Content

Definition of the pedosphere, soil functions, rocks as parent materials, minerals and weathering, soil organisms, soil organic matter, physical soil properties and functions, chemical soil properties and functions, soil formation, principles of soil classification, global soil regions, soil fertility, land use and soil degradation.

Lecture notes

Lecture notes can be purchased during the first lecture (15. SFr).

Literature


Prerequisites / notice

Prerequisites: Basic knowledge in chemistry, biology and geology.

701-0533-00L Soil Chemistry W 3 credits 2G R. Kretzschmar, D. I. Christl

Abstract

This course discusses chemical and biogeochemical processes in soils and their influence on the behavior and cycling of nutrients and pollutants in terrestrial systems. Approaches for quantitative modeling of the processes are introduced.

Objective

Understanding of important chemical soil properties and processes and their influence on the behavior (e.g., speciation, bioavailability, mobility) of nutrients and pollutants.

Content

Important topics include the structure and properties of clays and oxides, the chemistry of the soil solution, gas equilibria, dissolution and precipitation of mineral phases, cation exchange, surface complexation, chemistry of soil organic matter, redox reactions in flooded soils, soil acidification and soil salinization.

Lecture notes

Handouts in lectures.

Literature


E elective Block: Civil Engineering

Number Title Type ECTS Hours

101-0339-00L Environmental Geotechnics W 3 credits 2G L. M. Plötze

Abstract

Introduction of basic knowledge about problems with contaminated sites, investigation of these sites, risk management, remediation and reclamation techniques as well as monitoring systems. Introduction in landfill design and engineering with focus on barrier- and drainage systems and lining materials, evaluation of geotechnical problems, e.g. stability.

Objective

Introduction of basic knowledge about problems with contaminated sites, investigation of these sites, risk management, remediation and reclamation techniques as well as monitoring systems. Introduction in landfill design and engineering with focus on barrier- and drainage systems and lining materials, evaluation of geotechnical problems, e.g. stability.

Content

Definition of contaminated sites, site investigation methods, historical research and technical investigation, risk assessment, contamination transport, remediation, clean-up and retaining techniques (e.g. bioremediation, incineration, retaining walls, pump-and-treat, permeable reactive barriers), monitoring, research projects and results

Lecture notes

Dr. R. Hermanns Stengele, Dr. M. Plötze: Environmental Geotechnics (german) digital excursion

101-1249-00L Hydraulics of Engineering Structures W 3 credits 2G H. Fuchs, I. Albayrak, L. Schmocker

Abstract

Hydraulic fundamentals are applied to hydraulic structures for wastewater, flood protection and hydropower. Typical case studies from engineering practice are further described.

Objective

Understanding and quantification of fundamental hydraulic processes with particular focus on hydraulic structures for wastewater, flood protection and hydropower

Content

1. Introduction & Basic equations
2. Losses in flow & Maximum discharge
3. Uniform flow & Critical flow
4. Hydraulic jump & Stilling basins
5. Backwater curves
6. Weirs/End overfalls & Venturi
7. Mobile discharge measurements & Culverts/restrictors/inverted siphons
8. Fall manholes & Vortex drop
9. Conjunctions & Shock waves at abrupt wall deflections
10. Air/water flows and bottom outlets
11. Driftwood retention racks
12. Vegetated flows - Introduction
13. Vegetated flows - Application
14. Summary & questions/preparations for examination

Lecture notes

Text books

Literature


E elective Block: Energy

Number Title Type ECTS Hours

529-0193-00L Renewable Energy Technologies I W 4 credits 3G A. Wokaun, A. Steinfeld

Abstract

The lectures Renewable Energy Technologies I (529-0193-00L) and Renewable Energy Technologies II (529-0191-01L) can be taken independently from one another.

Scenarios for world energy demand and CO2 emissions, implications for climate. Methods for the assessment of energy chains. Potential and technology of renewable energies: Biomass (heat, electricity, biofuels), solar energy (low temp. heat, solar thermal and photovoltaic electricity, solar chemistry), Wind and ocean energy, heat pumps, geothermal energy, energy from waste. CO2 sequestration.
Objective
Scenarios for the development of world primary energy consumption are introduced. Students know the potential and limitations of renewable energies for reducing CO2 emissions, and their contribution towards a future sustainable energy system that respects climate protection goals.

Content

Lecture notes
Lecture notes will be distributed electronically during the course.

Literature

Prerequisites / notice
Fundamentals of chemistry, physics and thermodynamics are a prerequisite for this course.

227-1631-00L Energy System Analysis W 4 credits 3G G. Hug, S. Hellweg, F. Noembrini, A. Schlüter
Abstract
The course provides an introduction to the methods and tools for analysis of energy consumption, energy production and energy flows. Environmental aspects are included as well as economical considerations. Different sectors of the society are discussed, such as electric power, buildings, and transportation. Models for energy system analysis planning are introduced.

Objective
The purpose of the course is to give the participants an overview of the methods and tools used for energy systems analysis and how to use these in simple practical examples.

Content
The course gives an introduction to methods and tools for analysis of energy consumption, energy production and energy flows. Both larger systems, e.g. countries, and smaller systems, e.g. industries, homes, vehicles, are studied. The tools and methods are applied to various problems during the exercises. Different conventions of energy statistics used are introduced.

The course provides also an introduction to energy systems models for developing scenarios of future energy consumption and production. Bottom-up and Top-Down approaches are addressed and their features and applications discussed.

The course contains the following parts:
Part I: Energy flows and energy statistics
Part II: Environmental impacts
Part III: Electric power systems
Part IV: Energy in buildings
Part V: Energy in transportation
Part VI: Energy systems models

Lecture notes
Handouts
Literature

Electives
The entire course programs of ETH Zurich and the University of Zurich are open to the students to individual selection.

Electives ETH Zurich
Course Catalogue of ETH Zurich

GESS Science in Perspective
see GESS Science in Perspective: Type A: Enhancement of Reflection Capability
see GESS Science in Perspective: Language Courses ETH/UZH
Recommended GESS Science in Perspective (Type B) for D-BAUG

Bachelor's Thesis
Number Title Type ECTS Hours Lecturers
102-0006-00L Bachelor's Thesis O 10 credits 20D Lecturers
Abstract
The Bachelor Programme concludes with the Bachelor Thesis. This project is supervised by a professor. Writing up the Bachelor Thesis encourages students to show independence and to produce structured work.

Objective
Encourages students to show independence, to produce scientifically structured work and to apply engineering working methods.

Content
The contents base upon the fundamentals of the Bachelor Programme. Students can choose from different subjects and tasks. The thesis consists of both a written report and an oral presentation.

Environmental Engineering Bachelor - Key for Type
<table>
<thead>
<tr>
<th>Type</th>
<th>Code</th>
<th>Description</th>
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<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
<td>E-</td>
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<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
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<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
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<tr>
<td>Key for Hours</td>
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<td>V</td>
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<td>P</td>
<td>practical/laboratory course</td>
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<td>A</td>
<td>independent project</td>
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<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
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</tbody>
</table>

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Environmental Engineering Master

Master Studies (Programme Regulations 2016)

Majors

Major Urban Water Management

Compulsory Modules

Ecological System Design

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>102-0307-01L</td>
<td>Advanced Environmental, Social and Economic</td>
<td>O</td>
<td>5</td>
<td>3G</td>
<td>A. E. Braunschweig, S. Hellweg, R. Frischknecht</td>
</tr>
<tr>
<td></td>
<td>Assessments</td>
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<tr>
<td></td>
<td>Only for Environmental Engineering MSc.</td>
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<tr>
<td>Content</td>
<td>This course deepens students' knowledge of the environmental, economic, and social assessment methodologies and their various applications.</td>
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</tr>
<tr>
<td>Objective</td>
<td>This course has the aim of deepening students' knowledge of the environmental, economic and social assessment methodologies and their various applications.</td>
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</tr>
<tr>
<td>Prerequisites</td>
<td>- ability to judge the scientific quality and reliability of environmental assessment studies, the appropriateness of inventory data and modelling, and the adequacy of life cycle impact assessment models and factors.</td>
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<tr>
<td>Prerequisites</td>
<td>- knowledge about the current state of the scientific discussion and new research developments</td>
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</tr>
<tr>
<td>Prerequisites</td>
<td>- ability to properly plan, conduct and interpret environmental assessment studies</td>
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</tr>
<tr>
<td>Abstract</td>
<td>In particular, students completing the course should have the</td>
<td></td>
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</tr>
<tr>
<td>Prerequisites</td>
<td>- describe key sustainability problems of the current economic system and measuring units.</td>
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</tr>
<tr>
<td>Prerequisites</td>
<td>- describe the management system of an organisation and illustrate how to improve its sustainability management (especially planning and controlling), based on current ISO management standards and additional frameworks.</td>
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<tr>
<td>Prerequisites</td>
<td>- discuss approaches to measure environmental performance measurement of an organisation, including 'organisational LCA' (Ecobalance)</td>
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<tr>
<td>Prerequisites</td>
<td>- explain the pros and cons of single score environmental assessment methods</td>
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<tr>
<td>Prerequisites</td>
<td>- demonstrate life cycle costing from a sustainability viewpoint</td>
<td></td>
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<tr>
<td>Prerequisites</td>
<td>- interpret stakeholder relations of an organisation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prerequisites</td>
<td>- (if time allows) describe sustainable supply chain management</td>
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</tbody>
</table>

Content

Part I: Advanced Environmental Assessments
- Inventory database developments, transparency, data quality, data completeness, and data exchange formats, uncertainties
- Software tools (MFA, LCA)
- Allocation (multioutput processes and recycling)
- Hybrid LCA methods.
- Consequential and marginal analysis
- Impact assessment of waterborne chemical emissions, sum parameters, mixture toxicity
- Spatial differentiation in Life Cycle Assessment
- Workplace and indoor exposure in Risk and Life Cycle Assessment
- Subjectivity in environmental assessments
- Multicriteria Decision Analysis
- Case Studies

Part II: Implementation of Environmental and other Sustainability Goals:
- The structure of a management system, and elements to integrate environmental management (ISO 14001) and social management (SA8000 as well as ISO 26000), especially into strategy development, planning, controlling and communication;
- Sustainability Opportunities and Innovation
- The concept of 'Continuous Improvement' Life Cycle Costing, Life Cycle Management
- environmental performance measurement of an organisation, including 'organisational LCA' (Ecobalance), based on practical examples of companies and new concepts
- single score env. assessment methods (Swiss ecopoints)
- stakeholder management and sustainability oriented communication
- an intro into sustainability issues of supply chain management

Lecture notes

Part I: Slides and background reading material will be available on lecture homepage
Part II: Documents will be available on Ilias

Literature

Will be made available.

Prerequisites / notice

This course should only be elected by students of environmental engineering with a with a Module in Ecological Systems Design. All other students should take the individual courses in Advanced Environmental Assessment and/or Implementation of Environmental and other Sustainability goals (with or without exercise and lab).

Basic knowledge of environmental assessment tools is a prerequisite for this class. Students who have not yet had classwork in this topic are required to read an appropriate textbook before or at the beginning of this course (e.g. Jolliet, O et al. (2016). Environmental Life Cycle Assessment. CRC Press, Boca Raton - London - New York. ISBN 978-1-4398-8766-0 (Chapters 2-5.2)).

Environmental Engineering in Urban Water Management

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>102-0317-03L</td>
<td>Advanced Environmental Assessment (Computer Lab</td>
<td>O</td>
<td>1</td>
<td>1U</td>
<td>S. Pfister</td>
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<td></td>
<td>I)</td>
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</tr>
<tr>
<td>Abstract</td>
<td>Different tools and software used for environmental assessments, such as LCA are introduced. The students will have hands-on exercises in the computer rooms and will gain basic knowledge on how to apply the software and other resources in practice</td>
<td></td>
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<tr>
<td>Objective</td>
<td>Become acquainted with various software programs for environmental assessment including Life Cycle Assessment, Environmental Risk Assessment, Probabilistic Modeling, Material Flow Analysis.</td>
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</tbody>
</table>

Data: 06.03.2019 12:57 Autumn Semester 2016 Page 1418 of 1571

Students should be able to evaluate existing wastewater treatment plants and future designs using basic process understanding, mathematical modeling tools, and knowledge obtained from the current literature. The students shall be capable to apply and recognize the limits of the kinetic models which have been developed to simulate these systems.


Copies of overheads will be made available.

There will be a required textbook that students need to purchase (see http://www.sww.ifi.ethz.ch/studium/vorlesungen/process-engineering-i0.html for further information).

Prerequisite: 102-0217-00 Process Engineering Ia (in first half of semester).

System Analysis and Mathematical Modeling in Urban Water Management

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>102-0227-00L</td>
<td>Systems Analysis and Mathematical Modeling in Urban Water Management</td>
<td>O</td>
<td>6 credits</td>
<td>4G</td>
<td>E. Morgenroth, M. Maurer</td>
</tr>
</tbody>
</table>


Objective: The goal of this course is to provide the students with an understanding and the tools to develop their own mathematical models, to plan experiments, to evaluate error propagation and to test simple process control strategies in the field of process engineering in urban water management.

Content: The course will provide a broad introduction into the fundamentals of modeling water treatment systems. The topics are:
- Introduction into modeling and simulation
- The material balance equations, transport processes, transformation processes (kinetics, stoichiometry, conservation)
- Ideal reactors
- Hydraulic residence time distribution and modeling of real reactors
- Dynamic behavior of reactor systems
- Systems analytical tools: Sensitivity, parameter identification, error propagation, Monte Carlo simulation
- Introduction to process control (PID controller, fuzzy control)

Copies of overheads will be made available.

Process Engineering Ia

<table>
<thead>
<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>102-0217-00L</td>
<td>Process Engineering Ia</td>
<td>O</td>
<td>3 credits</td>
<td>2G</td>
<td>E. Morgenroth</td>
</tr>
</tbody>
</table>

Abstract: Biological processes used in wastewater treatment, organic waste management, biological resource recovery. Focus on fundamental principles of biological processes and process design based on kinetic and stoichiometric principles. Processes include anaerobic digestion for biogas production and aerobic wastewater treatment.

Objective: Students should be able to evaluate and design biological processes. Develop simple mathematical models to simulate treatment processes.


Copies of overheads will be made available.

Water Infrastructure Planning and Stormwater Management

Module will be offered from FS17 on.

Major Environmental Technologies

Compulsory Modules

Air Quality Control

<table>
<thead>
<tr>
<th>Number</th>
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</thead>
<tbody>
<tr>
<td>102-0377-00L</td>
<td>Air Pollution Modeling and Chemistry</td>
<td>O</td>
<td>3 credits</td>
<td>2G</td>
<td>S. Henne, A. C. Gerecke, S. Reimann Bhend</td>
</tr>
</tbody>
</table>

Abstract: Air pollutants cause negative effects on humans, wildlife and buildings. To control and reduce the impact of air pollutants, their transfer from sources to receptors needs to be known. This transfer includes transport within the atmospheric boundary layer, chemical transformation reactions and phase-transfer processes from air to liquid and solid materials (aerosols, water, ...).

Objective: The students understand the fundamental principles of atmospheric transport, dispersion and chemistry of pollutants on the local to regional scale and their transfer between air and condensed phases (aerosols, water, solids). This includes the knowledge of important atmospheric reactions, sources and sinks. The obtained understanding enables the students to apply computational tools to predict the transport and transformation of chemicals at the local to regional scale.
The goal of this course is to provide the students with an understanding and the tools to develop their own mathematical models, to plan systematic introduction of material balances, transport processes, kinetics, stoichiometry and conservation. Ideal reactors, residence time distribution and phase transfer rates of organic chemicals.

Lecture notes
Continued updates of:
- Slides and handouts
- Home assignments and sample solutions
- R package and code for some of the home assignments
- Free software packages for estimation of properties and fate of organic chemicals
- Key journal articles as discussed during lecture

Literature
- Atmospheric chemistry

Environmental organic chemistry and mass transfer
  Mackay D., Multimedia environmental models : the fugacity approach; Boca Raton, Fla.: Lewis Publishers; 2001; 2nd ed

Atmospheric dynamics and boundary layer

Atmospheric modelling

Introduction to R

Prerequisites / notice
strongly recommended: 102-0635-01L Luftreinhaltung (Air Pollution Control) or similar

Process Engineering in Urban Water Management

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<td>Process Engineering ib</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>E. Morgenroth</td>
</tr>
</tbody>
</table>

Prerequisite: 102-0217-00L Process Engineering Ia (1st half of semester).

Abstract

Objective
Students should be able to evaluate existing wastewater treatment plants and future designs using basic process understanding, mathematical modeling tools, and knowledge obtained from the current literature. The students shall be capable to apply and recognize the limits of the kinetic models which have been developed to simulate these systems.

Content
Advanced modeling of activated sludge systems
- Nitrification, denitrification, and biological P elimination
- Enrichment in mixed culture systems using, e.g., selectors
- Biofilm kinetics and application to full scale plants
- Critical review of treatment processes

Lecture notes
Copies of overheads will be made available.

Literature
There will be a required textbook that students need to purchase (see http://www.sww.ifu.ethz.ch/studium/vorlesungen/process-engineering-01.html for further information).

Prerequisites / notice
Prerequisite: 102-0217-00 Process Engineering Ia (in first half of semester).

System Analysis in Urban Water Management

<table>
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<tr>
<th>Number</th>
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<td>O</td>
<td>6</td>
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<td>E. Morgenroth, M. Maurer</td>
</tr>
</tbody>
</table>

Abstract

Objective
The goal of this course is to provide the students with an understanding and the tools to develop their own mathematical models, to plan experiments, to evaluate error propagation and to test simple process control strategies in the field of process engineering in urban water management.

Content
The course will provide a broad introduction into the fundamentals of modeling water treatment systems. The topics are:
- Introduction into modeling and simulation
- The material balance equations, transport processes, transformation processes (kinetics, stoichiometry, conservation)
- Ideal reactors
- Hydraulic residence time distribution and modeling of real reactors
- Dynamic behavior of reactor systems
- Systems analytical tools: Sensitivity, parameter identification, error propagation, Monte Carlo simulation
- Introduction to process control (PID controller, fuzzy control)

Lecture notes
Copies of overheads will be made available.

Literature
There will be a required textbook that students need to purchase:
At the core of this course is the separation of mixtures of solid bulk materials according to physical properties such as color, electrical conductivity, magnetism and so forth. After having taken this course, the students should have concept not only of the unit operations employed in WRT but also of how these unit operations are integrated into the flow sheets of production plants.

## Waste Management

**Remark:** 102-0337-00 Landfilling, Contaminated Sites and Radioactive Waste Repositories only for those students also taking module "System Analysis in Urban Water Management" as replacement of 102-0217-00 Process Engineering Ia in module "Waste Management".

### Number Title Type ECTS Hours Lecturers

102-0357-00L Waste Recycling Technologies O 3 credits 2G R. Bunge

**Abstract**
Waste Recycling Technology (WRT) is sub-discipline of Mechanical Process Engineering. WRT is employed in production plants processing contaminated soil, construction wastes, scrap metal, recovered paper and the like. While WRT is well established in Central Europe, it is only just now catching on in emerging markets as well.

**Objective**
At the core of this course is the separation of mixtures of solid bulk materials according to physical properties such as color, electrical conductivity, magnetism and so forth. After having taken this course, the students should have concept not only of the unit operations employed in WRT but also of how these unit operations are integrated into the flow sheets of production plants.

**Content**
- Introduction
- Waste Recycling: Scope and objectives
- Waste recycling technologies in Switzerland
- Fundamentals
- Properties of particles: Liberation conditions, Particle size and shape, Porosity of bulk materials
- Fluid dynamics of particles: Stationary particle beds, Fluidized beds, Free settling particles
- Flow sheet basics: Balancing mass flows
- Standard processes: batch vs. continuous assessment
- Assessment of separation success: Separation function; grade vs. recovery
- Separation Process
- Separation according to size and shape (Classification): Screening, Flow separation
- Separation according to material properties (Concentration): Manual Sorting, Gravity concentration; Magnetic separation, Eddy current separation, Electrostatic separation, Sensor technology, Froth flotation

**Lecture notes**
The script consists of the transparencies shown during the lectures. Background material will be provided on the script-server.

**Literature**
A list of recommended books will be provided.

**Prerequisites / notice**
We will approach this topic from the perspective not of theory, but of practical application. However, solid fundamentals in physics (in particular in mechanics) are strongly recommended.

102-0337-00L Landfilling, Contaminated Sites and Radioactive Waste Repositories O 3 credits 2G W. Hummel, L. M. Plötze

**Abstract**
Practices of landfilling and remediation of contaminated sites and disposal of radioactive waste are based on the same concepts that aim to protect the environment. The assessment of contaminants that may leach into the environment as a function of time and how to reduce the rate of their release is key to the design of chemical, technical and geological barriers.

**Objective**
Upon successful completion of this course students are able to:
- assess the risk posed to the environment of landfills, contaminated sites and radioactive waste repositories in terms of fate and transport of contaminants
- describe technologies available to minimize environmental contamination
- describe the principles in handling of contaminated sites and to propose and evaluate suitable remediation techniques
- explain the concepts that underlie radioactive waste disposal practices

**Content**
This lecture course comprises of lectures with exercises and guided case studies.
- A short overview of the principles of environmental protection in waste management and how this is applied in legislation.
- A overview of the chemistry underlying the release and transport of contaminants from the landfilled/contaminated material/radioactive waste repository focusing on processes that control redox state and pH buffer capacity; mobility of heavy metals and organic compounds
- Technical barrier design and function. Clay as a barrier.
- Contaminated site remediation: Site evaluation, remediation technologies
- Concepts and safety in radioactive waste management
- Role of the geological and engineered barriers and radionuclide transport in geological media.

**Lecture notes**
Short script plus copies of overheads

**Literature**
Literature will be made available.

**Prerequisites / notice**
This is an interdisciplinary course aimed at environmental scientists and environmental engineers.

102-0217-00L Process Engineering Ia O 3 credits 2G E. Morgenroth

**Abstract**
Biological processes used in wastewater treatment, organic waste management, biological resource recovery. Focus on fundamental principles of biological processes and process design based on kinetic and stoichiometric principles. Processes include anaerobic digestion for biogas production and aerobic wastewater treatment.

**Objective**
Students should be able to evaluate and design biological processes. Develop simple mathematical models to simulate treatment processes.
### Major Resource Management

#### Compulsory Modules

#### Ecological System Design

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<td>5</td>
<td>3G</td>
<td>A. E. Braunschweig, S. Hellweg, R. Frischknecht</td>
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</table>

**Abstract**

This course deepens students' knowledge of environmental, economic, and social assessment methodologies and their various applications.

**Objective**

This course has the aim of deepening students' knowledge of the environmental, economic and social assessment methodologies and their various applications.

- In particular, students completing the course should have the
  - ability to judge the scientific quality and reliability of environmental assessment studies, the appropriateness of inventory data and modelling, and the adequacy of life cycle impact assessment models and factors
  - knowledge about the current state of the scientific discussion and new research developments
  - ability to properly plan, conduct and interpret environmental assessment studies

In the course element "Implementation of Environmental and other Sustainability Goals", students will learn to

- describe key sustainability problems of the current economic system and its measuring units;
- describe the management system of an organisation and illustrate how to improve its sustainability management (especially planning and controlling), based on current ISO management standards and additional frameworks.
- discuss approaches to measure environmental performance measurement of an organisation, including 'organisational LCA' (Ecobalance)
- explain the pros and cons of single score environmental assessment methods
- demonstrate life cycle costing from a sustainability viewpoint
- interpret stakeholder relations of an organisation
- (if time allows) describe sustainable supply chain management

**Content**

- Part I (Advanced Environmental Assessments)
  - Inventory database developments, transparency, data quality, data completeness, and data exchange formats, uncertainties
  - Software tools (MFA, LCA)
  - Allocation (multioutput processes and recycling)
  - Hybrid LCA methods.
  - Consequential and marginal analysis
  - Impact assessment of waterborne chemical emissions, sum parameters, mixture toxicity
  - Spatial differentiation in Life Cycle Assessment
  - Workplace and indoor exposure in Risk and Life Cycle Assessment
  - Subjectivity in environmental assessments
  - multicriteria Decision Analysis
  - Case Studies

- Part II (Implementation of Environmental and other Sustainability Goals):
  - Sustainability problems of the current economic system and its measuring units;
  - The structure of a management system, and elements to integrate environmental management (ISO 14001) and social management (SA8000 as well as ISO 26000), especially into strategy development, planning, controlling and communication;
  - Sustainability Opportunities and Innovation
  - The concept of 'Continuous Improvement'
  - Life Cycle Costing, Life Cycle Management
  - environmental performance measurement of an organisation, including 'organisational LCA' (Ecobalance), based on practical examples of companies and new concepts
  - single score env. assessment methods (Swiss ecopoints)
  - stakeholder management and sustainability oriented communication
  - an intro into sustainability issues of supply chain management

Students will get small exercises related to course issues.

**Lecture notes**

Part I: Slides and background reading material will be available on lecture homepage

Part II: Documents will be available on Ilias

**Literature**

Will be made available.

**Prerequisites / notice**

This course should only be elected by students of environmental engineering with a with a Module in Ecological Systems Design. All other students should take the individual courses in Advanced Environmental Assessment and/or Implementation of Environmental and other Sustainability goals (with or without exercise and lab).

Basic knowledge of environmental assessment tools is a prerequisite for this class. Students who have not yet had classwork in this topic are required to read an appropriate textbook before or at the beginning of this course (e.g. Jolliet, O et al. (2016). Environmental Life Cycle Assessment. CRC Press, Boca Raton - London - New York. ISBN 978-1-4398-8766-0 (Chapters 2-5,2)).

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### Groundwater

**Abstract**

Different tools and software used for environmental assessments, such as LCA are introduced. The students will have hands-on exercises in the computer rooms and will gain basic knowledge on how to apply the software and other resources in practice

**Objective**

Become acquainted with various software programs for environmental assessment including Life Cycle Assessment, Environmental Risk Assessment, Probabilistic Modeling, Material Flow Analysis.
Waste Recycling Technologies

**Number** 102-0357-00L

**Title** Waste Recycling Technologies

**Type** O

**ECTS** 3 credits

**Hours** 2G

**Lecturers** R. Bunge

**Abstract** Waste Recycling Technology (WRT) is sub-discipline of Mechanical Process Engineering. WRT is employed in production plants, processing contaminated soil, construction wastes, scrap metal, recovered paper and the like. While WRT is well established in Central Europe, it is only just now catching on in emerging markets as well.

**Objective** At the core of this course is the separation of mixtures of solid bulk materials according to physical properties such as color, electrical conductivity, magnetism and so forth. After having taken this course, the students should have concept not only of the unit operations employed in WRT but also of how these unit operations are integrated into the flow sheets of production plants.

**Content**
- Introduction
- Waste Recycling: Scope and objectives
- Waste recycling technologies in Switzerland
- Fundamentals
  - Properties of particles: Liberation conditions, Particle size and shape, Porosity of bulk materials
  - Fluid dynamics of particles: Stationary particle beds, Fluidized beds, Free settling particles
  - Flow sheet basics: Balancing mass flows
- Standard processes: batch vs. continuous
- Assessment of separation success: Separation function; grade vs. recovery
- Separation Process
  - Separation according to size and shape (Classification): Screening, Flow separation
  - Separation according to material properties (Concentration): Manual Sorting, Gravity concentration; Magnetic separation, Eddy current separation, Electrostatic sorting, Sensor technology. Froth flotation
- Lecture notes
  - The script consists of the transparencies shown during the lectures. Background material will be provided on the script-server.
- Literature
  - A list of recommended books will be provided.
- Prerequisites / notice
  - We will approach this topic from the perspective not of theory, but of practical application. However, solid fundamentals in physics (in particular in mechanics) are strongly recommended.

Landfilling, Contaminated Sites and Radioactive Waste Repositories

**Number** 102-0337-00L

**Title** Landfilling, Contaminated Sites and Radioactive Waste Repositories

**Type** O

**ECTS** 3 credits

**Hours** 2G

**Lecturers** W. Hummel, L. M. Plötze

**Abstract** Practices of landfilling and remediation of contaminated sites and disposal of radioactive waste are based on the same concepts that aim to protect the environment. The assessment of contaminants that may leak into the environment as a function of time and how to reduce the rate of their release is key to the design of chemical, technical and geological barriers.

**Objective** Upon successful completion of this course students are able to:
- assess the risk posed to the environment of landfills, contaminated sites and radioactive waste repositories in terms of fate and transport of contaminants
- describe techniques available to minimize environmental contamination
- describe the principles in handling of contaminated sites and to propose and evaluate suitable remediation techniques
- explain the concepts that underlie radioactive waste disposal practices
- A short overview of the principles of environmental protection in waste management and how this is applied in legislation.
- A overview of the chemistry underlying the release and transport of contaminants from the landfilled/contaminated material/radioactive waste repository focusing on processes that control redox state and pH buffer capacity; mobility of heavy metals and organic compounds
- Technical barrier design and function. Clay as a barrier.
- Contaminated site remediation: Site evaluation, remediation technologies
- Concepts and safety in radioactive waste management
- Role of the geological and engineered barriers and radionuclide transport in geological media.

**Content**
- This lecture course comprises of lectures with exercises and guided case studies.
- A short overview of the principles of environmental protection in waste management and how this is applied in legislation.
- A overview of the chemistry underlying the release and transport of contaminants from the landfilled/contaminated material/radioactive waste repository focusing on processes that control redox state and pH buffer capacity; mobility of heavy metals and organic compounds
- Technical barrier design and function. Clay as a barrier.
- Contaminated site remediation: Site evaluation, remediation technologies
- Concepts and safety in radioactive waste management
- Role of the geological and engineered barriers and radionuclide transport in geological media.

**Lecture notes** Short script plus copies of overheads

**Literature** Literature will be made available.

**Prerequisites / notice** This is an interdisciplinary course aimed at environmental scientists and environmental engineers.

Process Engineering Ia

**Number** 102-0217-00L

**Title** Process Engineering Ia

**Type** O

**ECTS** 3 credits

**Hours** 2G

**Lecturers** E. Morgenroth

**Abstract** Biological processes used in wastewater treatment, organic waste management, biological resource recovery. Focus on fundamental principles of biological processes and process design based on kinetic and stoichiometric principles. Processes include anaerobic digestion for biogas production and aerobic wastewater treatment.

**Objective** Students should be able to evaluate and design biological processes. Develop simple mathematical models to simulate treatment processes.

**Content** Stoichiometry
- Microbial transformation processes
- Introduction to design and modeling of activated sludge processes
- Anaerobic processes, industrial applications, sludge stabilization

**Lecture notes** Copies of overheads will be made available.

**Literature** There will be a required textbook that students need to purchase (see http://www.sww.ifu.ethz.ch/studium/vorlesungen/process-engineering-i0.html for further information).

**Prerequisites / notice** For detailed information on prerequisites and information needed from Systems Analysis and Mathematical Modeling the student should consult the lecture program and important information (syllabus) of Process Engineering I that can be downloaded at http://www.sww.ifu.ethz.ch/studium/vorlesungen/process-engineering-i0.html

Water Resources Management

**Number** 102-0237-00L

**Title** Hydrology II

**Type** O

**ECTS** 3 credits

**Hours** 2G

**Lecturers** P. Burlando, S. Fatichi

**Abstract** The course presents advanced hydrological analyses of rainfall-runoff processes. The course is given in English.

**Objective** Tools for hydrological modelling are discussed at the event and continuous scale. The focus is on the description of physical processes and their modelling with practical examples.

Lecture notes  Parts of the script for "Hydrology I" are used. Also available are the overhead transparencies used in the lectures. The semester project consists of a two part instruction manual.

Literature  Additional literature is presented during the course.

Module will be offered from FS17 on.

Module: Flow and Transport

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<tr>
<th>Number</th>
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<th>ECTS</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>101-0267-01L</td>
<td>Numerical Hydraulics</td>
<td>O</td>
<td>3 credits</td>
<td>2G</td>
<td>M. Holzner</td>
</tr>
</tbody>
</table>

Abstract  In the course Numerical Hydraulics the basics of numerical modelling of flows are presented.

Objective  The goal of the course is to develop the understanding of the students for numerical simulation of flows to an extent that they can later use commercial software in a responsible and critical way.

Content  The basic equations are derived from first principles. Possible simplifications relevant for practical problems are shown and their applicability is discussed. Using the example of non-steady state pipe flow numerical methods such as the method of characteristics and finite difference methods are introduced. The finite volume method as well as the method of characteristics are used for the solution of the shallow water equations. Special aspects such as wave propagation and turbulence modelling are also treated.

All methods discussed are applied practically in exercises. This is done using programs in MATLAB which partially are programmed by the students themselves. Further, some generally available softwares such as Hydraulic Systems and HEC RAS for non-steady flows are used.

Lecture notes  Lecture notes, powerpoints shown in the lecture and programs used can be downloaded. They are also available in German.

Module: Groundwater

Module: Landscape

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<tr>
<th>Number</th>
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<tr>
<td>103-0347-00L</td>
<td>Landscape Planning and Environmental Systems</td>
<td>O</td>
<td>3 credits</td>
<td>2V</td>
<td>A. Grét-Regamey</td>
</tr>
</tbody>
</table>

Abstract  In the course, methods for the identification and measurement of landscape characteristics, as well as measures and implementation of landscape planning are taught. Landscape planning is put into the context of the environmental systems (soil, water, air, climate, flora and fauna) and discussed with regard to socio-political questions of the future.

Objective  The aims of this course are:
1) To illustrate the concept of landscape planning, the economic relevance of landscape and nature in the context of the environmental systems (soil, water, air, climate, flora and fauna).
2) To show landscape planning as an integral information system for the coordination of different instruments by illustrating the aims, methods, instruments and their functions in landscape planning.
3) To show the importance of ecosystem services.
4) To identify and measure the characteristics of landscape.
5) To learn how to use the instrument of GIS appropriately in landscape planning.
6) To use the instrument of GIS in landscape planning.

Content  In this course, the following topics are discussed:
- Definition of the concept of landscape
- Landscape change
- Landscape planning
- Methods, instruments and aims of landscape planning (politics)
- Socio-political questions of the future
- Environmental systems, IUCN Red List, ecological connectivity
- Urban landscape services
- Practice of landscape planning
- Use of GIS in landscape planning

Lecture notes  No script. The documentation, consisting of presentation slides are partly handed out and are provided for download on the PLUS website. The contents of the course will be illustrated in the associated lecture 103-0347-01 U (Landscape Planning and Environmental Systems (GIS Exercises)). An combination of courses is recommended.

Module: Water Resources Management

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<tr>
<th>Number</th>
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<tbody>
<tr>
<td>102-0237-00L</td>
<td>Hydrology II</td>
<td>O</td>
<td>3 credits</td>
<td>2G</td>
<td>P. Burlando, S. Fatchi</td>
</tr>
</tbody>
</table>

Abstract  The course presents advanced hydrological analyses of rainfall-runoff processes. The course is given in English.

Objective  Tools for hydrological modelling are discussed at the event and continuous scale. The focus is on the description of physical processes and their modelisation with practical examples.


Lecture notes  Parts of the script for "Hydrology I" are used. Also available are the overhead transparencies used in the lectures. The semester project consists of a two part instruction manual.

Literature  Additional literature is presented during the course.

Module: Major River and Hydraulic Engineering

Module: Compulsory Modules

Module: Flow and Transport
Lecturers

M. Holzner

The first part of the lecture treats the fundamentals required to deal with river engineering problems. Sampling methods for the river bed are specified in the lecture and in the manuscript and further documentation. All methods discussed are applied practically in exercises. This is done using programs in MATLAB which partially are programmed by the students themselves. Further, some generally available softwares such as Hydraulic Systems and HEC RAS for non-steady flows are used.

Lecturer notes

Lecture notes, powerpoints shown in the lecture and programs used can be downloaded. They are also available in German.

Hydraulic Engineering

Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
101-0247-01L | Numerical Hydraulics | O | 3 credits | 2G | M. Holzner

Abstract

In the course Numerical Hydraulics the basics of numerical modelling of flows are presented. The basic equations are derived from first principles. Possible simplifications relevant for practical problems are shown and their applicability is discussed. Using the example of non-steady state pipe flow numerical methods such as the method of characteristics and finite difference methods are introduced. The finite volume method as well as the method of characteristics are used for the solution of the shallow water equations. Special aspects such as wave propagation and turbulence modelling are also treated.

Content

The goal of the course is to develop the understanding of the students for numerical simulation of flows to an extent that they can later use commercial software in a responsible and critical way.

Objective

The students shall be capable to design and dimension river engineering works needed to influence the processes in watercourses. Further addressed are the design and dimensioning of river engineering works to create and protect flood protection and river restoration. Strongly recommended lectures:

Hydrology II

Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
101-0237-00L | Hydrology II | O | 3 credits | 2G | P. Burlando, S. Fatichi

Abstract

The course presents advanced hydrological analyses of rainfall-runoff processes. The course is given in English.

Objective

Tools for hydrological modelling are discussed at the event and continuous scale. The focus is on the description of physical processes and their modelisation with practical examples.

Content

Lecture notes
Parts of the script for "Hydrology I" are used. Also available are the overhead transparencies used in the lectures. The semester project consists of a two part instruction manual.

Literature
Additional literature is presented during the course.

Elective Modules
For all majors.

EM: Air Quality Control
Elective Module for Majors "Resource Management", "River and Hydraulic Engineering" "Urban Water Management" and "Water Resources Management".

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<tr>
<th>Number</th>
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<tbody>
<tr>
<td>102-0377-00L</td>
<td>Air Pollution Modeling and Chemistry</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>S. Henne, A. C. Gerecke, S. Reimann Bhend</td>
</tr>
</tbody>
</table>

Abstract
Air pollutants cause negative effects on humans, wildlife and buildings. To control and reduce the impact of air pollutants, their transfer from sources to receptors needs to be known. This transfer includes transport within the atmospheric boundary layer, chemical transformation reactions and phase-transfer processes from air to liquid and solid materials (aerosols, water, ...).

Objective
The students understand the fundamental principles of atmospheric transport, dispersion and chemistry of pollutants on the local to regional scale and their transfer between air and condensed phases (aerosols, water, solids). This includes the knowledge of important atmospheric reactions, sources and sinks. The obtained understanding enables the students to apply computational tools to predict the transport and transformation of chemicals at the local to regional scale.

Content
- Structure of the Atmosphere
- Thermodynamics of the atmosphere
- Atmospheric stability
- Atmospheric boundary layer and turbulence
- Dispersion in the atmospheric boundary layer
- Numerical models of atmospheric dispersion
- Gas phase reaction kinetics
- Tropospheric chemistry and ozone formation
- Chemistry box models
- Volatile organic pollutants (VOCs) and semi-volatile organic pollutants (SVOCs)
- Distribution of chemicals between different phases
- Kinetics of phase transfer processes
- Computational tools to estimate volatility, distribution and phase transfer rates of organic chemicals

Lecture notes
Continued updates of:
- Slides and handouts
- Home assignments and sample solutions
- R package and code for some of the home assignments
- Free software packages for estimation of properties and fate of organic chemicals
- Key journal articles as discussed during lecture

Literature
Atmospheric chemistry

Environmental organic chemistry and mass transfer
Mackay D., Multimedia environmental models : the fugacity approach; Boca Raton, Fla. : Lewis Publishers; 2001; 2nd ed

Atmospheric dynamics and boundary layer

Atmospheric modelling

Prerequisites / notice
-strongly recommended: 102-0635-01L Luftreinhaltung (Air Pollution Control) or similar

EM: Ecological System Design
Elective Module for Majors "Environmental Technologies", "River and Hydraulic Engineering" and "Water Resources Management".

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<tr>
<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>102-0307-01L</td>
<td>Advanced Environmental, Social and Economic Assessments Only for Environmental Engineering MSc</td>
<td>W</td>
<td>5</td>
<td>3G</td>
<td>A. E. Braunschweig, S. Hellweg, R. Frischknecht</td>
</tr>
</tbody>
</table>

Abstract
This course deepens students' knowledge of environmental, economic, and social assessment methodologies and their various applications.
Objective

This course has the aim of deepening students' knowledge of the environmental, economic and social assessment methodologies and their various applications.

In particular, students completing the course should have the
- ability to judge the scientific quality and reliability of environmental assessment studies, the appropriateness of inventory data and modelling, and the adequacy of life cycle impact assessment models and factors
- knowledge about the current state of the scientific discussion and new research developments
- ability to properly plan, conduct and interpret environmental assessment studies

In the course element "Implementation of Environmental and other Sustainability Goals", students will learn to
- describe key sustainability problems of the current economic system and measuring units;
- describe the management system of an organisation and illustrate how to improve its sustainability management (especially planning and controlling), based on current ISO management standards and additional frameworks;
- discuss approaches to measure environmental performance measurement of an organisation, including 'organisational LCA' (Ecobalance);
- explain the pros and cons of single score environmental assessment methods
- demonstrate life cycle costing from a sustainability viewpoint
- interpret stakeholder relations of an organisation
- (if time allows) describe sustainable supply chain management

Content

Part I (Advanced Environmental Assessments)
- Inventory database developments, transparency, data quality, data completeness, and data exchange formats, uncertainties
- Software tools (MFA, LCA)
- Allocation (multioutput processes and recycling)
- Hybrid LCA methods.
- Consequential and marginal analysis
- Impact assessment of waterborne chemical emissions, sum parameters, mixture toxicity
- Spatial differentiation in Life Cycle Assessment
- Workplace and indoor exposure in Risk and Life Cycle Assessment
- Subjectivity in environmental assessments
- Multicriteria Decision Analysis
- Case Studies

Part II (Implementation of Environmental and other Sustainability Goals):
- Sustainability problems of the current economic system and its measuring units;
- The structure of a management system, and elements to integrate environmental management (ISO 14001) and social management (SA8000 as well as ISO 26000), especially into strategy development, planning, controlling and communication;
- Sustainability Opportunities and Innovation
- The concept of 'Continuous Improvement'
- Life Cycle Costing, Life Cycle Management
- environmental performance measurement of an organisation, including 'organisational LCA' (Ecobalance), based on practical examples of companies and new concepts
- single score env. assessment methods (Swiss ecopoints)
- stakeholder management and sustainability oriented communication
- an intro into sustainability issues of supply chain management

Students will get small exercises related to course issues.

Lecture notes

Part I: Slides and background reading material will be available on lecture homepage

Part II: Documents will be available on Ilias

Literature

Will be made available.

Prerequisites / notice

This course should only be elected by students of environmental engineering with a with a Module in Ecological Systems Design. All other students should take the individual courses in Advanced Environmental Assessment and/or Implementation of Environmental and other Sustainability goals (with or without exercise and lab).

Basic knowledge of environmental assessment tools is a prerequisite for this class. Students who have not yet had classwork in this topic are required to read an appropriate textbook before or at the beginning of this course (e.g. Jolliet, O et al. (2016). Environmental Life Cycle Assessment. CRC Press, Boca Raton - London - New York. ISBN 978-1-4988-8766-0 (Chapters 2-5.2)).

102-0317-03L Advanced Environmental Assessment (Computer Lab W 1 credit 1U S. Pfister

Abstract

Different tools and software used for environmental assessments, such as LCA are introduced. The students will have hands-on exercises in the computer rooms and will gain basic knowledge on how to apply the software and other resources in practice

Objective

Become acquainted with various software tools for environmental assessment including Life Cycle Assessment, Environmental Risk Assessment, Probabilistic Modeling, Material Flow Analysis.

>>> EM: Flow and Transport

Elective Module for Majors “Environmental Technologies”, “Resource Management” and “Urban Water Management”.

Number Title Type ECTS Hours Lecturers

101-0267-01L Numerical Hydraulics W 3 credits 2G M. Holzner

Objective

In the course Numerical Hydraulics the basics of numerical modelling of flows are presented.

Content

The goal of the course is to develop the understanding of the students for numerical simulation of flows to an extent that they can later use commercial software in a responsible and critical way.

The basic equations are derived from first principles. Possible simplifications relevant for practical problems are shown and their applicability is discussed. Using the example of non-steady state pipe flow numerical methods such as the method of characteristics and finite difference methods are introduced. The finite volume method as well as the method of characteristics are used for the solution of the shallow water equations. Special aspects such as wave propagation and turbulence modelling are also treated.

All methods discussed are applied practically in exercises. This is done using programs in MATLAB which partially are programmed by the students themselves. Further, some generally available softwares such as Hydraulic Systems and HEC RAS for non-steady flows are used.

Lecture notes

Lecture notes, powerpoints shown in the lecture and programs used can be downloaded. They are also available in German.

Literature

Given in lecture

>>> EM: Groundwater

Elective Module for Majors “Environmental Technologies”, “River and Hydraulic Engineering” and “Urban Water Management”.

Module will be offered from FS17 on.
Advanced modeling of activated sludge systems

There will be a required textbook that students need to purchase (see http://www.sww.ifu.ethz.ch/studium/vorlesungen/process-engineering-i0.html for further information).

Knowledge of hydraulic structures and their function within a hydraulic scheme. Skills for the layout and design of hydraulic structures with regard to economy and safety are provided.

Type

Hydraulic structures and their function within a hydraulic scheme are explained. The basic concepts of their layout and design with regard to economy and safety are provided.

Objective

Knowledge of hydraulic structures and their function within a hydraulic scheme. Skills for the layout and design of hydraulic structures with regard to economy and safety.

Content

Weirs: Weir stability, gates, inflatable dams, appurtenant structures.
Conduits: Design of headframes, pressure shafts, and penstocks, constructive details and construction.
Power plants: Power house and turbine types, design, structure, construction.
Dams: Dam types, appurtenant structures (diversion, spillways, bottom outlet), dam type selection criteria, layout and design of gravity dams, buttress dams, arch dams, rockfill dams with central core or concrete face, measures in the foundation, mass concrete, RCC dams, reservoir siltation and sediment management, dam surveillance.
Artificial reservoirs: Purpose, layout, sealing, appurtenant structures, environmental aspects.

Lecture notes

No script. The documentation, consisting of presentation slides are partly handed out and are provided for download on the PLUS website.

Prerequisites / notice

Information: Enrolment of Hydraulic Engineering II is not recommended without having attended Hydraulic Engineering (101-0206-00L) previously since Hydraulic Engineering II is strongly based on Hydraulic Engineering (101-0206-00L).

EM: Hydraulic Engineering


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<tbody>
<tr>
<td>101-0247-01L</td>
<td>Hydraulic structures II</td>
<td>W</td>
<td>6</td>
<td>4G</td>
<td>R. Boes</td>
</tr>
</tbody>
</table>

Information: Enrolment of Hydraulic Engineering II is not recommended without having attended Hydraulic Engineering (101-0206-00L) previously since Hydraulic Engineering II is strongly based on Hydraulic Engineering (101-0206-00L).

Abstract

Hydraulic structures and their function within a hydraulic scheme are explained. The basic concepts of their layout and design with regard to economy and safety are provided.

Objective

Knowledge of hydraulic structures and their function within a hydraulic scheme. Skills for the layout and design of hydraulic structures with regard to economy and safety.

Content

Weirs: Weir stability, gates, inflatable dams, appurtenant structures.
Conduits: Design of headframes, pressure shafts, and penstocks, constructive details and construction.
Power plants: Power house and turbine types, design, structure, construction.
Dams: Dam types, appurtenant structures (diversion, spillways, bottom outlet), dam type selection criteria, layout and design of gravity dams, buttress dams, arch dams, rockfill dams with central core or concrete face, measures in the foundation, mass concrete, RCC dams, reservoir siltation and sediment management, dam surveillance.
Artificial reservoirs: Purpose, layout, sealing, appurtenant structures, environmental aspects.

Lecture notes

No script. The documentation, consisting of presentation slides are partly handed out and are provided for download on the PLUS website.

Prerequisites / notice

Information: Enrolment of Hydraulic Engineering II is not recommended without having attended Hydraulic Engineering (101-0206-00L) previously since Hydraulic Engineering II is strongly based on Hydraulic Engineering (101-0206-00L).

EM: Landscape


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<tbody>
<tr>
<td>103-0347-00L</td>
<td>Landscape Planning and Environmental Systems</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>A. Grêt-Regamey</td>
</tr>
</tbody>
</table>

Abstract

In the course, methods for the identification and measurement of landscape characteristics, as well as measures and implementation of landscape planning are taught. Landscape planning is put into the context of the environmental systems (soil, water, air, climate, flora and fauna) and discussed with regard to socio-political questions of the future.

Objective

The aims of this course are:
1) To illustrate the concept of landscape planning, the economic relevance of landscape and nature in the context of the environmental systems (soil, water, air, climate, flora and fauna);
2) To show landscape planning as an integral information system for the coordination of different instruments by illustrating the aims, methods, instruments and functions in landscape planning.
3) To show the importance of ecosystem services.
4) To point out basic information about nature and landscape: Analysis and assessment of the complex interactions between landscape elements, effects of existing and foreseeable utilization of space (nature goods and services and landscape functions).
5) To identify and measure the characteristics of landscape.
6) Learn how to use the instrument of GIS appropriately in landscape planning.

Content

In this course, the following topics are discussed:
- Definition of the concept of landscape
- Landscape change
- Landscape planning
- Methods, instruments and aims of landscape planning (politics)
- Socio-political questions of the future
- Environmental systems, IUCN Red List, ecological connectivity
- Urban landscapes services
- Practice of landscape planning
- Use of GIS in landscape planning

Lecture notes

No script. The documentation, consisting of presentation slides are partly handed out and are provided for download on the PLUS website.

EM: Process Engineering in Urban Water Management

Elective Module for Majors “Resource Management”, “River and Hydraulic Engineering” and “Water Resources Management”.

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<tbody>
<tr>
<td>102-0217-01L</td>
<td>Process Engineering Ib</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>E. Morgenroth</td>
</tr>
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</table>

Prerequisite: 102-0217-00L Process Engineering Ia (1st half of semester).

Abstract


Objective

Students should be able to evaluate existing wastewater treatment plants and future designs using basic process understanding, mathematical modeling tools, and knowledge obtained from the current literature. The students shall be capable to apply and recognize the limits of the kinetic models which have been developed to simulate these systems.

Content

Advanced modeling of activated sludge systems
Nitrification, denitrification, and biological P elimination
Enrichment in mixed culture systems using, e.g., selectors
Biofilm kinetics and application to full scale plants
Critical review of treatment processes

Lecture notes

Copies of overheads will be made available.

Literature

There will be a required textbook that students need to purchase (see http://www.sww.ifu.ethz.ch/studium/vorlesungen/process-engineering-i0.html for further information).
EM: Remote Sensing and Earth Observation

**Prerequisite:** 102-0217-00 Process Engineering la (in first half of semester).

**Prerequisite notes:**

Remark: Students also taking module "Remote Sensing and Earth Observation" as replacement of 102-0617-01L Methodologies for Image Processing of Remote Sensing Data in module "Landscape" have to chose one out following list:

1. 701-0104-00L Statistical Modelling of Spatial Data (FS) oder
2. 701-1674-00L Spatial Analysis, Modelling and Optimisation (FS) oder
3. 701-1644-00L Mountain Forest Hydrology (HS).

### Course Overview

**Title:** The course should provide an understanding of SAR techniques and the use of the imaging tools for bio/geophysical parameter estimation.

**Prerequisites:** EM: Remote Sensing and Earth Observation

**Literature:**


**Objective:**

- be capable to design and dimension river engineering works needed to influence the processes in watercourses
- know the fundamentals and be able to apply the approaches and methods to treat river engineering problems associated with flood protection and river restoration
- be capable to design and dimension river engineering works needed to influence the processes in watercourses
- be capable to design and dimension river engineering works needed to influence the processes in watercourses

**Content:**

- The first part of the lecture treats the fundamentals required to deal with river engineering problems. Sampling methods for the river bed material and methods to calculate the discharge in alluvial rivers are presented. The process of river bed armoring and the principles of incipient motion, initiation of erosion as well as sediment transport (bed load, suspended load) are treated.
- The second part of the lecture, the procedures to quantify the sediment budget and the morphological changes (erosion, aggradation) in river systems are explained. Furthermore, the process of natural channel formation and the different plan forms of rivers (straight, meandering, braided) are discussed. Own chapters are dedicated to the topics of channel stability, bed forms, river morphology and scour.
- The last part of the lecture concentrates on the design and dimensioning of river engineering works. The topics focused on are the stabilization of banks and of the longitudinal profile of rivers.

**Lecture notes**

- Lecture notes "River Engineering" (in German, 470 pages, including list of references)

**Prerequisites / notice**

- Hydrology (102-0293-AAL), Hydraulics I (101-0203-01L) and Hydraulic Engineering (101-0206-00L)

**EM: River Systems**

**Prerequisite Module for Majors** "Environmental Technologies”, "Resource Management”, "Urban Water Management” and "Water Resources Management”.

**Number** 101-0258-00L

**Title** River Engineering

**ECTS** 3 credits

**Type** W

**Lecturers** G. R. Bezzola

**Abstract**

The lecture addresses the fundamentals to quantitatively describe the flow of water, the transport and bed erosion and of the annual sediment load in a given river reach.

**Objective**

- be able to describe the interrelation between discharge, sediment transport and channel evolution quantitatively
- know the fundamentals and be able to apply the approaches and methods to treat river engineering problems associated with flood protection and river restoration
- be capable to design and dimension river engineering works needed to influence the processes in watercourses

**Content**

- The first part of the lecture treats the fundamentals required to deal with river engineering problems. Sampling methods for the river bed material and methods to calculate the discharge in alluvial rivers are presented. The process of river bed armoring and the principles of incipient motion, initiation of erosion as well as sediment transport (bed load, suspended load) are treated.
- The second part of the lecture, the procedures to quantify the sediment budget and the morphological changes (erosion, aggradation) in river systems are explained. Furthermore, the process of natural channel formation and the different plan forms of rivers (straight, meandering, braided) are discussed. Own chapters are dedicated to the topics of channel stability, bed forms, river morphology and scour.
- The last part of the lecture concentrates on the design and dimensioning of river engineering works. The topics focused on are the stabilization of banks and of the longitudinal profile of rivers.

**Lecture notes**

- Lecture notes "River Engineering" (in German, 470 pages, including list of references)

**Prerequisites / notice**

- Hydrology (102-0293-AAL), Hydraulics I (101-0203-01L) and Hydraulic Engineering (101-0206-00L)

**EM: Soil**

**Prerequisite Module for Majors** "Environmental Technologies”, "Resource Management”, "River and Hydraulic Engineering”, "Urban Water Management” and "Water Resources Management”.

**Number** 701-0535-00L

**Title** Environmental Soil Physics/Vadose Zone Hydrology

**ECTS** 3 credits

**Type** W

**Lecturers** D. Or

**Abstract**

The course provides theoretical and practical foundations for understanding and characterizing physical and transport properties of soils/near-surface earth materials, and quantifying hydrological processes and fluxes of mass and energy at multiple scales. Emphasis is given to land-atmosphere interactions, the role of plants on hydrological cycles, and biophysical processes in soils.
Objective

Students are able to
- characterize quantitative knowledge needed to measure and parameterize structural, flow and transport properties of partially-saturated porous media.
- quantify driving forces and resulting fluxes of water, solute, and heat in soils.
- apply modern measurement methods and analytical tools for hydrological data collection
- conduct and interpret a limited number of experimental studies
- explain links between physical processes in the vadose-zone and major societal and environmental challenges

Content

Weeks 1 to 3: Physical Properties of Soils and Other Porous Media Units and dimensions, definitions and basic mass-volume relationships between the solid, liquid and gaseous phases; soil texture; particle size distributions; surface area; soil structure. Soil colloids and clay behavior

Soil Water Content and its Measurement - Definitions; measurement methods - gravimetric, neutron scattering, gamma attenuation; and time domain reflectometry; soil water storage and water balance.

Weeks 4 to 5: Soil Water Retention and Potential (Hydrostatics) - The energy state of soil water; total water potential and its components; properties of water (molecular, surface tension, and capillary rise); modern aspects of capillarity in porous media; units and calculations and measurement of equilibrium soil water potential components; soil water characteristic curves definitions and measurements; parametric models; hysteresis. Modern aspects of capillarity

Demo-Lab: Laboratory methods for determination of soil water characteristic curve (SWC), sensor pairing

Weeks 6 to 9: Water Flow in Soil - Hydrodynamics:
- Part 1: Laminar flow in tubes (Poiseuille's Law); Darcy's Law, conditions and states of flow; saturated flow; hydraulic conductivity and its measurement.
- Part 2: Unsaturated steady state flow; unsaturated hydraulic conductivity models and applications; non-steady flow and Richards Eq.; approximate solutions to infiltration (Green-Ampt, Philip); field methods for estimating soil hydraulic properties.

Midterm exam

- Part #2: Measurement of vertical infiltration into dry soil column - Green-Ampt, and Philip's approximations; infiltration rates and wetting front propagation.

Part 3 - Use of Hydrus model for simulation of unsaturated flow

Week 10 to 11: Energy Balance and Land Atmosphere Interactions - Radiation and energy balance; evapotranspiration definitions and estimation; transpiration, plant development and transpiration coefficients small and large scale influences on hydrological cycle; surface evaporation.

Week 12 to 13: Solute Transport in Soils Transport mechanisms of solutes in porous media; breakthrough curves; convection-dispersion eq.; solutions for pulse and step solute application; parameter estimation; salt balance.

Lab #3: Miscible displacement and breakthrough curves for a conservative tracer through a column; data analysis and transport parameter estimation.

Additional topics:
- Temperature and Heat Flow in Porous Media - Soil thermal properties; steady state heat flow; nonsteady heat flow; estimation of thermal properties; engineering applications.
- Biological Processes in the Vadose Zone An overview of below-ground biological activity (plant roots, microbial, etc.); interplay between physical and biological processes. Focus on soil-atmosphere gaseous exchange; and challenges for bio- and phytoremediation.

Lecture notes

Classnotes on website: Vadose Zone Hydrology, by Or D., J.M. Wraith, and M. Tuller (available at the beginning of the semester)
http://www.step.ethz.ch/education/active-courses/vadose-zone-hydrology

Literature

Supplemental textbook (not mandatory) -Environmental Soil Physics, by: D. Hillel

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>701-1681-00L</td>
<td>Element Balancing and Soil Functions in Managed Ecosystems</td>
<td>3 credits</td>
<td>2G</td>
<td>A. Keller</td>
</tr>
<tr>
<td>102-0227-00L</td>
<td>Systems Analysis and Mathematical Modeling in Urban Water Management</td>
<td>6 credits</td>
<td>4G</td>
<td>E. Morgenroth, M. Maurer</td>
</tr>
</tbody>
</table>
Abstract

Objective
The goal of this course is to provide the students with an understanding and the tools to develop their own mathematical models, to plan experiments, to evaluate error propagation and to test simple process control strategies in the field of process engineering in urban water management.

Content
The course will provide a broad introduction into the fundamentals of modeling water treatment systems. The topics are:
- Introduction into modeling and simulation
- The material balance equations, transport processes, transformation processes (kinetics, stoichiometry, conservation)
- Ideal reactors
- Hydraulic residence time distribution and modeling of real reactors
- Dynamic behavior of reactor systems
- Systems analytical tools: Sensitivity, parameter identification, error propagation, Monte Carlo simulation
- Introduction to process control (PID controller, fuzzy control)

Lecture notes
Copies of overheads will be made available.

Literature
There will be a required textbook that students need to purchase:

Prerequisites / notice
This course will be offered together with the course Process Engineering Ia. It is advantageous to follow both courses simultaneously.

102-0217-00L
Process Engineering Ia

Abstract
Biological processes used in wastewater treatment, organic waste management, biological resource recovery. Focus on fundamental principles of biological processes and process design based on kinetic and stoichiometric principles. Processes include anaerobic digestion for biogas production and aerobic wastewater treatment.

Objective
Students should be able to evaluate and design biological processes. Develop simple mathematical models to simulate treatment processes.

Content
Stoichiometry
- Microbial transformation processes
- Introduction to design and modeling of activated sludge processes
- Anaerobic processes, industrial applications, sludge stabilization

Lecture notes
Copies of overheads will be made available.

Literature
There will be a required textbook that students need to purchase (see http://www.sww.ifu.ethz.ch/studium/vorlesungen/process-engineering-i0.html for further information).

Prerequisites / notice
For detailed information on prerequisites and information needed from Systems Analysis and Mathematical Modeling the student should consult the lecture program and important information (syllabus) of Process Engineering I that can be downloaded at http://www.sww.ifu.ethz.ch/studium/vorlesungen/process-engineering-i0.html.

EM: Waste Management
Elective Module for Majors "River and Hydraulic Engineering" "Urban Water Management" and "Water Resources Management".

Remark: 102-0337-00 Landfilling, Contaminated Sites and Radioactive Waste Repositories only for those students also taking module "System Analysis in Urban Water Management" as replacement of 102-0217-00 Process Engineering Ia in module "Waste Management".

Number
Title
Type
ECTS
Hours
Lecturers

102-0217-00L
Process Engineering Ia

W 3 credits
2G
E. Morgenroth

Abstract
Biological processes used in wastewater treatment, organic waste management, biological resource recovery. Focus on fundamental principles of biological processes and process design based on kinetic and stoichiometric principles. Processes include anaerobic digestion for biogas production and aerobic wastewater treatment.

Objective
Students should be able to evaluate and design biological processes. Develop simple mathematical models to simulate treatment processes.

Content
Stoichiometry
- Microbial transformation processes
- Introduction to design and modeling of activated sludge processes
- Anaerobic processes, industrial applications, sludge stabilization

Lecture notes
Copies of overheads will be made available.

Literature
There will be a required textbook that students need to purchase (see http://www.sww.ifu.ethz.ch/studium/vorlesungen/process-engineering-i0.html for further information).

Prerequisites / notice
For detailed information on prerequisites and information needed from Systems Analysis and Mathematical Modeling the student should consult the lecture program and important information (syllabus) of Process Engineering I that can be downloaded at http://www.sww.ifu.ethz.ch/studium/vorlesungen/process-engineering-i0.html.

102-0337-00L
Landfilling, Contaminated Sites and Radioactive Waste Repositories

Abstract
Practices of landfilling and remediation of contaminated sites and disposal of radioactive waste are based on the same concepts that aim to protect the environment. The assessment of contaminants that may leach into the environment as a function of time and how to reduce the rate of their release is key to the design of chemical, technical and geological barriers.

Objective
Upon successful completion of this course students are able to:
- assess the risk posed to the environment of landfills, contaminated sites and radioactive waste repositories in terms of fate and transport of contaminants
- describe technologies available to minimize environmental contamination
- describe the principles in handling of contaminated sites and to propose and evaluate suitable remediation techniques
- explain the concepts that underlie radioactive waste disposal practices
- a short overview of the principles of environmental protection in waste management and how this is applied in legislation.
- a survey of the chemical underlying the release and transport of contaminants from the landfilled/contaminated material/radioactive waste repository focusing on processes that control redox state and pH buffer capacity; mobility of heavy metals and organic compounds
- Technical barrier design and function. Clay as a barrier.
- Contaminated site remediation: Site evaluation, remediation technologies
- Concepts and safety in radioactive waste management
- Role of the geological and engineered barriers and radionuclide transport in geological media.

Content
Introduction into modeling and simulation
- Dynamic behavior of reactor systems
- Systems analytical tools: Sensitivity, parameter identification, error propagation, Monte Carlo simulation
- Introduction to process control (PID controller, fuzzy control)

Lecture notes
Short script plus copies of overheads

Literature
Literature will be made available.

Prerequisites / notice
This is an interdisciplinary course aimed at environmental scientists and environmental engineers.
In the Experimental and Computer Laboratory students are introduced to research and good scientific practice. Experiments are conducted under controlled conditions to study physical processes and their implications. Lecturers guide students in understanding the separation of mixtures of solid bulk materials according to physical properties such as color, electrical conductivity, magnetism, and so forth. After having taken this course, the students should have a good grasp of how these unit operations are integrated into the flow sheets of production plants.

At the core of this course is the separation of mixtures of solid bulk materials according to physical properties such as color, electrical conductivity, magnetism, and so forth. After having taken this course, the students should have a good grasp of how these unit operations are integrated into the flow sheets of production plants.

Advanced topics in hydrological modelling are discussed at the event and continuous scale. The focus is on the description of physical processes and their modellisation with practical examples. The course consists of a two part instruction manual. Lecture notes are provided on the script-server. A list of recommended books will be provided.

The student will learn the following skills: basic scientific work, planning and conducting scientific experiments, uncertainty estimations of measurements, applied numerical simulations, modern sensor technology, writing reports.

The Experimental and Computer Laboratory is building on courses in the corresponding modules. Material from these courses is a prerequisite or co-requisite (as specified below) for participating in the Experimental and Computer Laboratory (MODULE: Project in the Environmental and Computer Laboratory).

Expected outcomes of this course include:

- **Knowledge**:
  - Understanding of physical processes and their modellisation in environmental engineering.
  - Knowledge of the separation of mixtures of solid bulk materials according to physical properties such as color, electrical conductivity, magnetism, and so forth.

- **Skills**:
  - Ability to plan and conduct scientific experiments.
  - Ability to estimate uncertainties of measurements and simulations.
  - Ability to describe physical processes and their modellisation with practical examples.

- **Attitudes**:
  - Appreciation of the importance of good scientific practice.

Prerequisites / notice

No particular background knowledge is required. However, solid fundamentals in physics (in particular in mechanics) are strongly recommended.

We will approach this topic from the perspective not of theory, but of practical application. However, solid fundamentals in physics (in particular in mechanics) are strongly recommended.

Module will be offered from FS17 on.

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### EM: Water Infrastructure Planning and Stormwater Management


Module will be offered from FS17 on.

### EM: Water Resources Management

**Elective Module for Majors “Environmental Technologies”, and “Urban Water Management”**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>102-0237-00L</td>
<td>Hydrology II</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>P. Burlando, S. Fatichi</td>
</tr>
</tbody>
</table>

**Abstract**
The course presents advanced hydrological analyses of rainfall-runoff processes. The course is given in English.

**Objective**
Tools for hydrological modelling are discussed at the event and continuous scale. The focus is on the description of physical processes and their modellisation with practical examples.

**Content**

**Lecture notes**
Parts of the script for “Hydrology I” are used. Also available are the overhead transparencies used in the lectures. The semester project consists of a two part instruction manual.

A list of recommended books will be provided.

### Specialized Computer Laboratory

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>102-0527-00L</td>
<td>Experimental and Computer Laboratory I (Year Course)</td>
<td>O</td>
<td>0 credits</td>
<td>6P</td>
<td>D. Braun, L. Bielely, N. Derlon, P. U. Lehmann Grunder, B. Lüthi, C. Paschmann, S. Pfister, A. Siviglia, A. Strith, D. F. Vetsch</td>
</tr>
</tbody>
</table>

**Abstract**
In the Experimental and Computer Laboratory students are introduced to research and good scientific practice. Experiments are conducted in different disciplines of environmental engineering. Data collected during experiments are compared to the corresponding numeric simulations. The results are documented in reports or presentations.

**Objective**
The student will learn the following skills: basic scientific work, planning and conducting scientific experiments, uncertainty estimations of measurements, applied numerical simulations, modern sensor technology, writing reports.

**Content**
The Experimental and Computer Laboratory is building on courses in the corresponding modules. Material from these courses is a prerequisite or co-requisite (as specified below) for participating in the Experimental and Computer Laboratory (MODULE: Project in the Environmental and Computer Laboratory).

- AIR: Air Quality Measurements
- WASTE: Anaerobic Digestion
- ESD: Environmental Assessment
- GROUND: Groundwater Field Course Kappelen
- WRM: Modelling Optimal Water Allocation
- FLOW: 1D Open Channel Flow Modelling
- LAND: Landscape Planning and Environmental Systems
- RIVER: Discharge Measurements
- HydEngr: Hydraulic Experiments
- RemSens: Microwave Measurements
- SOIL: Soil and Environmental Measurements Lab

**Lecture notes**
Written material will be available.

**Specialized Computer Laboratory**

<table>
<thead>
<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>103-0347-70L</td>
<td>Supplementary course to 102-0527-00L Experimental and Computer Laboratory I</td>
<td>W</td>
<td>1 credit</td>
<td>1U</td>
<td>A. Strith</td>
</tr>
</tbody>
</table>

This is a supplementary course for students in the Laboratory Courses in Environmental Engineering who wish to complete all the exercises in Landscape planning and environmental system, as in the 3CP course 103.
0347-01L Landscape Planning and Environmental Systems (GIS Exercises).

Abstract
Supplement course to the Lab. Courses in Environm. Engineering. Methods for the identification and measurement of landscape characteristics, as well as measures and implementation of landscape planning are deepened. Landscape planning is put into the context of the enironm. systems (soil, water, air, climate, flora and fauna) and discussed with regard to socio-political questions of the future.

★★ Eelectives
The entire course programs of ETH Zurich and the University of Zurich are open to the students to individual selection.

Course Catalogue of ETH Zurich

★★ Master Studies (Programme Regulations 2006)
★★ Major Courses
★★★ Major in Water Resources Management

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0267-01L</td>
<td>Hydrology II</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>P. Burlando, S. Fatichi</td>
</tr>
<tr>
<td>102-0237-00L</td>
<td>Numerical Hydraulics</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>M. Holzner</td>
</tr>
<tr>
<td>102-0287-00L</td>
<td>Fluvial Systems</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>P. Molnar</td>
</tr>
</tbody>
</table>

Objective

The course has two fundamental aims: (1) it aims to provide environmental engineers with the physical process basis of fluvial system behavior, including climatic and human activities acting on the system; (2) The processes of sediment production, uplift sheet-tilt-qiuli erosion, basin sediment yield, rainfall-triggered landsliding, sediment budgets, and the modelling of the individual processes involved. (3) Processes in the river, floodplain and riparian zone, including river network topology, channel geometry, aquatic habitat, role of riparian vegetation, including basics of fluvial system management. The main focus of the course is hydrological and the scales of interest are field and catchment scales.

Literature

This course is presented as an introduction to fluvial forms and processes and geomorphic concepts of landscape change, including basics of fluvial system management. The main focus of the course is hydrological and the scales of interest are field and catchment scales. Additional literature is presented during the course.

Prerequisites / notice

Prerequisites: Hydrology I and Hydrology II (or contact instructor).

★★★ Major in Urban Water Management

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>102-0217-00L</td>
<td>Process Engineering Ia</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>E. Morgenroth</td>
</tr>
<tr>
<td>102-0227-00L</td>
<td>Systems Analysis and Mathematical Modeling in</td>
<td>O</td>
<td>6</td>
<td>4G</td>
<td>E. Morgenroth, M. Maurer</td>
</tr>
</tbody>
</table>

Abstract

Biological processes used in wastewater treatment, organic waste management, biological resource recovery. Focus on fundamental principles of biological processes and process design based on kinetic and stoichiometric principles. Processes include anaerobic digestion for biogas production and aerobic wastewater treatment.

Objective

Students should be able to evaluate and design biological processes. Develop simple mathematical models to simulate treatment processes.

Content

Stoichiometry
Microbial transformation processes
Introduction to design and modeling of activated sludge processes
Anaerobic processes, industrial applications, sludge stabilization

Lecture notes

Copies of overheads will be made available.

Literature

There will be a required textbook that students need to purchase (see http://www.sww.ifi.ethz.ch/studium/vorlesungen/process-engineering-0.html for further information).

Prerequisites / notice

For detailed information on prerequisites and information needed from Systems Analysis and Mathematical Modeling the student should consult the lecture program and important information (syllabus) of Process Engineering I that can be downloaded at http://www.sww.ifi.ethz.ch/studium/vorlesungen/process-engineering-0.html
Urban Water Management

Abstract

Objective
The goal of this course is to provide the students with an understanding and the tools to develop their own mathematical models, to plan experiments, to evaluate error propagation and to test simple process control strategies in the field of process engineering in urban water management.

Content
The course will provide a broad introduction into the fundamentals of modeling water treatment systems. The topics are:
- Introduction into modeling and simulation
- The material balance equations, transport processes, transformation processes (kinetics, stoichiometry, conservation)
- Ideal reactors
- Hydraulic residence time distribution and modeling of real reactors
- Dynamic behavior of reactor systems
- Systems analytical tools: Sensitivity, parameter identification, error propagation, Monte Carlo simulation
- Introduction to process control (PID controller, fuzzy control)

Lecture notes
Copies of overheads will be made available.

Literature

Prerequisites / notice
This course will be offered together with the course Process Engineering Ia. It is advantageous to follow both courses simultaneously.

---


In the Major in "Ecolog. Systems Design, Air Quality Contr. and Waste Manag." one out of three possible combinations of modules must be taken:

1st combination: ESD & Air Quality Control;
2nd combination: Air quality control & Waste management;
3rd combination: Waste management & ESD.

Students that choose either combination 2 or 3 and have Urban Water Management as a second Major need to take course "102-0337-00L Landfilling, Contaminated Sites and Radioactive Waste Repositories" (offered in spring semester) instead of "102-0217-00L Process Engineering I (Biological Processes).

Number
Title
Type
ECTS
Hours
Lecturers

102-0217-00L Process Engineering Ia
O
3 credits
2G
E. Morgenroth

Abstract
Biological processes used in wastewater treatment, organic waste management, biological resource recovery. Focus on fundamental principles of biological processes and process design based on kinetic and stoichiometric principles. Processes include anaerobic digestion for biogas production and aerobic wastewater treatment.

Objective
Students should be able to evaluate and design biological processes. Develop simple mathematical models to simulate treatment processes.

Content
Stoichiometry
Microbial transformation processes
Introduction to design and modeling of activated sludge processes
Anaerobic processes, industrial applications, sludge stabilization

Lecture notes
Copies of overheads will be made available.

Literature

Prerequisites / notice
For detailed information on prerequisites and information needed from Systems Analysis and Mathematical Modeling the student should consult the lecture program and important information (syllabus) of Process Engineering I that can be downloaded at http://www.sww.ifu.ethz.ch/studium/vorlesungen/process-engineering-i0.html

102-0307-01L Advanced Environmental, Social and Economic Assessments
Only for Environmental Engineering MSc.

Abstract
This course deepens students' knowledge of environmental, economic, and social assessment methodologies and their various applications.

Objective
This course has the aim of deepening students' knowledge of the environmental, economic and social assessment methodologies and their various applications.

In particular, students completing the course should have the
- ability to judge the scientific quality and reliability of environmental assessment studies, the appropriateness of inventory data and modelling, and the adequacy of life cycle impact assessment models and factors
- knowledge about the current state of the scientific discussion and new research developments
- ability to properly plan, conduct and interpret environmental assessment studies

In the course element "Implementation of Environmental and other Sustainability Goals", students will learn to
- describe key sustainability problems of the current economic system and measuring units
- describe the management system of an organisation and illustrate how to improve its sustainability management (especially planning and controlling), based on current ISO management standards and additional frameworks.
- discuss approaches to measure environmental performance measurement of an organisation, including 'organisational LCA' (Ecobalance)
- explain the pros and cons of single score environmental assessment methods
- demonstrate life cycle costing from a sustainability viewpoint
- interpret stakeholder relations of an organisation
- (if time allows) describe sustainable supply chain management

Data: 06.03.2019 12:57
Autumn Semester 2016
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### Content

**Part I** (Advanced Environmental Assessments)
- Inventory database developments, transparency, data quality, data completeness, and data exchange formats, uncertainties
- Software tools (MFA, LCA)
- Allocation (multioptput processes and recycling)
- Hybrid LCA methods.
- Consequential and marginal analysis
- Impact assessment of waterborne chemical emissions, sum parameters, mixture toxicity
- Spatial differentiation in Life Cycle Assessment
- Workplace and indoor exposure in Risk and Life Cycle Assessment
- Subjectivity in environmental assessments
- Multicriteria Decision Analysis
- Case Studies

**Part II** (Implementation of Environmental and other Sustainability Goals):
- Sustainability problems of the current economic system and its measuring units;
- The structure of a management system, and elements to integrate environmental management (ISO 14001) and social management (SA8000 as well as ISO 26000), especially into strategy development, planning, controlling and communication;
- Sustainability Opportunities and Innovation
- The concept of 'Continuous Improvement'
- Life Cycle Costing, Life Cycle Management
- environmental performance measurement of an organisation, including ‘organisational LCA’ (Ecobalance), based on practical examples of companies and new concepts
- single score env. assessment methods (Swiss ecopoints)
- stakeholder management and sustainability oriented communication
- an intro into sustainability issues of supply chain management

Students will get small exercises related to course issues.

### Lecture notes

**Part I: Slides and background reading material will be available on lecture homepage**

**Part II: Documents will be available on ilias**

### Literature

Will be made available.

### Prerequisites / notice

This course should only be elected by students of environmental engineering with a with a Module in Ecological Systems Design. All other students should take the individual courses in Advanced Environmental Assessment and/or Implementation of Environmental and other Sustainability goals (with or without exercise and lab).

Basic knowledge of environmental assessment tools is a prerequisite for this class. Students who have not yet had classwork in this topic are required to read an appropriate textbook before or at the beginning of this course (e.g. Jolliet, O et al. (2016). Environmental Life Cycle Assessment. CRC Press, Boca Raton - London - New York. ISBN 978-1-4398-8766-0 (Chapters 2-5.2)).

### 102-0317-03L Advanced Environmental Assessment (Computer Lab)

<table>
<thead>
<tr>
<th>O</th>
<th>1 credit</th>
<th>1U</th>
<th>S. Pfister</th>
</tr>
</thead>
</table>

**Abstract**

Different tools and software used for environmental assessments, such as LCA are introduced. The students will have hands-on exercises in the computer room and will gain basic knowledge on how to apply the software and other resources in practice.

**Objective**

Become acquainted with various software programs for environmental assessment including Life Cycle Assessment, Environmental Risk Assessment, Probabilistic Modeling, Material Flow Analysis.

### 102-0357-00L Waste Recycling Technologies

<table>
<thead>
<tr>
<th>O</th>
<th>3 credits</th>
<th>2G</th>
<th>R. Bunge</th>
</tr>
</thead>
</table>

**Abstract**

Waste Recycling Technology (WRT) is sub-discipline of Mechanical Process Engineering. WRT is employed in production plants processing contaminated soil, construction wastes, scrap metal, recovered paper and the like. While WRT is well established in Central Europe, it is only just now catching on in emerging markets as well.

**Objective**

At the core of this course is the separation of mixtures of solid bulk materials according to physical properties such as color, electrical conductivity, magnetism and so forth. After having taken this course, the students should have concept not only of the unit operations employed in WRT but also of how these unit operations are integrated into the flow sheets of production plants.

**Content**

- **Introduction**
  - Waste Recycling; Scope and objectives
  - Waste recycling technologies in Switzerland

  **Fundamentals**
  - Properties of particles: Liberation conditions, Particle size and shape, Porosity of bulk materials
  - Fluid dynamics of particles: Stationary particle beds, Fluidized beds, Free settling particles
  - Flow sheet basics: Balancing mass flows
  - Standard processes: batch vs. continuous
  - Assessment of separation success: Separation function; grade vs. recovery

  **Separation Process**
  - Separation according to size and shape (Classification): Screening, Flow separation
  - Separation according to material properties (Concentration): Manual Sorting, Gravity concentration; Magnetic separation, Eddy current separation, Electrostatic separation, Sensor technology, Froth flotation

  **Lecture notes**
  - The script consists of the transparencies shown during the lectures. Background material will be provided on the script-server.
  - A list of recommended books will be provided.

  **Library**
  - We will approach this topic from the perspective not of theory, but of practical application. However, solid fundamentals in physics (in particular in mechanics) are strongly recommended.

### 102-0377-00L Air Pollution Modeling and Chemistry

<table>
<thead>
<tr>
<th>O</th>
<th>3 credits</th>
<th>2G</th>
<th>S. Henne, A. C. Gerecke, S. Reimann Bhend</th>
</tr>
</thead>
</table>

**Abstract**

Air pollutants cause negative effects on humans, wildlife and buildings. To control and reduce the impact of air pollutants, their transfer from sources to receptors needs to be known. This transfer includes transport within the atmospheric boundary layer, chemical transformation reactions and phase-transfer processes from air to liquid and solid materials (aerosols, water, ...).

**Objective**

The students understand the fundamental principles of atmospheric transport, dispersion and chemistry of pollutants on the local to regional scale and their transfer between air and condensed phases (aerosols, water, solids). This includes the knowledge of important atmospheric reactions, sources and sinks. The obtained understanding enables the students to apply computational tools to predict the transport and transformation of chemicals at the local to regional scale.
Content
- Structure of the Atmosphere
- Thermodynamics of the atmosphere
- Atmospheric stability
- Atmospheric boundary layer and turbulence
- Dispersion in the atmospheric boundary layer
- Numerical models of atmospheric dispersion
- Gas phase reaction kinetics
- Tropospheric chemistry and ozone formation
- Chemistry box models
  - Volatile organic pollutants (VOCs) and semi-volatile organic pollutants (SVOCs)
  - Distribution of chemicals between different phases
  - Kinetics of phase transfer processes
  - Computational tools to estimate volatility, distribution and phase transfer rates of organic chemicals

Lecture notes
Continued updates of:
- Slides and handouts
- Home assignments and sample solutions
- R package and code for some of the home assignments
- Free software packages for estimation of properties and fate of organic chemicals
- Key journal articles as discussed during lecture

Literature

Atmospheric chemistry

Environmental organic chemistry and mass transfer
Mackay D., Multimedia environmental models : the fugacity approach; Boca Raton, Fla.: Lewis Publishers; 2001; 2nd ed

Atmospheric dynamics and boundary layer

Atmospheric modelling

Prerequisites / notice
This is an interdisciplinary course aimed at environmental scientists and environmental engineers.

102-0337-00L Landfilling, Contaminated Sites and Radioactive Waste Repositories

Objective
Upon successful completion of this course students are able to:
- assess the risk posed to the environment of landfills, contaminated sites and radioactive waste repositories in terms of fate and transport of contaminants
- describe technologies available to minimize environmental contamination
- describe the principles in handling of contaminated sites and to propose and evaluate suitable remediation techniques
- explain the concepts that underlie radioactive waste disposal practices

Content
This lecture course comprises of lectures with exercises and guided case studies.
- A short overview of the principles of environmental protection in waste management and how this is applied in legislation.
- A overview of the chemistry underlying the release and transport of contaminants from the landfilled/contaminated material/radioactive waste repository focusing on processes that control redox state and pH buffer capacity; mobility of heavy metals and organic compounds
- Technical barrier design and function. Clay as a barrier.
- Contaminated site remediation: Site evaluation, remediation technologies
- Concepts and safety in radioactive waste management
- Role of the geological and engineered barriers and radionuclide transport in geological media.

Lecture notes
Short script plus copies of overheads

Literature
Introduction to R

Prerequisites / notice
strongly recommended: 102-0635-01L Luftreinhaltung (Air Pollution Control) or similar

101-0247-01L Hydraulic structures II

Abstract
Hydraulic structures and their function within a hydraulic scheme are explained. The basic concepts of their layout and design with regard to economy and safety are provided.

Objective
Knowledge of hydraulic structures and their function within a hydraulic scheme. Skills for the layout and design of hydraulic structures with regard to economy and safety.

Content
Weirs: Weir stability, gates, inflatable dams, appurtenant structures.
Conduits: Design of headraces, pressure shafts, and penstocks, constructive details and construction.
Power plants: Power house and turbine types, design, structure, construction.
Dams: Dam types, appurtenant structures ( diversion, spillways, bottom outlet), dam type selection criteria, layout and design of gravity dams, buttress dams, arch dams, rockfill dams with central core or concrete face, measures in the foundation, mass concrete, RCC dams, reservoir siltation and sediment management, dam surveillance.
Artificial reservoirs: Purpose, layout, sealing, appurtenant structures, environmental aspects.

Lecture notes
manuscript and further documentation

Remark: 101-0269-00 Numerical Modelling in Fluvial Hydraulics and River Engineering in FS (not in HS anymore)

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<td>O</td>
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<td>R. Boes</td>
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Information: Enrollment of Hydraulic Engineering II is not recommended without having attended Hydraulic Engineering (101-0206-00L) previously since Hydraulic Engineering II is strongly based on Hydraulic Engineering (101-0206-00L).

Data: 06.03.2019 12:57  Autumn Semester 2016  Page 1436 of 1571
The course provides theoretical and practical foundations for understanding and characterizing physical and transport properties of soils. The course should provide an understanding of SAR techniques and the use of the imaging tools for bio/geophysical parameter estimation. At the end of the course the student has the understanding of SAR basics and principles, SAR polarimetry, SAR interferometry and environmental parameter estimation from multi-parametric SAR data.

The course will provide the basics and principles of Radar Remote Sensing (specifically Synthetic Aperture Radar (SAR)) and its imaging. The course addresses the fundamentals to quantitatively describe the flow of water, the transport of sediments and morphological changes like erosion or deposition in watercourses. Further addressed are the design and dimensioning of river engineering works to create and ensure sufficient capacity, channel stability as well as to ensure the ecological functions of the watercourse.

The students shall
- be able to describe the interrelation between discharge, sediment transport and channel evolution quantitatively.
- know the fundamentals and be able to apply the approaches and methods to treat river engineering problems associated with flood protection and river restoration.
- be capable to design and dimension river engineering works needed to influence the processes in watercourses.

This exercise bases on field data, which are partly collected by the students on a river in nature. Besides the collection of fundamentals and methods to calculate the discharge in alluvial rivers are presented. The process of river bed armoring and the principles of incipient motion, initiation of erosion as well as sediment transport (bed load, suspended load) are treated.

A practical exercise (voluntary, unmarked) is offered to deepen the learned subjects. This exercise bases on field data, which are partly collected by the students on a river in nature. Besides the collection of fundamentals and methods to calculate the discharge in alluvial rivers are presented. The process of river bed armoring and the principles of incipient motion, initiation of erosion as well as sediment transport (bed load, suspended load) are treated.

Students are able to
- characterize quantitative knowledge needed to measure and parameterize structural, flow and transport properties of partially-saturated porous media.
- quantify driving forces and resulting fluxes of water, solute, and heat in soils.
- apply modern measurement methods and analytical tools for hydrological data collection.
- conduct and interpret a limited number of experimental studies.
- explain links between physical processes in the vadose-zone and major societal and environmental challenges.

Environmental Soil Physics/Vadose Zone Hydrology

The course provides theoretical and practical foundations for understanding and characterizing physical and transport properties of soils/ near-surface earth materials, and quantifying hydrological processes and fluxes of mass and energy at multiple scales. Emphasis is given to land-atmosphere interactions, the role of plants on hydrological cycles, and biophysical processes in soils.

Students are able to
- characterize quantitative knowledge needed to measure and parameterize structural, flow and transport properties of partially-saturated porous media.
- quantify driving forces and resulting fluxes of water, solute, and heat in soils.
- apply modern measurement methods and analytical tools for hydrological data collection.
- conduct and interpret a limited number of experimental studies.
- explain links between physical processes in the vadose-zone and major societal and environmental challenges.

Environmental Applications

The course will provide the basics and principles of Radar Remote Sensing (specifically Synthetic Aperture Radar (SAR)) and its imaging techniques for the use of environmental parameter estimation.

The course should provide an understanding of SAR techniques and the use of the imaging tools for bio/geophysical parameter estimation. At the end of the course the student has the understanding of SAR basics and principles, SAR polarimetry, SAR interferometry and environmental parameter estimation from multi-parametric SAR data.

The course is giving an introduction into SAR techniques, the interpretation of SAR imaging responses and the use of SAR for different environmental applications. The outline of the course is the following:

1. Introduction into SAR basics and principles
2. Introduction into electromagnetic wave theory
3. Introduction into scattering theory and decomposition techniques
4. Introduction into SAR interferometry
5. Introduction into polarimetric SAR interferometry
6. Introduction into bio/geophysical parameter estimation (classification/segmentation, soil moisture estimation, earth quake and volcano monitoring, forest height inversion, wood biomass estimation etc.)

Radar Remote Sensing

The course will provide the basics and principles of Radar Remote Sensing (specifically Synthetic Aperture Radar (SAR)) and its imaging techniques for the use of environmental parameter estimation.

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River Engineering

The lecture addresses the fundamentals to quantitatively describe the flow of water, the transport of sediments and morphological changes like erosion or deposition in watercourses. Further addressed are the design and dimensioning of river engineering works to create and ensure sufficient capacity, channel stability as well as to ensure the ecological functions of the watercourse.

The students shall
- be able to describe the interrelation between discharge, sediment transport and channel evolution quantitatively.
- know the fundamentals and be able to apply the approaches and methods to treat river engineering problems associated with flood protection and river restoration.
- be capable to design and dimension river engineering works needed to influence the processes in watercourses.

The first part of the lecture treats the fundamentals required to deal with river engineering problems. Sampling methods for the river bed material and methods to calculate the discharge in alluvial rivers are presented. The process of river bed armoring and the principles of incipient motion, initiation of erosion as well as sediment transport (bed load, suspended load) are treated.

In the second part of the lecture, the procedures to quantify the sediment budget and the morphological changes (erosion, aggradation) in river systems are explained. Furthermore, the process of natural channel formation and the different plan forms of rivers (straight, meandering, braided) are discussed. Own chapters are dedicated to the topics of channel stability, bed forms, river morphology and scour.

The last part of the lecture concentrates on the design and dimensioning of river engineering works. The topics focussed on are the stabilization of banks and of the longitudinal profile of rivers.

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The course will provide the basics and principles of Radar Remote Sensing (specifically Synthetic Aperture Radar (SAR)) and its imaging techniques for the use of environmental parameter estimation.

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The course is giving an introduction into SAR techniques, the interpretation of SAR imaging responses and the use of SAR for different environmental applications. The outline of the course is the following:

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3. Introduction into scattering theory and decomposition techniques
4. Introduction into SAR interferometry
5. Introduction into polarimetric SAR interferometry
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- explain links between physical processes in the vadose-zone and major societal and environmental challenges.
Content

Weeks 1 to 3: Physical Properties of Soils and Other Porous Media. Units and dimensions, definitions and basic mass-volume relationships between the solid, liquid and gaseous phases; soil texture; particle size distributions; surface area; soil structure. Soil colloids and clay behavior

Soil Water Content and its Measurement - Definitions; measurement methods - gravimetric, neutron scattering, gamma attenuation; and time domain reflectometry; soil water storage and water balance.

Weeks 4 to 5: Soil Water Retention and Potential (Hydrostatics) - The energy state of soil water; total water potential and its components; properties of water (molecular, surface tension, and capillary rise); modern aspects of capillarity in porous media; units and calculations and measurement of equilibrium soil water potential components; soil water characteristic curves definitions and measurements; parametric models; hysteresis. Modern aspects of capillarity

Demo-Lab: Laboratory methods for determination of soil water characteristic curve (SWC), sensor pairing

Weeks 6 to 9: Water Flow in Soil - Hydrodynamics:

Part 1 - Laminar flow in tubes (Poiseuille's Law); Darcy's Law, conditions and states of flow; saturated flow; hydraulic conductivity and its measurement.

Lab #1: Measurement of saturated hydraulic conductivity in uniform and layered soil columns using the constant head method.

Part 2 - Unsaturated steady state flow; unsaturated hydraulic conductivity models and applications; non-steady flow and Richards Eq.; approximate solutions to infiltration (Green-Ampt, Philip); field methods for estimating soil hydraulic properties.

Midterm exam

Lab #2: Measurement of vertical infiltration into dry soil column - Green-Ampt, and Philip's approximations; infiltration rates and wetting front propagation.

Part 3 - Use of Hydrus model for simulation of unsaturated flow

Week 10 to 11: Energy Balance and Land Atmosphere Interactions - Radiation and energy balance; evapotranspiration definitions and estimation; transpiration, plant development and transpiration coefficients small and large scale influences on hydrological cycle; surface evaporation.

Week 12 to 13: Solute Transport in Soils Transport mechanisms of solutes in porous media; breakthrough curves; convection-dispersion eq.; solutions for pulse and step solute application; parameter estimation; salt balance.

Lab #3: Miscible displacement and breakthrough curves for a conservative tracer through a column; data analysis and transport parameter estimation.

Additional topics:

Temperature and Heat Flow in Porous Media - Soil thermal properties; steady state heat flow; nonsteady heat flow; estimation of thermal properties; engineering applications.

Biological Processes in the Vadose Zone An overview of below-ground biological activity (plant roots, microbial, etc.); interplay between physical and biological processes. Focus on soil-atmosphere gaseous exchange; and challenges for bio- and phytoremediation.

Lecture notes

Classnotes on website: Vadose Zone Hydrology, by Or D., J.M. Wraith, and M. Tuller (available at the beginning of the semester)

http://www.step.ethz.ch/education/active-courses/vadose-zone-hydrology

Lecture notes

Supplemental textbook (not mandatory) - Environmental Soil Physics, by: D. Hillel

Literature

701-1315-00L

Biogeochemistry of Trace Elements O 3 credits 2G A. Voegelin, M. Etique, L. Winkel

The course addresses the biogeochemical classification and behavior of trace elements, including key processes driving the cycling of important trace elements in aquatic and terrestrial environments and the coupling of abiotic and biotic transformation processes of trace elements. Examples of the role of trace elements in natural or engineered systems will be presented and discussed in the course.

Objective

The students are familiar with the chemical characteristics, the environmental behavior and fate, and the biogeochemical reactivity of different groups of trace elements. They are able to apply their knowledge on the interaction of trace elements with geosphere components and on abiotic and biotic transformation processes of trace elements to discuss and evaluate the behavior and impact of trace elements in aquatic and terrestrial systems.

Content

(i) Definition, importance and biogeochemical classification of trace elements. (ii) Key biogeochemical processes controlling the cycling of different trace elements (base metals, redox-sensitive and chalcophile elements, volatile trace elements) in natural and engineered environments. (iii) Abiotic and biotic processes that determine the environmental fate and impact of selected trace elements.

Lecture notes

Selected handouts (lecture notes, literature, exercises) will be distributed during the course.

Prerequisites / notice

Students are expected to be familiar with the basic concepts of aquatic and soil chemistry covered in the respective classes at the bachelor level (soil mineralogy, soil organic matter, acid-base and redox reactions, complexation and sorption reactions, precipitation/dissolution reactions, thermodynamics, kinetics, carbonat buffer system).

This lecture is a prerequisite for attending the laboratory course "Trace elements laboratory".

701-1681-00L

Element Balancing and Soil Functions in Managed Ecosystems O 3 credits 2G A. Keller

Applying element balances of agricultural soils and the assessment of soil functions for real applications in computer exercises to design preventive strategies against soil pollution and to support sustainable management of regional agroecosystems also in the context of spatial planning procedures.

Objective

The students learn to critically assess changes in land use management on element cycles in agro-ecosystems and to assess soil services (soil functions). They design solutions for chemical problems in soil protection at the regional scale and learn to assess soil functions using different methods.

Content

The students apply a regional balance model for Swiss regions in computer exercises and assess major soil functions of agricultural soils. You assess the sustainability of current land use and analyse management options improving nutrient and metal cycling in agro-ecosystems. The students will have the opportunity to calculate specific scenarios regarding land use management and environmental changes. Special focus we be paid on the soil services such as regulation-, production function and soil as habitat, and the assessment of these functions based on soil mapping data.

Lecture notes

Literature and Exercises for a case study

Literature

Literature will be provided.
The course consists of lectures and computer exercises. The course take place every 2 weeks à 4 hours. Recommended prerequisites for attending this course:
- Bodenschutz und Landnutzung
- Biochemistry of Trace Elements
- Angewandte Bodenökologie

### 651-4033-00L

**Soil Mechanics and Foundation Engineering**

**Abstract**
The course presents the principles of soil mechanics and soil behaviour characteristics and its applications in geotechnical structures and systems. It is based on more descriptive courses on Engineering Geology within the BSc Geol. Program and is a compulsory prerequisite for other courses within the MSc Eng. Geol. program.

**Objective**
Understanding the principles of soil behaviour and the fundamentals of geotechnical practices in soils.

**Content**
- Soil Mechanics:
  - Fundamental concepts of strength and deformation of different soils. Introduction to geotechnical calculations
  - Significance of (ground)water
  - Geotechnical Engineering in Soils:
    - Evaluation of geotechnical scenarios, handling of forecast uncertainties, relation of soil properties and soil composition, interactions between soil and building,
    - standard construction methods in soils (foundations, slopes, dams and levees),
    - requirements for the geotechnical prognosis

**Prerequisites / notice**

- This lecture is supported by the textbook: "Geotechnical Engineering" by Donald P. Coduto, 2nd edition, 2011; ISBN-13: 978-0-13-125425-8
- Courses recommended:
  - Introduction to Engineering Geology (BSc level)
  - Introduction to Groundwater
  - Sedimentology and Quaternary deposits
  - Principles of Physics

### Specialized Computer Laboratory

#### Number
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<th>102-0527-00L</th>
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**Title**
Experimental and Computer Laboratory I (Year Course)

**Abstract**
In the Experimental and Computer Laboratory students are introduced to research and good scientific practice. Experiments are conducted in different disciplines of environmental engineering. Data collected during experiments are compared to the corresponding numeric simulations. The results are documented in reports or presentations.

**Objective**
The student will learn the following skills: basic scientific work, planning and conducting scientific experiments, uncertainty estimations of measurements, applied numerical simulations, modern sensor technology, writing reports.

**Content**
The Experimental and Computer Laboratory is building on courses in the corresponding modules. Material from these courses is a prerequisite or co-requisite (as specified below) for participating in the Experimental and Computer Laboratory (MODULE: Project in the Experimental and Computer Laboratory):
- AIR: Air Quality Measurements
- WASTE: Anaerobic Digestion
- ESD: Environmental Assessment
- GROUND: Groundwater Field Course Kappelen
- WRM: Modelling Optimal Water Allocation
- FLOW: 1D Open Channel Flow Modelling
- LAND: Landscape Planning and Environmental Systems
- RIVER: Discharge Measurements
- HdyEngr: Hydraulic Experiments
- RemSens: Microwave Measurements
- SOIL: Soil and Environmental Measurements Lab

**Lecture notes**
Written material will be available.

#### Minors

#### Number
| 102-0227-00L |

**Title**
Systems Analysis and Mathematical Modeling in Urban Water Management

**Abstract**

**Objective**
The goal of this course is to provide the students with an understanding and the tools to develop their own mathematical models, to plan experiments, to evaluate error propagation and to test simple process control strategies in the field of process engineering in urban water management.

**Content**
The course will provide a broad introduction into the fundamentals of modeling water treatment systems. The topics are:
- Introduction into modeling and simulation
- The material balance equations, transport processes, transformation processes (kinetics, stoichiometry, conservation)
- Ideal reactors
- Hydraulic residence time distribution and modeling of real reactors
- Dynamic behavior of reactor systems
- Systems analytical tools: Sensitivity, parameter identification, error propagation, Monte Carlo simulation
- Introduction to process control (PID controller, fuzzy control)

**Lecture notes**
Copies of overheads will be made available.

**Literature**
There will be a required textbook that students need to purchase:

**Prerequisites / notice**
This course will be offered together with the course Process Engineering Ia. It is advantageous to follow both courses simultaneously.
Biological processes used in wastewater treatment, organic waste management, biological resource recovery. Focus on fundamental principles of biological processes and process design based on kinetic and stoichiometric principles. Processes include anaerobic digestion for biogas production and wastewater treatment.

Students should be able to evaluate and design biological processes. Develop simple mathematical models to simulate treatment processes.

We will explain the fundamentals of physics of glaciers which are necessary for treating applied problems. We will go into climate-glacier interactions, flow of glaciers, lake ice and hydrology of glaciers.

Hydraulic structures and their function within a hydraulic scheme are explained. The basic concepts of their layout and design with regard to economy and safety are provided.

Hydraulic structures and their function within a hydraulic scheme. Skills for the layout and design of hydraulic structures with regard to economy and safety.

The course focuses on selected topics in hydraulic engineering, water management and aquatic ecology relating to hydropower and flood protection projects.

The lecture focuses on selected topics in hydraulic engineering, water management and aquatic ecology relating to hydropower and flood protection projects.

Different selected topics in hydraulic engineering will be focused on, e.g. dam safety, possible problems at reservoirs like sedimentation or natural hazards by impulse waves, the hydraulics of river flows, spillways and intake structures at dams and weirs, hydropower and hydrometeorology, fish-ecological aspects at low-head hydropower plants and eco-hydraulics like flow-vegetation interaction. Another focus will be put on typical approaches and procedures in the planning process of hydropower projects.

The lecture presents a view of the processes acting on and shaping the landscape and the fluvial landforms that result. The fluvial system is viewed in terms of the production and transport of sediment on hillslopes, the structure of the river network and channel morphology, fluvial processes in the river, riparian zone and floodplain, and basics of catchments in river management.

Content
- Stoichiometry
- Microbial transformation processes
- Introduction to design and modeling of activated sludge processes
- Anaerobic processes, industrial applications, sludge stabilization

Lecture notes
Copies of overheads will be made available.

Literature
There will be a required textbook that students need to purchase (see http://www.sww.ifu.ethz.ch/studium/vorlesungen/process-engineering-i0.html for further information).

Prerequisites / notice
For detailed information on prerequisites and information needed from Systems Analysis and Mathematical Modeling the student should consult the lecture program and important information (syllabus) of Process Engineering I that can be downloaded at http://www.sww.ifu.ethz.ch/studium/vorlesungen/process-engineering-i0.html

Information: Enrolment of Hydraulic Engineering II is not recommended without having attended Hydraulic Engineering (101-0206-00L) previously since Hydraulic Engineering II is strongly based on Hydraulic Engineering (101-0206-00L).

Abstract
Hydraulic structures and their function within a hydraulic scheme are explained. The basic concepts of their layout and design with regard to economy and safety are provided.

Objective
Knowledge of hydraulic structures and their function within a hydraulic scheme. Skills for the layout and design of hydraulic structures with regard to economy and safety.

Content
- Weirs: Weir stability, gates, inflatable dams, appurtenant structures.
- Conduits: Design of headraces, pressure shafts, and penstocks, constructive details and construction.
- Power plants: Power house and turbine types, design, structure, construction.
- Dams: Dam types, appurtenant structures (diversion, spillways, bottom outlet), dam type selection criteria, layout and design of gravity dams, buttress dams, arch dams, rockfill dams with central core or concrete face, measures in the foundation, mass concrete, RCC dams, reservoir siting and sediment management, dam surveillance.
- Artificial reservoirs: Purpose, layout, sealing, appurtenant structures, environmental aspects.

Lecture notes
Handouts are available online.

Literature
A handbook and further documentation is specified in the lecture and in the manuscript.

Prerequisites / notice
Information: Enrolment of Hydraulic Engineering II is not recommended without having attended Hydraulic Engineering (101-0206-00L) previously since Hydraulic Engineering II is strongly based on Hydraulic Engineering (101-0206-00L).

Abstract
The lecture focuses on selected topics in hydraulic engineering, water management and aquatic ecology relating to hydropower and flood protection projects.

Objective
To deepen knowledge on special aspects in hydraulic engineering and to understand the procedures and the planning sequence of hydropower projects.

Content
- Different selected topics in hydraulic engineering will be focused on, e.g. dam safety, possible problems at reservoirs like sedimentation or natural hazards by impulse waves, the hydraulics of river flows, spillways and intake structures at dams and weirs, hydropower and aquatic ecology like fish-ecological aspects at low-head hydropower plants and eco-hydraulics like flow-vegetation interaction. Another focus will be put on typical approaches and procedures in the planning process of hydropower projects.

Lecture notes
Lecture notes/handouts are available online.

Literature
Relevant literature is provided in the lecture.

Prerequisites / notice
External speakers will present current topics and projects in Switzerland and abroad.

Applied Glaciology

Objective
To understand the fundamental physical processes in glaciology. To learn some basic numerical modelling techniques for glacier flow. To identify glaciological hazards and to learn some assessment and mitigation possibilities.

Content
- Basics in physical glaciology
- Dynamics of glaciers: deformation of glacier ice, role of water in glacier motion, reaction of glaciers to climate changes, glacier calving, surges
- Ice falls, ice avalanches
- Glacier floods
- Lake ice and bearing capacity

Lecture notes
Handouts are available.

Literature
Relevante Literatur wird während der Vorlesung angegeben.

Prerequisites / notice
Für aktuelle Fallbeispiele werden risikobasierte Massnahmen bei glaziologischen Naturgefahren diskutiert.

Voraussetzung: Es werden Grundkenntnisse in Mechanik und Physik vorausgesetzt.

Fluvial Systems

Objective
The course has two fundamental aims: (1) it aims to provide environmental engineers with the physical process basis of fluvial system change, using the right language and terminology to describe landforms; and (2) it aims to provide quantitative skills in making simple and more complex predictions of change and the data and models required.

Abstract
The course presents a view of the processes acting on and shaping the landscape and the fluvial landforms that result. The fluvial system is viewed in terms of the production and transport of sediment on hillslopes, the structure of the river network and channel morphology, fluvial processes in the river, riparian zone and floodplain, and basics of catchments in river management.
The course consists of three sections: (1) Introduction to fluvial forms and processes and geomorphic concepts of landscape change, including climatic and human activities acting on the system. (2) The processes of sediment production, upland sheet-rill-gully erosion, basin sediment yield, rainfall-triggered landsliding, sediment budgets, and the modelling of the individual processes involved. (3) Processes in the river, floodplain and riparian zone, including river network topology, channel geometry, aquatic habitat, role of riparian vegetation, including basics of fluvial system management. The main focus of the course is hydrological and the scales of interest are field and catchment scales.

**Lecture notes**

There is no script.

**Literature**

The course materials consist of a series of 13 lecture presentations and notes to each lecture. The lectures were developed from textbooks, professional papers, and ongoing research activities of the instructor. All material is on the course webpage.

**Prerequisites / notice**

Prerequisites: Hydrology I and Hydrology 2 (or contact instructor).

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Semester</th>
<th>Credits</th>
<th>Type</th>
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<td>102-0237-00L</td>
<td>Advanced Environmental, Social and Economic Assessments</td>
<td>W</td>
<td>5 credits</td>
<td>3G</td>
<td>A. E. Braunschweig, S. Hellweg, R. Frischknecht</td>
</tr>
</tbody>
</table>

**Abstract**

This course deepens students' knowledge of environmental, economic, and social assessment methodologies and their various applications.

**Objective**

This course has the aim of deepening students' knowledge of the environmental, economic and social assessment methodologies and their various applications.

- ability to judge the scientific quality and reliability of environmental assessment studies, the appropriateness of inventory data and modelling, and the adequacy of life cycle impact assessment models and factors
- ability to properly plan, conduct and interpret environmental assessment studies

In the course element "Implementation of Environmental and other Sustainability Goals", students will learn to
- describe the management system of an organisation and illustrate how to improve its sustainability management (especially planning and controlling), based on current ISO management standards and additional frameworks.
- discuss approaches to measure environmental performance measurement of an organisation, including 'organisational LCA’ (Ecobalance)
- explain the pros and cons of single score environmental assessment methods
- demonstrate life cycle costing from a sustainability viewpoint
- interpret stakeholder relations of an organisation
- (if time allows) describe sustainable supply chain management
### Part I (Advanced Environmental Assessments)

- Inventory database developments, transparency, data quality, data completeness, and data exchange formats, uncertainties
- Software tools (MFA, LCA)
- Allocation (multiooutput processes and recycling)
- Hybrid LCA methods.
- Consequential and marginal analysis
- Impact assessment of waterborne chemical emissions, sum parameters, mixture toxicity
- Spatial differentiation in Life Cycle Assessment
- Workplace and indoor exposure in Risk and Life Cycle Assessment
- Subjectivity in environmental assessments
- Multicriteria Decision Analysis
- Case Studies

### Part II (Implementation of Environmental and other Sustainability Goals):

- Sustainability problems of the current economic system and its measuring units;
- The structure of a management system, and elements to integrate environmental management (ISO 14001) and social management (SA8000 as well as ISO 26000), especially into strategy development, planning, controlling and communication
- Sustainability Opportunities and Innovation
- The concept of 'Continuous Improvement'
- Life Cycle Costing, Life Cycle Management
- environmental performance measurement of an organisation, including ‘organisational LCA’ (Ecobalance), based on practical examples of companies and new concepts
- single score env. assessment methods (Swiss ecopoints)
- stakeholder management and sustainability oriented communication
- an intro into sustainability issues of supply chain management

### Literature

Part I: Slides and background reading material will be available on lecture homepage
Part II: Documents will be available on Ilias

### Prerequisites / notice

This course should only be elected by students of environmental engineering with a with a Module in Ecological Systems Design. All other students should take the individual courses in Advanced Environmental Assessment and/or Implementation of Environmental and other Sustainability goals (with or without exercise and lab).

Basic knowledge of environmental assessment tools is a prerequisite for this class. Students who have not yet had classwork in this topic are required to read an appropriate textbook before or at the beginning of this course (e.g. Jolliet, O et al. (2016). Environmental Life Cycle Assessment. CRC Press, Boca Raton - London - New York. ISBN 978-1-4398-8766-0 (Chapters 2-5.2)).

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>W</th>
<th>2G</th>
<th>R. Bunge</th>
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<tbody>
<tr>
<td>102-0357-00L</td>
<td>Waste Recycling Technologies</td>
<td>3</td>
<td>2G</td>
<td>R. Bunge</td>
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</tbody>
</table>

**Abstract**

Waste Recycling Technology (WRT) is sub-discipline of Mechanical Process Engineering. WRT is employed in production plants, processing contaminated soil, construction wastes, scrap metal, recovered paper and the like. While WRT is well established in Central Europe, it is only just now catching on in emerging markets as well.

**Objective**

At the core of this separation is the separation of mixtures of solid bulk materials according to physical properties such as color, electrical conductivity, magnetism and so forth. After having taken this course, the students should have concept not only of the unit operations employed in WRT but also of how these unit operations are integrated into the flow sheets of production plants.

**Content**

1. Introduction
2. Waste Recycling: Scope and objectives
3. Waste recycling technologies in Switzerland
4. Fundamentals
5. Properties of particles; Liberation conditions, Particle size and shape, Porosity of bulk materials
6. Fluid dynamics of particles: Stationary particle beds, Fluidized beds, Free settling particles
7. Flow sheet basics: Balancing mass flows
8. Standard processes: batch vs. continuous
9. Assessment of separation success: Separation function; grade vs. recovery
10. Separation Process
11. Separation according to size and shape (Classification): Screening, Flow separation
12. Separation according to material properties (Concentration): Manual separation, Electrostatic separation, Sensor technology, Froth flotation

**Lecture notes**

The script consists of the transparencies shown during the lectures. Background material will be provided on the script-server.

**Literature**

A list of recommended books will be provided.

**Prerequisites / notice**

We will approach this topic from the perspective not of theory, but of practical application. However, solid fundamentals in physics (in particular in mechanics) are strongly recommended.

<table>
<thead>
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<th>Title</th>
<th>W</th>
<th>2G</th>
<th>I. Hajnsek</th>
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<tr>
<td>102-0617-00L</td>
<td>Basics and Principles of Radar Remote Sensing for Environmental Applications</td>
<td>3</td>
<td>2G</td>
<td>I. Hajnsek</td>
</tr>
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</table>

**Abstract**

The course will provide the basics and principles of Radar Remote Sensing (specifically Synthetic Aperture Radar (SAR)) and its imaging techniques for the use of environmental parameter estimation.

**Objective**

The course should provide an understanding of SAR techniques and the use of the imaging tools for bio/geophysical parameter estimation. At the end of the course the student has the understanding of:
1. SAR basics and principles,
2. SAR polarimetry,
3. SAR interferometry and
4. environmental parameter estimation from multi-parametric SAR data

**Content**

The course is giving an introduction into SAR techniques, the interpretation of SAR imaging responses and the use of SAR for different environmental applications. The outline of the course is the following:
1. Introduction into SAR basics and principles
2. Introduction into electromagnetic wave theory
3. Introduction into scattering theory and decomposition techniques
4. Introduction into SAR interferometry
5. Introduction into polarimetric SAR interferometry
6. Introduction into bio/geophysical parameter estimation (classification/segmentation, soil moisture estimation, earth quake and volcano monitoring, forest height inversion, wood biomass estimation etc.)

**Lecture notes**

Handouts for each topic will be provided
The goal of this course is to provide the students with a thorough understanding of the key concepts behind structural reliability and risk analysis. After this course the students will have refreshed their knowledge of probability theory and statistics to model uncertainties in view of engineering applications. They will be able to analyze the reliability of a structure and to use risk assessment methods for decision making under uncertain conditions. They will be aware of the state-of-the-art computational methods and software in this field.

The third part of the course addresses risk assessment methods. Techniques for the identification of hazard scenarios and their representation by fault trees and event trees are described. Risk is defined with respect to the concept of expected utility in the framework of decision making. Elements of Bayesian decision making, i.e. pre-, post and pre-post risk assessment methods are presented.

The course also includes a tutorial using the UQLab software dedicated to real world structural reliability analysis.

Lecture notes
Slides of the lectures are available online every week. A printed version of the full set of slides is proposed to the students at the beginning of the semester.

Literature

S. Marelli, R. Schöbi, B. Sudret, UQLab user manual - Structural reliability (rare events estimation), Report UQLab-v0.92-107.

Prerequisites / notice
Basic course on probability theory and statistics

529-0047-00L Structural Reliability and Risk Analysis W 3 credits 2G B. Sudret

Abstract
Structural reliability aims at quantifying the probability of failure of systems due to uncertainties in their design, manufacturing and environmental conditions. Risk analysis combines this information with the consequences of failure in view of optimal decision making. The course presents the underlying probabilistic modelling and computational methods for reliability and risk assessment.

Objective
The goal of this course is to provide the students with a thorough understanding of the key concepts behind structural reliability and risk analysis. After this course the students will have refreshed their knowledge of probability theory and statistics to model uncertainties in view of engineering applications. They will be able to analyze the reliability of a structure and to use risk assessment methods for decision making under uncertain conditions. They will be aware of the state-of-the-art computational methods and software in this field.

Content
Engineers are confronted every day to decision making under limited amount of information and uncertain conditions. When designing new structures and systems, the design codes such as SIA or Euro-codes usually provide a framework that guarantees safety and reliability. However the level of safety is not quantified explicitly, which does not allow the analyst to properly choose between design variants and evaluate a total cost in case of failure. In contrast, the framework of risk analysis allows one to incorporate the uncertainty in decision making.

The first part of the course is a reminder on probability theory that is used as a main tool for reliability and risk analysis. Classical concepts such as random variables and vectors, dependence and correlation are recalled. Basic statistical inference methods used for building a probabilistic model from the available data, e.g. the maximum likelihood method, are presented.

The second part is related to structural reliability analysis, i.e. methods that allow one to compute probabilities of failure of a given system with respect to prescribed criteria. The framework for this is first set up. Reliability indices are introduced together with the first order-second moment method (FOSM) and the first order reliability method (FORM). Methods based on Monte Carlo simulation are then reviewed and illustrated through various examples. By-products of reliability analysis such as sensitivity measures and partial safety coefficients are derived and their links to structural design codes is shown. The reliability of structural systems is also introduced as well as the methods used to reassess existing structures based on new information.

The third part of the course addresses risk assessment methods. Techniques for the identification of hazard scenarios and their representation by fault trees and event trees are described. Risk is defined with respect to the concept of expected utility in the framework of decision making. Elements of Bayesian decision making, i.e. pre-, post and pre-post risk assessment methods are presented.

The course also includes a tutorial using the UQLab software dedicated to real world structural reliability analysis.

Lecture notes
Slides of the lectures are available online every week. A printed version of the full set of slides is proposed to the students at the beginning of the semester.

Literature

S. Marelli, R. Schöbi, B. Sudret, UQLab user manual - Structural reliability (rare events estimation), Report UQLab-v0.92-107.

Prerequisites / notice
Basic course on probability theory and statistics

701-0423-00L Structural Reliability W 3 credits 2G L. Winkel

Abstract
This course gives an introduction to chemical processes in aquatic systems and shows applications to various systems. The following topics are treated: acid-base reactions and carbonate system, solubility of solids and weathering, redox reactions, complexation of metals, reactions at the solid/water interface, applications to lakes, rivers and groundwater.

Objective
Understanding of chemical processes in aquatic systems. Quantitative application of chemical equilibria to processes in natural waters. The following topics are treated: acid-base reactions, carbonate system; solubility of solid phases and weathering; complexation of metals and metal cycling in natural waters; redox reactions; reactions at the interface solid phase-water; applications to lakes, rivers, groundwater.
Upon completion of this course, the student should have acquired:

- Understand the limits and the potential of corporate sustainability for sustainable development.

Content

- Business implications of sustainable development, in particular for the assessment of sustainability performance, strategic change towards sustainability, technological innovations and sustainability, and finance and corporate sustainability.
- Critical thinking skills for corporate sustainability.

Objective

- Develop critical thinking skills (argumentation, communication, evaluative judgment) that are useful in the context of corporate sustainability using an innovative writing and peer review method.
- Be able to recognize and realize opportunities for corporate sustainability in a business environment.

Lecture notes

Presentation slides will be made available on moodle prior to lectures.

Literature

Selected scientific articles and book-chapters.
The course is structured as follows:
- Overview of rationale, objectives, concepts and origins of sustainable development;
- Importance and application of sustainability in science, politics, society, and economy;
- Sustainable (local / regional) development in different national / international contexts;
- Analysis and evaluation methods of sustainable development with a focus on social justice;
- Trade-offs in selected examples.

Lecture notes
Handouts.

Literature
Selected scientific articles & book chapters

851-0589-00L Technology and Innovation for Development  W  3 credits  2V  P. Aerni

Abstract
Technological change plays a crucial role in efforts to create a more sustainable future. In this context, policy decision makers must design rules that minimize its risks and maximize its benefits for society at large. The course discusses this challenge from an interdisciplinary perspective taking into account legal, economic, historical, development and environmental aspects.

Objective
- to recognize the challenges and opportunities of technological change in terms of sustainable development
- to become familiar with policy instruments to promote innovation
- to improve understanding of political decision-making processes in the regulation of science & technology
- improved understanding of the role of science and technology in the context of human and societal development

Content
Science and Technology Policy is normally associated with the improvement of national competitiveness; yet, it is also an integral part of effective environmental and development policies. The course will discuss the challenges and opportunities of technological change in terms of sustainable development and show how public policy on the national and the international level is responding to this change.

In this context, students are to become familiar with the basic principles of political economy and New Growth Theory and how such theories help explain political decisions as well as political outcomes in the area of Science, Technology and Innovation. State interventions are either designed to regulate (e.g. environmental regulations, anti-trust law) or facilitate (e.g. intellectual property rights protection, public investment in R&D and technical education, technology transfer) technological change. This will be illustrated by looking at different industries and different national systems of innovation. Subsequently the positive and negative consequences for society and the natural environment will be discussed from a short-term and a long-term perspective.

Lecture notes
Reader with issue-specific articles. E-version is partly available under https://www.ethz.ch/content/specialinterest/gess/cis/international-relations/en/teaching/materials/tech.html
### Prerequisites / notice
The 2-hour course (5-7 p.m.) will be held as a series of lectures. The course materials will be available in form of an electronic Reader at the beginning of the semester. The class will be taught in English. Students will be asked to give a (a) presentation (15 Minutes) or write a review paper based on a article selected from the electronic script, and (b) they will have to pass a written test at the end of the course in order to obtain 3 credit points in the ECTS System. In the final mark (a) will have a weight of 40% and (b) 60%.

### Literature


### Prerequisites / notice
The seminar is designed for students and researchers (MA, PhD, PostDoc) who use inter- and transdisciplinary elements in their projects. It addresses the challenges of this research: How to integrate disciplines? How (and in what role) to include societal actors? How to bring results to fruition? We discuss these questions based on case studies and theories and on the participant's projects.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Seminar on Transdisciplinary Research for Sustainable Development</th>
<th>W</th>
<th>2 credits</th>
<th>2S</th>
<th>C. E. Pohl, M. Stauffacher</th>
</tr>
</thead>
</table>

### Abstract
The seminar covers the following topics:

1. Theories and concepts of inter- and transdisciplinary research
2. The specific challenges of inter- and transdisciplinary research
3. Involving stakeholders
4. Collaborating disciplines
5. Exploration of tools and methods
6. Analysing participants' projects to improve inter- and transdisciplinary elements

### Objective
The participants understand the specific challenges of inter- and transdisciplinary research in general and in the context of sustainable development in particular. They know methods and concepts to address these challenges and apply them to their research projects.

### Content
- The seminar will cover the following topics:
  1. Theories and concepts of inter- and transdisciplinary research
  2. The specific challenges of inter- and transdisciplinary research
  3. Involving stakeholders
  4. Collaborating disciplines
  5. Exploration of tools and methods
  6. Analysing participants' projects to improve inter- and transdisciplinary elements

### Literature
Literature will be made available to the participants.
Prerequisites / notice: The seminar is specifically suitable for PhD or PostDoc researchers. It is open to master students (minor "global change and sustainability") and further interested people, who preferably are preparing, or working on, a project/thesis.

701-0473-00L Weather Systems W 3 credits 2G M. A. Sprenger, C. Grams
Abstract: This lecture introduces the theoretical principles and the observational and analytical methods of atmospheric dynamics. Based on these principles, the following aspects are discussed: the energetics of the global circulation, the basic synoptic- and meso-scale flow phenomena, in particular the dynamics of extratropical cyclones, and the influence of mountains on the atmospheric flow.
Objective: The students are able to:
- explain up-to-date meteorological observation techniques and the basic methods of theoretical atmospheric dynamics
- to discuss the mathematical basis of atmospheric dynamics, based on selected atmospheric flow phenomena
- to explain the basic dynamics of the global circulation and of synoptic- and meso-scale flow features
- to explain how mountains influence the atmospheric flow on different scales
Content: Satellite observations; analysis of vertical soundings; geostrophic and thermal wind; cyclones at mid-latitude; global circulation; north-atlantic oscillation; atmospheric blocking situations; Eulerian and Lagrangian perspective; potential vorticity; Alpine dynamics (storms, orographic wind); planetary boundary layer
Lecture notes: Lecture notes and slides
Literature: Atmospheric Science, An Introductory Survey
John M. Wallace and Peter V. Hobbs, Academic Press

701-0479-00L Environmental Fluid Dynamics W 3 credits 2G H. Wernili, M. Croci-Maspoli
Abstract: This course covers the basic physical concepts and mathematical equations used to describe environmental fluid systems on the rotating Earth. Fundamental concepts (e.g. vorticity dynamics and waves) are formally introduced, applied quantitatively and illustrated using examples. Exercises help to deepen knowledge of the material.
Objective: Students are able to:
- name the bases, concepts and methods of environmental fluid dynamics.
- understand and discuss the components of the basic physical equations in fluid dynamics
- to apply basic mathematical equations to simple problems of environmental fluid dynamics
Content: Basic physical terminology and mathematical laws:
- Continuum hypothesis, forces, constitutive laws, state equations and basic principles of thermodynamics, kinematics, laws of mass and momentum on rotating earth.
- Concepts and illustrative flow systems: vorticity dynamics, boundary layers, instability, turbulence - with respect to environmental fluid systems.
- Scale analysis: dimensionless variables and dynamical similarity, simplification of the fluid system, e.g. shallow water assumption, geostrophic flow.
Lecture notes: Waves in environmental fluid systems.
Literature: In English language
Will be presented in class.
See also: web-site.

701-1315-00L Biogeochemistry of Trace Elements W 3 credits 2G A. Voegelin, M. Etique, L. Winkel
Abstract: The course addresses the biogeochemical classification and behavior of trace elements, including key processes driving the cycling of important trace elements in aquatic and terrestrial environments and the coupling of abiotic and biotic transformation processes of trace elements. Examples of the role of trace elements in natural or engineered systems will be presented and discussed in the course.
Objective: The students are familiar with the chemical characteristics, the environmental behavior and fate, and the biogeochemical reactivity of different groups of trace elements. They are able to apply their knowledge on the interaction of trace elements with geosphere components and on abiotic and biotic transformation processes of trace elements to discuss and evaluate the behavior and impact of trace elements in aquatic and terrestrial systems.
Content: (i) Definition, importance and biogeochemical classification of trace elements. (ii) Key biogeochemical processes controlling the cycling of different trace elements (base metals, redox-sensitive and chalcophile elements, volatile trace elements) in natural and engineered environments. (iii) Abiotic and biotic processes that determine the environmental fate and impact of selected trace elements.
Lecture notes: Selected handouts (lecture notes, literature, exercises) will be distributed during the course.
Prerequisites / notice: Students are expected to be familiar with the basic concepts of aquatic and soil chemistry covered in the respective classes at the bachelor level (soil mineralogy, soil organic matter, acid-base and redox reactions, complexation and sorption reactions, precipitation/dissolution reactions, thermodynamics, kinetics, carbonate buffer system).
This lecture is a prerequisite for attending the laboratory course "Trace elements laboratory".

701-1681-00L Element Balancing and Soil Functions in Managed Ecosystems W 3 credits 2G A. Keller
Abstract: Applying element balances of agricultural soils and the assessment of soil functions for real applications in computer exercises to design preventive strategies against soil pollution and to support sustainable management of regional agroecosystems also in the context of spatial planning procedures.
Objective: The students learn to critically assess changes in land use management on element cycles in agro-ecosystems and to assess soil services (soil functions). You design solutions for chemical problems in soil protection at the regional scale and learn to assess soil functions using different methods.
Content: The students apply a regional balance model for Swiss regions in computer exercises and assess major soil functions of agricultural soils. You assess the sustainability of current land use and analyse management options improving nutrient and metal cycling in agro-ecosystems. The students will have the opportunity to calculate specific scenarios regarding land use management and environmental changes. Special focus we be paid on the soil services such as regulation-, production function and soil as habitat, and the assessment of these functions based on soil mapping data.
Lecture notes: Literature and Exercises for a case study
Literature: Literature will be provided.
Prerequisites / notice: The course consists of lectures and computer exercises. The course take place every 2 weeks à 4 hours.

101-0258-00L River Engineering W 3 credits 2G G. R. Bezzola
Abstract: The lecture addresses the fundamentals to quantitatively describe the flow of water, the transport of sediments and morphological changes like erosion or deposition in watercourses. Further addressed are the design and dimensioning of river engineering works to create and ensure sufficient capacity, channel stability as well as to ensure the ecological functions of the watercourse.
151-0709-00L  Stochastic Methods for Engineers and Natural Scientists ■

Objective
- By the end of the course you should be able to mathematically describe random quantities and their effect on physical systems. Moreover, you should be able to develop basic stochastic models of such systems.

Content
- Probability theory, single and multiple random variables, mappings of random variables
- Stochastic differential equations, Ito calculus, PDF evolution equations
- Polynomial chaos and other expansion methods
- Stochastic differential equations, Ito calculus, PDF evolution equations
- Explain the concepts that underlie radioactive waste disposal practices

Literature

102-0337-00L  Landfilling, Contaminated Sites and Radioactive Waste Repositories ■

Objective
- The students shall be able to describe the interrelation between discharge, sediment transport and channel evolution quantitatively
- know the fundamentals and be able to apply the approaches and methods to treat river engineering problems associated with flood protection and river restoration
- be capable to design and dimension river engineering works needed to influence the processes in watercourses

Content
- The first part of the lecture treats the fundamentals required to deal with river engineering problems. Sampling methods for the river bed material and methods to calculate the discharge in alluvial rivers are presented. The process of river bed arming and the principles of incipient motion, initiation of erosion as well as sediment transport (bed load, suspended load) are treated.
- In the second part of the lecture, the procedures to quantify the sediment budget and the morphological changes (erosion, aggregation) in river systems are explained. Furthermore, the process of natural channel formation and the different plan forms of rivers (straight, meandering, braided) are discussed. Own chapters are dedicated to the topics of channel stability, bed forms, river morphology and scour.
- The last part of the lecture concentrates on the design and dimensioning of river engineering works. The topics focussed on are the stabilization of banks and of the longitudinal profile of rivers.

Literature
- Lecture notes “River Engineering” (in German, 470 pages, including list of references)
- The lecture notes contain a comprehensive list of references for further reading.

Prerequisites / notice
- Strongly recommended lectures:
  - Hydrology (102-0293-AAL), Hydraulics I (101-0203-01L) and Hydraulic Engineering (101-0206-00L)

A practical exercise (voluntary, unmarked) is offered to deepen the learned subjects.

This exercise bases on field data, which are partly collected by the students on a river in nature. Besides the collection of fundamentals and field data, the exercise comprehends the calculation of the stage-discharge relationship, of the critical discharges for initiation of bed load transport and bed erosion and of the annual sediment load in a given river reach.

102-0377-00L  Air Pollution Modeling and Chemistry

Objective
- Air pollutants cause negative effects on humans, wildlife and buildings. To control and reduce the impact of air pollutants, their transfer from sources to receptors needs to be known. This transfer includes transport within the atmospheric boundary layer, chemical transformation reactions and phase-transfer processes from air to liquid and solid materials (aerosols, water, ...).
- The students understand the fundamental principles of atmospheric transport, dispersion and chemistry of pollutants on the local to regional scale and their transfer between air and condensed phases (aerosols, water, solids). This includes the knowledge of important atmospheric reactions, sources and sinks. The obtained understanding enables the students to apply computational tools to predict the transport and transformation of chemicals at the local to regional scale.
Content
- Structure of the Atmosphere
- Thermodynamics of the atmosphere
- Atmospheric stability
- Atmospheric boundary layer and turbulence
- Dispersion in the atmospheric boundary layer
- Numerical models of atmospheric dispersion
- Gas phase reaction kinetics
- Tropospheric chemistry and ozone formation
- Chemistry box models
- Volatile organic pollutants (VOCs) and semi-volatile organic pollutants (SVOCs)
- Distribution of chemicals between different phases
- Kinetics of phase transfer processes
- Computational tools to estimate volatility, distribution and phase transfer rates of organic chemicals

Lecture notes
Continued updates of:
- Slides and handouts
- Home assignments and sample solutions
- R package and code for some of the home assignments
- Free software packages for estimation of properties and fate of organic chemicals
- Key journal articles as discussed during lecture

Literature
Atmospheric chemistry

Environmental organic chemistry and mass transfer
Mackay D., Multimedia environmental models : the fugacity approach; Boca Raton, Fla.: Lewis Publishers; 2001; 2nd ed

Atmospheric dynamics and boundary layer

Atmospheric modelling

Introduction to R

701-0535-00L Environmental Soil Physics/Vadose Zone Hydrology W 3 credits 2G+2U D. Or

Abstract
The course provides theoretical and practical foundations for understanding and characterizing physical and transport properties of soils/near-surface earth materials, and quantifying hydrological processes and fluxes of mass and energy at multiple scales. Emphasis is given to land-atmosphere interactions, the role of plants on hydrological cycles, and biophysical processes in soils.

Objective
Students are able to
- characterize quantitative knowledge needed to measure and parameterize structural, flow and transport properties of partially-saturated porous media,
- quantify driving forces and resulting fluxes of water, solute, and heat in soils.
- apply modern measurement methods and analytical tools for hydrological data collection
- conduct and interpret a limited number of experimental studies
- explain links between physical processes in the vadose-zone and major societal and environmental challenges
Weeks 1 to 3: Physical Properties of Soils and Other Porous Media

Units and dimensions, definitions and basic mass-volume relationships between the solid, liquid and gaseous phases; soil texture; particle size distributions; surface area; soil structure. Soil colloids and clay behavior.

Soil Water Content and its Measurement - Definitions; measurement methods - gravimetric, neutron scattering, gamma attenuation; and time domain reflectometry; soil water storage and water balance.

Weeks 4 to 5: Soil Water Retention and Potential (Hydrostatics) - The energy state of soil water; total water potential and its components; properties of water (molecular, surface tension, and capillary rise); modern aspects of capillarity in porous media; units and calculations and measurement of equilibrium soil water potential components; soil water characteristic curves definitions and measurements; parametric models; hysteresis. Modern aspects of capillarity

Demo-Lab: Laboratory methods for determination of soil water characteristic curve (SWC), sensor pairing

Weeks 6 to 9: Water Flow in Soil - Hydrodynamics:

Part 1 - Laminar flow in tubes (Poiseuille's Law); Darcy's Law, conditions and states of flow; saturated flow; hydraulic conductivity and its measurement.

Lab #1: Measurement of saturated hydraulic conductivity in uniform and layered soil columns using the constant head method.

Part 2 - Unsaturated steady state flow; unsaturated hydraulic conductivity models and applications; non-steady flow and Richards Eq.; approximate solutions to infiltration (Green-Ampt, Philip); field methods for estimating soil hydraulic properties.

Midterm exam

Lab #2: Measurement of vertical infiltration into dry soil column - Green-Ampt, and Philip's approximations; infiltration rates and wetting front propagation.

Part 3 - Use of Hydrus model for simulation of unsaturated flow

Week 10 to 11: Energy Balance and Land Atmosphere Interactions - Radiation and energy balance; evapotranspiration definitions and estimation; transpiration, plant development and transpiration coefficients small and large scale influences on hydrological cycle; surface evaporation.

Week 12 to 13: Solute Transport in Soils - Transport mechanisms of solutes in porous media; breakthrough curves; convection-dispersion eq.; solutions for pulse and step solute application; parameter estimation; salt balance.

Lab #3: Miscible displacement and breakthrough curves for a conservative tracer through a column; data analysis and transport parameter estimation.

Additional topics:

Temperature and Heat Flow in Porous Media - Soil thermal properties; steady state heat flow; nonsteady heat flow; estimation of thermal properties; engineering applications.

Biological Processes in the Vadose Zone - An overview of below-ground biological activity (plant roots, microbial, etc.); interplay between physical and biological processes. Focus on soil-atmosphere gaseous exchange; and challenges for bio- and phytoremediation.

Lecture notes

Classnotes on website: Vadose Zone Hydrology, by Or D., J.M. Wraith, and M. Tuller (available at the beginning of the semester)

http://www.step.ethz.ch/education/active-courses/vadose-zone-hydrology

Literature

Supplemental textbook (not mandatory) - Environmental Soil Physics, by: D. Hillel

Minors Limited to 6 KP Totaly

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<th>Number</th>
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<td>102-0317-03L</td>
<td>Advanced Environmental Assessment (Computer Lab I)</td>
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<td></td>
<td></td>
<td>S. Pfister</td>
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<td>102-0535-00L</td>
<td>Noise Abatement</td>
<td>W</td>
<td>5</td>
<td>4G</td>
<td>K. Eggenschwiler, J. M. Wunderli</td>
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<tr>
<td>102-0215-00L</td>
<td>Urban Water Management II</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>M. Maurer, P. Staufer</td>
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## Consolidation of the basic procedures for design and operation of technical networks in water engineering.

### Lecture notes can be purchased during the first lecture (15.- SFr)

- **Consolidation of the basic procedures for design and operation of technical networks in water engineering.**

- **Definition of contaminated sites, site investigation methods, historical research and technical investigation, risk assessment,**

- **Environmental Geotechnics**

- **Technical networks in urban water engineering. Water supply: Optimization, water hammer, corrosion and hygiene. Urban drainage: Urban hydrology, non stationary flow, pollutant transport, infiltration of rainwater, wet weather pollution control. General planning, organisation and operation of regional drainage systems.**

- **Optimierung von Wasserverteilnetzen**

- **Druckstösse**

- **Kalkauffällung, Korrosion von Leitungen**

- **Hygiene in Verteilsystemen**

- **Siedlungshydrologie: Niederschlag, Ablussbildung**

- **Instationäre Strömungen in Kanalisations**

- **Stofftransport in der Kanalisation**

- **Einleitbedingungen bei Regenwetter**

- **Versickerung von Regenwasser**

- **Generelle Entwässerungsplanung (GEP)**

### Lecture notes

Written material and copies of the overheads will be available.

### Prerequisites / notice

Prerequisite: Introduction to Urban Water Management

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
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<tbody>
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<td>Hydraulics of Engineering Structures</td>
<td>3</td>
<td>W</td>
<td>H. Fuchs, I. Albayrak, L. Schmocker</td>
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<tr>
<td>101-0339-00L</td>
<td>Environmental Geotechnics</td>
<td>3</td>
<td>W</td>
<td>L. M. Plötze</td>
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<tr>
<td>701-0501-00L</td>
<td>Pedosphere</td>
<td>3</td>
<td>W</td>
<td>R. Kretzschmar</td>
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<tr>
<td>701-0533-00L</td>
<td>Soil Chemistry</td>
<td>3</td>
<td>W</td>
<td>R. Kretzschmar, D. I. Christl</td>
</tr>
</tbody>
</table>

### Literature


- Exhaustive references are contained in the suggested text book.

### Lecture notes

- Dr. R. Hermanns Stengele, Dr. M. Plötze: Environmental Geotechnics (german) digital excursion

- Lecture notes can be purchased during the first lecture (15.- SFr)


### Prerequisites / notice

- Former Title until HS15: Wastewater Hydraulics.

- Prerequisite: Introduction to Urban Water Management

- Generelle Entwässerungsplanung (GEP)

- Einleitbedingungen bei Regenwetter

- Stofftransport in der Kanalisation

- Instationäre Strömungen in Kanalisations

- Siedlungshydrologie: Niederschlag, Ablussbildung

- Optimierung von Wasserverteilnetzen

- Druckstösse

- Kalkauffällung, Korrosion von Leitungen

- Hygiene in Verteilsystemen

- Siedlungshydrologie: Niederschlag, Ablussbildung

- Instationäre Strömungen in Kanalisations

- Stofftransport in der Kanalisation

- Einleitbedingungen bei Regenwetter

- Versickerung von Regenwasser

- Generelle Entwässerungsplanung (GEP)

### Objective

- Understanding and quantification of fundamental hydraulic processes with particular focus on hydraulic structures for wastewater, flood protection and hydropower

- Definition of contaminated sites, site investigation methods, historical research and technical investigation, risk assessment

- Environmental Geotechnics


- Optimierung von Wasserverteilnetzen

- Druckstösse

- Kalkauffällung, Korrosion von Leitungen

- Hygiene in Verteilsystemen

- Siedlungshydrologie: Niederschlag, Ablussbildung

- Instationäre Strömungen in Kanalisations

- Stofftransport in der Kanalisation

- Einleitbedingungen bei Regenwetter

- Versickerung von Regenwasser

- Generelle Entwässerungsplanung (GEP)

### Content

1. Introduction & Basic equations
2. Losses in flow & Maximum discharge
3. Uniform flow & Critical flow
4. Hydraulic jump & Stillling basins
5. Backwater curves
6. Weirs/End overfalls & Venturi
7. Mobile discharge measurements & Culverts/restrictors/inverted siphons
8. Fall manholes & Vortex drop
9. Conjunctions & Shock waves at abrupt wall deflections
10. Air/water flows and bottom outlets
11. Driftwood retention racks
12. Vegetated flows - Introduction
13. Vegetated flows - Application
14. Summary & questions/preparations for examination
The Master Programme concludes with the Master Thesis, which has to be done in one of the chosen Majors and has to be completed within 16 weeks. The Master Thesis is supervised by a professor and shall attest the students ability to work independently and to produce scientifically structured work.

### Project Work

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>102-0199-01L</td>
<td>Project on Water Resources Management</td>
<td>W</td>
<td>12 credits</td>
<td>24A</td>
<td>Lecturers</td>
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<td>Working during one semester on a task in Water Resources Management</td>
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<td></td>
<td>Objective: Promote independent, structured and scientific work; learn to apply engineering methods; deepen the knowledge in the field of the treated task.</td>
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<td>24A</td>
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<tr>
<td>102-0399-01L</td>
<td>Project on Ecological Systems Design, Air Quality</td>
<td>W</td>
<td>12 credits</td>
<td>24A</td>
<td>Lecturers</td>
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<td>Working during one semester on a task in Material Flow and Waste Management</td>
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<tr>
<td>102-0499-01L</td>
<td>Project on Soil Protection</td>
<td>W</td>
<td>12 credits</td>
<td>24A</td>
<td>Lecturers</td>
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<td></td>
<td>Working during one semester on a task in Soil Protection</td>
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<td>102-0599-01L</td>
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<td>12 credits</td>
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### Practical Work Experience

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>102-0003-00L</td>
<td>External Professional Training</td>
<td>O</td>
<td>16 credits</td>
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<tr>
<td></td>
<td>External professional training according to a special regulation. The compulsory professional training lasts for at least 12 weeks and is a precondition to be allowed to write up the Master thesis, and to acquire the Master degree.</td>
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<td>Objective: Experience how environmentally friendly solutions are reached in praxis.</td>
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<td></td>
<td>Prerequisites / notice: Das Reglement für das obligatorische Berufspraktikum im Masterstudiengang Umwelt ingenieurwissenschaften kann heruntergeladen werden unter: <a href="http://www.umwelt">http://www.umwelt</a> ingenieurwissenschaften kann heruntergeladen werden unter:</td>
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### Electives

The entire course programs of ETH Zurich and the University of Zurich are open to the students to individual selection.

#### ETHEZ Zürich

Course Catalogue of ETH Zurich

#### Master's Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>102-0010-00L</td>
<td>Master's Thesis in Water Resources Management</td>
<td>W</td>
<td>24 credits</td>
<td>47D</td>
<td>Supervisors</td>
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<tr>
<td></td>
<td>Only students who fulfill the following criteria are allowed to begin with their master thesis: a. successful completion of the bachelor programme; b. fulfilling of any additional requirements necessary to gain admission to the master programme.</td>
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<td>Objective: To work independently and to produce a scientifically structured work.</td>
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<tr>
<td>102-0010-10L</td>
<td>Master's Thesis in Urban Water Management</td>
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<td>47D</td>
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<td></td>
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</tbody>
</table>
The topics of the Master Thesis are published by the professors. The Topic can be set also in consultation between the student and the professor.

### 102-0010-20L  
**Master's Thesis in Ecological Systems Design, Air Quality Control and Waste Management**  
Only students who fulfill the following criteria are allowed to begin with their master thesis:  
a. successful completion of the bachelor programme;  
b. fulfilling of any additional requirements necessary to gain admission to the master programme.

**Abstract**  
The Master Programme concludes with the Master Thesis, which has to be done in one of the chosen Majors and has to be completed within 16 weeks. The Master Thesis is supervised by a professor and shall attest the students ability to work independently and to produce scientifically structured work.

**Objective**  
To work independently and to produce a scientifically structured work.

**Content**  
The topics of the Master Thesis are published by the professors. The Topic can be set also in consultation between the student and the professor.

### 102-0010-30L  
**Master's Thesis in Hydraulic Engineering**  
Only students who fulfill the following criteria are allowed to begin with their master thesis:  
a. successful completion of the bachelor programme;  
b. fulfilling of any additional requirements necessary to gain admission to the master programme.

**Abstract**  
The Master Programme concludes with the Master Thesis, which has to be done in one of the chosen Majors and has to be completed within 16 weeks. The Master Thesis is supervised by a professor and shall attest the students ability to work independently and to produce scientifically structured work.

**Objective**  
To work independently and to produce a scientifically structured work.

**Content**  
The topics of the Master Thesis are published by the professors. The Topic can be set also in consultation between the student and the professor.

### 102-0010-40L  
**Master's Thesis in Soil Protection**  
Only students who fulfill the following criteria are allowed to begin with their master thesis:  
a. successful completion of the bachelor programme;  
b. fulfilling of any additional requirements necessary to gain admission to the master programme.

**Abstract**  
The Master Programme concludes with the Master Thesis, which has to be done in one of the chosen Majors and has to be completed within 16 weeks. The Master Thesis is supervised by a professor and shall attest the students ability to work independently and to produce scientifically structured work.

**Objective**  
To work independently and to produce a scientifically structured work.

**Content**  
The topics of the Master Thesis are published by the professors. The Topic can be set also in consultation between the student and the professor.

### GESS Science in Perspective

- see GESS Science in Perspective: Type A: Enhancement of Reflection Capability
- see GESS Science in Perspective: Language Courses ETH/UZH
- Recommended GESS Science in Perspective (Type B) for D-BAUG.

### Course Units for Additional Admission Requirements

The courses below are only available for MSc students with additional admission requirements.

**Number**  
**Title**  
**Type**  
**ECTS**  
**Hours**  
**Lecturers**

**101-0203-AAL**  
**Hydraulics I**  
Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

- Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

**Abstract**  
The course teaches the basics of hydromechanics, relevant for civil and environmental engineers.

**Objective**  
Familiarization with the basics of hydromechanics of steady state flows

**Content**  
Properties of water, hydrostatics, continuity, Euler equation of motion, Navier Stokes equation, similarity, Bernoulli principle, momentum equation for finite volumes, potential flows, ideal fluids-real fluids, boundary layer, pipe flow, open channel flow, flow in porous media, flow measurements, demonstration experiments in the lecture hall and in the laboratory

**Lecture notes**  
Script and collection of problems available

**Literature**  
Bollrich, Technische Hydromechanik 1, Verlag Bauwesen, Berlin

**102-0214-AAL**  
**Introduction to Urban Water Management**  
Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

- Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

**Abstract**  
Introduction to urban water management (water supply, urban drainage, wastewater treatment, sewage sludge treatment). Introduction to Urban Water Management is a self-study course.

**Objective**  
This course provides an introduction and an overview over the topics of urban water management (water supply, urban drainage, wastewater treatment, sewage sludge treatment). It supports the understanding of the interactions of the relevant technical and natural systems. Simple design models are introduced.
Students learn about environmental assessment tools, such as material flow analysis, risk assessment, and life cycle assessment. They are introduced to the methodological basics of these tools and are encouraged to critically assess existing studies. The required reading and studying should correspond roughly the time invested in the course Siedlungswasserwirtschaft GZ. Students are welcome to ask the assistants for help with questions they have regarding the reading.

Prerequisites / notice
Some students joining the MSc program in Environmental Engineering at ETH Zürich have to take additional courses from our BSc program. The decision of what courses to take is done at the time of admission at ETH.

This course is required for further in depth courses in urban water management.

Prerequisite: Hydraulics I and Hydrology

102-0324-AAL Ecological Systems Analysis

Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract
Methodological basics and application of various environmental assessment tools.

Objective
Students learn about environmental assessment tools, such as material flow analysis, risk assessment, and life cycle assessment. They can identify and apply the appropriate tool in a given situation. Also, they are able to critically assess existing studies.

Content
- Methodological basics of material flow analysis, risk assessment and life cycle assessment
- Application of these methods to case studies

Lecture notes
No script, but literature available on homepage.

Literature

Prerequisites / notice
None

102-0325-AAL Waste Management

Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract
Introduction into the problems of waste handling with the goal to get the ability of seeing and improving the influence of commodities and products with there packaging to the environment - as they are becoming waste. Knowing the different mechanical and chemical processes, which are applicable in the field of waste management.

Objective
- To reconstruct the historical development of the waste problems (C2)
- To know the problems of a modern waste management (C4)
- To see and to improve the influence of commodities and products to the environment (C5)
- To recognize waste and his components as raw material and resources and to get the know how for a correct handling (C6)
- To know the different mechanical and chemical processes, which are applicable in the field of waste management (C6)

Content
- Waste composition as a mirror of the human evolution
- Waste definition (formation, amount, energy content, waste composition)
- Several recycling possibilities and processes
- Thermal waste treatment (electricity/district heat as products), including off-gas cleaning and incineration residue handling with regards to the final residue storage in a landfill and the problems which have to be solved there
- Special fields like biological waste handling (composting, fermentation), handling of special wastes and municipal sewage sludge treatment
- Economical aspects

Lecture notes
Siehe englische Ausgabe

Literature
see bibliographie in the script

Prerequisites / notice
Basic of chemical processes has to be known

102-0455-AAL Groundwater I

Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract
Introduction into the problems of waste handling with the goal to get the ability of seeing and improving the influence of commodities and products with there packaging to the environment - as they are becoming waste. Knowing the different mechanical and chemical processes, which are applicable in the field of waste management.

Objective
- To reconstruct the historical development of the waste problems (C2)
- To know the problems of a modern waste management (C4)
- To see and to improve the influence of commodities and products to the environment (C5)
- To recognize waste and his components as raw material and resources and to get the know how for a correct handling (C6)
- To know the different mechanical and chemical processes, which are applicable in the field of waste management (C6)

Content
- Waste composition as a mirror of the human evolution
- Waste definition (formation, amount, energy content, waste composition)
- Several recycling possibilities and processes
- Thermal waste treatment (electricity/district heat as products), including off-gas cleaning and incineration residue handling with regards to the final residue storage in a landfill and the problems which have to be solved there
- Special fields like biological waste handling (composting, fermentation), handling of special wastes and municipal sewage sludge treatment
- Economical aspects

Lecture notes
Siehe englische Ausgabe

Literature
see bibliographie in the script

Prerequisites / notice
Basic of chemical processes has to be known
Abstract

The course provides an introduction into quantitative analysis of groundwater flow and transport. It is focused on formulating flow and transport problems in groundwater, which are to be solved analytically or numerically.

Objective

a) Students understand the basic concepts of flow and contaminant transport processes and boundary conditions in groundwater.

b) Students are able to formulate simple practical flow and transport problems.

c) Students are able to understand and apply simple analytical solutions to simple flow and transport problems.

d) Students are able to use simple numerical codes to adequately solve simple flow (and transport) problems.

Content

Properties of porous media.
Exercises: Groundwater use, porosity, grain size analysis.

Flow properties, Darcy's law, filter.
Exercises: Darcy's law.

Analytical solutions, confined aquifers, steady-state flow.
Exercises: Head isolines.

Use of superposition principles, transient flow, free surface flow.
Exercises: Analytical solutions to flow problems.

Finite difference solutions to flow problems I.
Exercises: Analytical solutions to flow problems.

Finite difference solutions to flow problems II.
Exercises: Finite difference formulations to flow problems.

Transport processes.
Exercises: Computer workshop using PMWIN.

Analytical solutions to transport problems I.
Exercises: Computer workshop using PMWIN.

Analytical solutions to transport problems II.
Exercises: Analytical solutions to transport problems.

Path lines, groundwater protection.
Exercises: Analytical solutions to transport problems.

Groundwater remediation, groundwater management.
Exercises: Groundwater remediation.

Lecture notes

Folien auf Internet unter www.ihw.ethz.ch/GWH/education/index
Altes Skript auf Internet www.ihw.ethz.ch/GWH/education/index
Weitere Texte auf Internet www.ihw.ethz.ch/GWH/education/index
Didaktische Software auf Internet unter www.ihw.ethz.ch/GWH/education/index

Literature

W. Kinzelbach, R. Rausch, Grundwassermodellierung, Gebrüder Bornträger, Stuttgart, 1995
Krusemann, de Ridder, Untersuchung und Anwendung von Pumpversuchen, Verl. R. Müller, Köln, 1970
G. de Marsily, Quantitative Hydrogeology, Academic Press, 1986

Air Pollution Control

Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract

The lecture provides an introduction to the formation of air pollutants by technical processes, the emission of these chemicals into the atmosphere and the impact on air quality. Theoretical description and modeling of these processes, air quality measurement techniques and pollution control techniques are covered.

Objective

The students gain general knowledge of the factors resulting in air pollution and the techniques used for air pollution control. The students can identify major air pollution sources and understand the methods for measurement, data collection and analysis. The students can evaluate possible control methods and equipment, design a control system and estimate the efficiency and cost.

Content

- the physical and chemical processes leading to emission of pollutants
- air quality analysis
- the meteorological parameters influencing air pollution dispersion
- deterministic and stochastic models, describing the air pollution dispersion
- measurement concepts to observe ambient air pollution
- removal of gaseous pollutants by absorption and adsorption
- control of NOx and SOx
- fundamentals of particulate control
- design and application of wet scrubbers

Literature

Text book

Prerequisites / notice

College lectures on basic physics, chemistry and mathematics.
Introduction to Water Resources Management

Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Abstract
The course offers an introduction to the basics of water resources analysis and management covering the topics of water demand vs availability, water exploitation and reservoir design, aquatic physics, water quality and pollution, water conservation and remediation in rivers, lakes and aquifers, sustainable water use.

Objective
Wassergüte: Anforderungen, Schadstoffausbreitung, Selbstreinigung, Thermische Belastung, relevante Schadstoffe und Quellen, Stossbelastungen, Zeitkonstanten und Grössenordnungen.
Wasserwirtschaft: Struktur von Dargebot und Nachfrage.
Optionen zur Schliessung der Disparität: Reservoire, Grundwasserspeicher, Überleitungen, Wasserwirtschaftliche Rahmenplanung (Masterplan), Gewässerschutz, Sanierung und Renaturierung (Oberflächengewässer und Grundwasser), Variabilität, Stochastik und Risiko.
Nachhaltigkeit: Definitionen, Beispiele für nicht-nachhaltiges Wirtschaften, Wasserprobleme der Entwicklungsländer, Wasser und Landwirtschaft, Projektbewertung und Umweltverträglichkeitsprüfung, Ökonomische und Soziologische Bezüge.

Alle Aspekte sollen mit Fallbeispielen illustriert werden.

Lecture notes
Skript in wöchentlichen Folgen.

Computer Science II

Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Abstract
Introduction to programming in Java. Procedural foundations of programming and outlook to object oriented programming. Variables, types, assignments, control structures (branch, loop), data structures, algorithms, line graphics, graphical user interface. Writing small programs.
Working with a professional programming environment (Eclipse).

Objective
The students will be able to write simple programs and to modify existing programs.

Content
This course offers an introduction to variables, control structures (branch, loop), algorithms and data structures, as well as an outlook to modularisation and object oriented techniques.
In the exercises students train programming skills (in the programming language JAVA). Students can solve the exercises on their own laptop or in the computer labs at ETH. The software used in this course runs on MS Windows, MacOS X and Linux.

Prerequisites / notice
Prerequisites:
252-0845-00 Computer Science I (D-BAUG)

Chemistry I and II

Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Abstract
General Chemistry I and II: Chemical bond and molecular structure, chemical thermodynamics, chemical equilibrium, kinetics, acids and bases, electrochemistry

Objective
Introduction to general and inorganic chemistry. Basics of the composition and the change of the material world. Introduction to the thermodynamically controlled physico-chemical processes. Macroscopic phenomena and their explanation through atomic and molecular properties. Using the theories to solve qualitatively and quantitatively chemical and ecologically relevant problems.

Content
1. Stoichiometry
2. Atoms and Elements (Quantenmechanical Model of the Atom)
3. Chemical Bonding
4. Thermodynamics
5. Chemical Kinetics
6. Chemical Equilibrium (Acids and Bases, Solubility Equilibria)
7. Electrochemistry

Lecture notes
Nivaldo J. Tro
Chemistry - A molecular Approach (Pearson), Chapter 1-18
Housecroft and Constable, CHEMISTRY
Oxtoby, Gillis, Nachtrieb, MODERN CHEMISTRY

Chemistry II

Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Abstract
Chemistry II: Redox reactions, chemistry of the elements, introduction to organic chemistry

Objective
Erweitern der allgemeinen Grundlagen und Erarbeiten einer Basis, um Prozesse in komplexeren Umweltsystemen (Wasser / Luft / Boden) in ihrem zeitlichen und quantitativen Ablauf verstehen und beurteilen zu können.
Content

1. Redox reactions

2. Inorganic Chemistry
   Rules for nomenclature of inorganic compounds. Systematic description of the groups of elements in the periodical system and the most important compounds of these elements. Formation of compounds as a consequence of the electronoc structure of the elements.

3. Introduction to organic chemistry
   Description of the most important classes of compounds and of the functional groups. Principal reactivity of these functional groups. Stereochemistry.
   Reaction mechanisms: SN1- and SN2-reactions, electrophilic aromatic substitutions, eliminations (E1 and E2), addition reactions (C=C and C=O double bonds), Chemistry of carboxy and carboxylic groups.
   Rules for nomenclature of inorganic compounds. Systematic description of the groups of elements in the periodical system and the most important compounds of these elements. Formation of compounds as a consequence of the electronoc structure of the elements.

Lecture notes

Literature


701-0255-AAL  Biochemistry  Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

E-  2 credits  4R  H.P. Kohler

Abstract
Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Objective
Introduction to basic biochemistry and the most important metabolic reactions.
Based on the biology and chemistry courses in the 1. and 2. semester more detailed biochemical knowledge about enzymology, membrane biochemistry, and central metabolism will be presented

Content
Introduction, basics, composition of cells, biochemical units, repetition of relevant organic chemistry
Structure and function of proteins
Carbohydrates, structure of DNA
Lipids an biological membranes
Enzymes and enzyme kinetics
Catalytic strategies
Metabolism: Basic concepts and design. Repetition of basic thermodynamics
Glycolysis
The citric acid cycle
Oxidative phosphorylation
Fatty acid metabolism

Lecture notes

Literature

Prerequisites / notice
Basic knowledge in biology and chemistry is a precondition.

752-4001-AAL  Microbiology  Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

E-  2 credits  4R  M. Schuppler

Abstract
Teaching of basic knowledge in microbiology with main focus on Microbial Cell Structure and Function, Molecular Genetics, Microbial Growth, Metabolic Diversity, Phylogeny and Taxonomy, Prokaryotic Diversity, Human-Microbe Interactions, Biotechnology.

Objective
Teaching of basic knowledge in microbiology.

Content

Literature
Die Behandlung der Themen erfolgt auf der Basis des Lehrbuchs Brock, Biology of Microorganisms

102-0293-AAL  Hydrology  Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

E-  3 credits  6R  P. Burlando

Abstract

Objective
Kennen der Grundzüge der Hydrologie. Kennenlernen von Methoden, zur Abschätzung hydrologischer Grössen, die zur Dimensionierung von Wasserbauwerken und für die Nutzung von Wasserressourcen relevant sind.

Data: 06.03.2019 12:57  Autumn Semester 2016  Page 1457 of 1571
Content

Der hydrologische Kreislauf: globale Wasserressourcen, Wasserbilanz, räumliche und zeitliche Dimension der hydrologischen Prozesse.
Niederschlag: Niederschlagsmechanismen, Regenmessung, räumliche/zeitliche Verteilung des Regens, Niederschlagsregime, Punktniederschlag/Gebietsniederschlag, Isotopen, Thiesenpolygon, Extremlinien, Dimensionierungsabfluss

Interzeption: Messung und Schätzung.

Evaporation und Evapotranspiration: Prozesse, Messung und Schätzung, potentielle und effektive Evapotranspiration, Energiebilanzmethode, empirische Methode.

Infiltration: Messung, Horton-Gleichung, empirische und konzeptionelle Methoden, F-index und Prozenteuerte Methode, SCS-CN Methode.

Einzugsgebietsscharakteristik: Morphologie des Einzugsgebiets, topografische und unterirdische Wasserscheide, hypsometrische Kurve, Gefälle, Dichte des Entwässerungsnetzes.


Schnee und Eis: Schnee- und Eisschmelzgeschehen und -messungen Schätzung des Schneeschmelzprozesses durch die Energiebilanzmethode, Abfluss aus Schneeschmelze, Temperatur-Index- und Grad-Tag-Verfahren.


Lecture notes

Die Kopie der Folien zur Vorlesung können auf den Webseiten der Professur für Hydrologie und Wasserwirtschaft herunterladen werden

Literature


Prerequisites / notice


Environmental Engineering Master - Key for Type

<table>
<thead>
<tr>
<th>O</th>
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Key for Hours

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ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Environmental Studies TC

Detailed information on the programme at: https://www.ethz.ch/en/studies/teacher-training.html

Educational Science

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<thead>
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<th>Number</th>
<th>Title</th>
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<td>O</td>
<td>2</td>
<td>2G</td>
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<td>programs &quot;Teaching Diploma&quot; or &quot;Teaching Certificate&quot;. It is about</td>
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<td>learning in childhood and adolescence.</td>
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<td><strong>Abstract</strong></td>
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<td>This course looks into scientific theories and also empirical</td>
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<td>studies on human learning and relates them to the school.</td>
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<td><strong>Objective</strong></td>
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<td>Anyone wishing to be a successful teacher must first of all</td>
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<td>understand the learning process. Against this background, theories</td>
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<td>and findings on the way humans process information and on human</td>
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<td>behaviour are prepared in such a manner that they can be used for</td>
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<td>planning and conducting lessons. Students additionally gain an</td>
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<td>understanding of what is going on in learning and behavioural</td>
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<td>research so that teachers are put in a position where they can</td>
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<td>further educate themselves in the field of research into teaching</td>
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<td>and learning.</td>
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<td></td>
<td>1) Marcus Hasselhorn &amp; Andreas Goid (2006). Pädagogische Psychologie:</td>
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<td>Erfolgreiches Lernen und Lehren. Stuttgart: Kohlhammer. 2) Jeanne</td>
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851-0240-03L | Introduction to Test Theory and Test Construction in Educational Contexts (University of Zürich) | W | 4 credits | 2S | University lecturers |

*No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: 200a968*

*Mind the enrolment deadlines at UZH: http://www.uzh.ch/studies/application/mobilitaet_en.html*

**Abstract**

In this seminar, students establish the scientific fundamentals of performance measurement and educational diagnostics and study them on the basis of different current issues.

**Objective**

At the end of the seminar, participants will be in a position to:
- describe the scientific fundamentals of test theory and test structure.
- evaluate examples of scientifically-developed tests in their application context.
- if necessary, critically question the performance assessment that they employ in practice and professionalise it still further.

**Content**

- Die konkreten Inhalte des Seminars ergeben sich aufgrund der Präferenzen der Teilnehmenden und der daraus abgeleiteten Themenübersicht für Vorträge und Seminararbeiten. Im Rahmen der Startveranstaltung wird eine Liste mit möglichen Themen abgegeben und erläutert. Schwerpunkte der Themenvorschläge sind:
  - Testentwicklung
  - Gütekriterien von Tests
  - Aufgabenkonstruktion
  - Datenauswertung
  - Rasch-Modell
  - Internationale Vergleichstests
  - Zulassungsstests

**Lecture notes**

Im Verlaufe des Semesters werden einzelne Unterlagen in den Veranstaltungen abgegeben. Dazu gehören auch die Handouts der verschiedenen, studentischen Vorträge.

**Literature**

Als Grundlagenliteratur werden folgende Werke empfohlen:
- Weitere Literatur wird in der Lehrveranstaltung genannt.

**Prerequisites / notice**

Die Leistungsanforderungen richten sich im Umfang nach der Zahl zu erwerbender ECTS-Punkte, wobei 1 ECTS-Punkt einem Zeitaufwand von ca. 30 Arbeitsstunden entspricht. ETHZ-Studierende können im Rahmen dieser Veranstaltung 3 ECTS-Punkte erwerben.

Dazu sind folgende Leistungen zu erbringen:
- Schreiben einer schriftlichen Arbeit
- Referat (RE)
- Pflichtlektüre entsprechend der Angaben in der Lehrveranstaltung
- Weitere Literatur wird in der Lehrveranstaltung genannt.

Weitere Angaben zu den Leistungsanforderungen werden im Rahmen der Startveranstaltung abgegeben und erläutert.

851-0240-15L | Colloquium on the Science of Learning and Instruction | W | 1 credit | 1K | E. Stern, P. Greutmann, further lecturers |

**Abstract**

In the colloquium we discuss scientific projects concerning the teaching in mathematics, computer science, natural sciences and technology (STEM). The colloquium is conducted by the professorships participating in the Competence Center EducETH (ETH) and in the Institute for Educational Sciences (UZH).

**Objective**

Participants are exemplarily introduced to different research methods used in research on learning and instruction and learn to weigh advantages and disadvantages of these approaches.

851-0242-05L | Cognitively Activating Instructions in MINT Subjects | W | 2 credits | 2S | R. Schumacher |

*Enrolment only possible with matriculation in Teaching*

Data: 06.03.2019 12:57
Autumn Semester 2016
Page 1459 of 1571
Abstract
This seminar focuses on teaching units in chemistry, physics and mathematics that have been developed at the MINT Learning Center of the ETH Zurich. In the first meeting, the mission of the MINT Learning Center will be communicated. Furthermore, in groups of two, the students will intensively work on, refine and optimize a teaching unit following a goal set in advance.

Objective
- Get to know cognitively activating instructions in MINT subjects
- Get information about recent literature on learning and instruction

Prerequisites / notice
Für eine reibungslose Semesterplanung wird um frühe Anmeldung und persönliches Erscheinen zum ersten Lehrveranstaltungstermin ersucht.

851-0242-07L

Human Intelligence
Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).
Number of participants limited to 30.
This course unit can only be enrolled after successful participation in, or during enrollment in the course "Human Learning (EW 1)"

Abstract
The focus will be on the book "Intelligenz: Grosse Unterschiede und ihre Folgen" by Stern and Neubauer. Participation at the first meeting is obligatory. It is required that all participants read the complete book. Furthermore, in two meetings of 90 minutes, concept papers developed in small groups (5 - 10 students) will be discussed.

Objective
- Understanding of research methods used in the empirical human sciences
- Getting to know intelligence tests
- Understanding findings relevant for education

851-0242-08L

Research Methods in Educational Science
Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).
Number of participants limited to 30.
This course unit can only be enrolled after successful participation in, or during enrollment in the course "Human Learning (EW 1)"

Abstract
Literature from the learning sciences is critically discussed with a focus on research methods. At the first meeting, working groups will be assembled and meetings with those will be set up. In the small groups participants will write critical essays about the read literature. At the third meeting, we will discuss the essays and develop research questions in group work.

Objective
- Understand research methods used in the empirical educational sciences
- Understand and critically examine information from scientific journals and media
- Understand pedagogically relevant findings from the empirical educational sciences

851-0240-22L

Coping with Psychosocial Demands of Teaching (EW4 W DZ)
Number of participants limited to 20.
The successful participation in EW1 ("Human Learning") and EW2 ("Designing Learning Environments for School") is recommended, but not a mandatory prerequisite.

Abstract
In this class, students will learn concepts and skills for coping with psychosocial demands of teaching

Objective
(1) They know the basic rules of negotiation and conflict management (e.g., mediation) and can apply them in the school context (e.g., in conversations with parents).
(2) They can apply diverse techniques of classroom management (e.g., prevention of disciplinary problems in the classroom) and know relevant authorities for further information (e.g., legal conditions).
Objective
- Students use their specialist-subject, educational-science and subject-didactics training to draw up concepts for teaching.
- They are able to assess the significance of tuition topics for their subject from different angles (including interdisciplinary angles) and impart these to their pupils.
- They learn the skills of the teaching trade.
- They practise finding the balance between instruction and openness so that pupils can and, indeed, must make their own cognitive contribution.
- They learn to assess pupils' work.
- Together with the teacher in charge of their teacher training, the students constantly evaluate their own performance.

Content
The students will be able to watch and evaluate the teaching of colleagues and experts. They get profit out of their teaching experiences not only when preparing but also when teaching. Doing so they will be supported by their mentors.

Two lessons of the course will be split off for the examination - procedure.

Lecture notes
Dokumente unter
https://www.ethz.ch/de/studium/didaktische-ausbildung/studienangebot-zulassung/didaktik-zertifikat/dokumente--didaktik-zertifikat-.html
- Raster zum Bericht über das Unterrichtspraktikum im DZ Umweltlehre an der ETH Zürich (PDF)
- Beurteilungsbogen Prüfungslektionen Umweltlehre
- Schriftliche Unterrichtsvorbereitung für Prüfungslektionen (PDF)

Literature
Wird von der Praktikumslehrperson bestimmt.

Environmental Studies TC - Key for Type

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Key for Hours

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ECTS
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
### Mathematics I

**Number:** 401-0251-00L  
**Title:** Mathematics I  
**ECTS:** 6  
**Hours:** 4V+2U  
**Lecturers:** A. Cannas da Silva  

**Abstract:** This course covers mathematical concepts and techniques necessary to model, solve and discuss scientific problems - notably through ordinary differential equations.

**Objective:** Mathematics is of ever increasing importance to the Natural Sciences and Engineering. The key is the so-called mathematical modelling cycle, i.e. the translation of problems from outside of mathematics into mathematics, the study of the mathematical problems (often with the help of high level mathematical software packages) and the interpretation of the results in the original environment.

**Content:**

2. Linear Algebra and Complex Numbers: systems of linear equations, Gauss-Jordan elimination, matrices, determinants, eigenvalues and eigenvectors, cartesian and polar forms for complex numbers, complex powers, complex roots, fundamental theorem of algebra.

3. Ordinary Differential Equations: separable ordinary differential equations (ODEs), integration by substitution, 1st and 2nd order linear ODEs, homogeneous systems of linear ODEs with constant coefficients, introduction to 2-dimensional dynamical systems.

**Literature:**
- Bretscher, O.: Linear Algebra with Applications (Pearson Prentice Hall).
- Oxtoby, Gillis, Nachtrieb, MODERN CHEMISTRY (englisch)
- Housecroft and Constable, CHEMISTRY (englisch)
- Brown, LeMay, Bursten CHEMIE (deutsch)

**Prerequisites / notice:** Prerequisites: familiarity with the basic notions from Calculus, in particular those of function and derivative.

**Lecture notes / Literature:**
- Online-Skript mit durchgerechneten Beispielen.

**Practical work:**
- Developing solutions (design thinking, Checklands’ soft systems methodology).
- Qualitative system modelling (Systaim), preparing reports, posters and presentations, role behaviour and collaboration in groups, inquiry, scientific writing and managing references (by experts of ETH library), the overall topic of the case study, the interpretation of the results in the original environment.

**Content:**
1. Tackling Environmental Problems I  
**ECTS:** 5  
**Hours:** 4G  
**Lecturers:** C. E. Pohl, P. Krütli, B. B. Pearce  

**Abstract:** Each year in the case study we analyse a different problem from the field of sustainable development and develop solutions to it. Students are able:

- to compile a case study dossier for a given topic. The dossier presents (a) the state of knowledge and (b) the need for further knowledge and action,
- to integrate knowledge of diverse perspectives in a qualitative systems model, to identify problems within the system and to suggest possible solutions from a specific stakeholder's perspective,
- to make an inquiry on a given subject, structure the results, interpret the results in relation to the research question, write a report and present the results,
- name the different roles within a group, explain the role(s) they are suited for, self-organise in groups, identify problems of collaboration and constructively address the problems.

**Objective:** In the first semester the students compile what is known about the problem, its causes and possible solutions. Each group of students makes an inquiry to a given part of the overall problem. The inquiry includes a thematic as well as stakeholder analysis.

**Content:** During synthesis week, which takes place during semester break, the results of the different part inquiries are integrated in a qualitative systems model. The students identify specific problems within the system and develop solutions.

Most of the time students work independently in groups. Tutors support the students in key steps. Introductions are given for:

- The overall topic of the case study,
- Inquiry, scientific writing and managing references (by experts of ETH library),
- Role behaviour and collaboration in groups,
- Preparing reports, posters and presentations,
- Qualitative system modelling (Systaim),
- Developing solutions (design thinking, Checklands' soft systems methodology).
The understanding of some basic principles of biology (inheritance, evolution and phylogeny) and an overview of the diversity of life.

The first semester focuses on the organismal biology aspects of genetics, evolution and diversity of life in the Campbell chapters 12-34.


Students are able to explain important properties of the three environmental systems, to discuss critical drivers, trends and conflicts of their use and to compare potential solutions.

Lecture notes
- Slides are provided by instructors and are accessible via moodle.
- no script

Literature
- Natural history books
- Aquatic and terrestrial systems
- Corresponding methods for studying the systems will be presented.
- Corresponding methodological approaches are demonstrated. In a more applied part of the lecture threats to biodiversity and the appropriate management are discussed.

Prerequisites / notice
- The lecture is the first in a series of two lectures given over two semesters for students with biology as a basic subject.

### 701-0243-01L Biology III: Essentials of Ecology

**Objective**
- Übersicht der aquatischen und terrestrischen Lebensräume mit ihren Bewohnern
- Einfluss von Umweltfaktoren (Temperatur, Strahlung, Wasser, Nährstoffe etc.) auf Organismen; Anpassung an bestimmte Umweltbedingungen
- Populationsdynamik: Ursachen, Beschreibung, Vorhersage und Regulation
- Interaktionen zwischen Arten (Konkurrenz, Koexistenz, Prädation, Parasitismus, Nahrungsnetze)
- Lebensgemeinschaften: Struktur, Stabilität, Sukzession
- Ökosysteme: Kompartimente, Stoff- und Energieflusse
- Biodiversität: Variation, Ursachen, Gefährdung und Erhaltung
- Aktuelle Naturschutzprobleme und -massnahmen
- Evolutionäre Ökologie: Methodik, Spezialisierung, Koevolution

**Content**
- Erstes Kapitel: Grundlagen des Ökosystems
- Zweiteter Stoff: Ökologische Systeme
- Drittes Kapitel: Ökologische Systeme
- Vierter Stoff: Ökologische Systeme
- Fünftes Kapitel: Ökologische Systeme
- Sechstes Kapitel: Ökologische Systeme

**Lecture notes**
- Underlagen, Vorlesungsskripten und relevante Literatur sind in der Lehrdokumentenablage abrufbar. Die Unterlagen für die nächste Vorlesung stehen jeweils spätestens am Freitagmorgen zur Verfügung.

**Literature**
The classification and analysis of natural and artificial compounds is a key subject of this course. Students learn to apply selected concepts and tools from computer science for working on interdisciplinary projects. The following topics are covered: modeling and simulations, visualizing multi-dimensional data, managing data with lists and tables and with relational databases, introduction to programming, universal methods for algorithm design.

The students learn to:
- choose and apply appropriate tools from computer science,
- process and analyze real-world data from their subject of study,
- handle the complexity of real-world data,
- know universal methods for algorithm design.

Content:
1. Modeling and simulations
2. Visualizing multidimensional data
3. Data management with lists and tables
4. Data management with a relational database
5. Introduction to macro programming
6. Introduction to programming with Python

Lecture notes:
Lecture notes or other documentation are provided by instructors and accessible via moodle.

Additional First Year Compulsory Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>252-0839-00L</td>
<td>Informatics</td>
<td>O</td>
<td>2</td>
<td>2G</td>
<td>L. E. Fässler, M. Dahinden</td>
</tr>
</tbody>
</table>

Abstract:
Students learn to apply selected concepts and tools from computer science for working on interdisciplinary projects. The following topics are covered: modeling and simulations, visualizing multi-dimensional data, managing data with lists and tables and with relational databases, introduction to programming, universal methods for algorithm design.

Objective:
The students learn to:
- choose and apply appropriate tools from computer science,
- process and analyze real-world data from their subject of study,
- handle the complexity of real-world data,
- know universal methods for algorithm design.

Content:
1. Modeling and simulations
2. Visualizing multidimensional data
3. Data management with lists and tables
4. Data management with a relational database
5. Introduction to macro programming
6. Introduction to programming with Python

Lecture notes:
All materials for the lecture are available at www.evim.ethz.ch.

Lecture notes
The script will be published on the web. Details will be provided on the first day of the semester.

Literature
A thorough study of all script materials is requested before the course starts.

529-0030-00L Laboratory Course: Elementary Chemical Techniques O 3 credits 6P N. Kobot, M. Morbidelli, M. H. Schroth, B. Wehrli

Abstract:
This practical course provides an introduction to elementary laboratory techniques. The experiments cover a wide range of techniques, including analytical and synthetic techniques (e.g. investigation of soil and water samples or the preparation of simple compounds). Furthermore, the handling of gaseous substances is practised.

Objective:
This course is based on application-oriented learning. The students spend most of their time working through projects with data from natural science and discussing their results with teaching assistants. To learn the computer science basics there are electronic tutorials available.

Content:
The classification and analysis of natural and artificial compounds is a key subject of this course. It provides an introduction to elementary laboratory techniques, and the experiments cover a wide range of analytic and synthetic tasks: Selected samples (e.g. soil and water) will be analysed with various methods, such as titrations, spectroscopy or ion chromatography. The chemistry of aqueous solutions (acid-base equilibria and solvatation or precipitation processes) is studied. The synthesis of simple inorganic complexes or organic molecules is practised. Furthermore, the preparation and handling of environmentally relevant gaseous species like carbon dioxide or nitrogen oxides is a central subject of the Praktikum.

Lecture notes:
All materials for the lecture are available at www.evim.ethz.ch.

Lecture notes:
The script will be published on the web. Details will be provided on the first day of the semester.

Literature
The script will be published on the web. Details will be provided on the first day of the semester.

A thorough study of all script materials is requested before the course starts.

751-0801-00L Biology I: Laboratory Exercises O 1 credit 2U E. B. Truernit

Abstract:

Objective:

Content:

Literature
Handouts
For further reading (not obligatory):
Gerhard Wanner; Mikroskopisch-Botanisches Praktikum, Georg Thieme Verlag, Stuttgart.

Prerequisites / notice:
Groups of a maximum of 30 students.

Social Sciences and Humanities

Pflichtteil

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-0757-00L</td>
<td>Principles of Economics</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>R. Schubert</td>
</tr>
</tbody>
</table>

Abstract:
This course covers the bases for understanding micro- and macroeconomic issues and theories. Participants are given the tools to argue in economic and political terms and to evaluate the corresponding measures. Group and individual exercises deepen the knowledge gained.

Objective:
Students are able to:
- describe fundamental micro- and macroeconomic issues and theories,
- apply suitable economic arguments to a given theme,
- evaluate economic measures.

Content:
Supply and demand behaviour of firm and households; market equilibrium and taxation; national income and indicators; inflation; unemployment; growth; macroeconomics policies

Lecture notes:
available on electronic platform

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### Bachelor Studies (Programme Regulations 2011)
#### Basic Courses II

<table>
<thead>
<tr>
<th>Examination Block 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
</tr>
<tr>
<td>402-0063-00L</td>
</tr>
</tbody>
</table>

**Abstract**

Introduction to the "way of thinking" and the methodology in Physics, with the help of demonstration experiments. The Chapters treated are Electromagnetism, Refraction and Diffraction of Waves, Elements of Quantum Mechanics with applications to Spectroscopy, Thermodynamics, Phase Transitions, Transport Phenomena. Whenever possible, examples relevant to the students' main field of study are given.

**Objective**

Introduction to the scientific methodology. The student should develop his/her capability to turn physical observations into mathematical models, and to solve the latter.

**Content**

Elektromagnetismus, Elektromagnetische Wellen, Wellenoptik, Strahlenoptik, Quantenoptik, Quantenmechanik, Thermische Eigenschaften, Transportphänomene, Wärmestrahlung

**Abstract**

Skript wird verteilt.

**Literature**

Friedhelm Kuypers  
Physik für Ingenieure und Naturwissenschaftler  
Band 2 Elektrizität, Optik, Wellen  
Wiley-VCH, 2012  
ISBN 3527411445, 9783527411443

Douglas C. Giancoli  
Physik  
3. erweiterte Auflage  
Pearson Studium

Hans J. Paus  
Physik in Experimenten und Beispielen  
Carl Hanser Verlag, München, 2002, 1068 S.

Paul A. Tipler  
Physik  
Spektrum Akademischer Verlag, 1998, 1522 S., ca Fr. 120.-

David Halliday, Robert Resnick, Jearl Walker  
Physik  
Wiley-VCH, 2003, 1388 S., Fr. 87.- (bis 31.12.03)

dazu gratis Online Ressourcen (z.B. Simulationen): www.halliday.de

| 701-0245-00L | Introduction to Evolutionary Biology | O | 2 credits | 2V | G. Velicer, S. Wielgoss |

**Abstract**

This course introduces important questions about the evolutionary processes involved in the generation and maintenance of biological diversity across all domains of life and how evolutionary science investigates these questions.

**Objective**

This course introduces important questions about the evolutionary processes involved in the generation and maintenance of biological diversity across all domains of life and how evolutionary science investigates these questions. The topics covered range from different forms of selection, phylogenetic analysis, population genetics, life history theory, the evolution of sex, social evolution to human evolution. These topics are important for the understanding of a number of evolutionary problems in the basic and applied sciences.

**Content**

Topics likely to be covered in this course include research methods in evolutionary biology, adaptation, evolution of sex, evolutionary transitions, human evolution, infectious disease evolution, life history evolution, macroevolution, mechanisms of evolution, phylogenetic analysis, population dynamics, population genetics, social evolution, speciation and types of selection.

**Literature**

Textbook:  
Evolutionary Analysis  
Scott Freeman and Jon Herron  

**Prerequisites / notice**

The exam is based on lecture and textbook.

| 701-0255-00L | Biochemistry | O | 2 credits | 2V | H.P. Kohler |

**Abstract**

Building on the biology courses in the 1st and 2nd semesters, this course covers basic biochemical knowledge in the areas of enzymology and metabolism. Those completing the course are able to describe and understand fundamental cellular metabolic processes.

**Objective**

Students are able to understand  
- the structure and function of biological macromolecules  
- the kinetic bases of enzyme reactions  
- thermodynamic and mechanistic basics of relevant metabolic processes

Students are able to describe the relevant metabolic reactions in detail.
## Program

**Introduction, basics, composition of cells, biochemical units, repetition of relevant organic chemistry**
- Structure and function of proteins
- Carbohydrates
- Lipids and biological membranes
- Enzymes and enzyme kinetics
- Catalysis

**Metabolism**: Basic concepts and design. Repetition of basic thermodynamics
- Glycolysis, fermentation
- The citric acid cycle
- Oxidative phosphorylation
- Fatty acid metabolism

**Teaching of basic knowledge in microbiology. C. Roques**

**Atmosphere**: Teaching of basic knowledge in microbiology with main focus on Microbial Cell Structure and Function, Molecular Genetics, Microbial Growth, Metabolic Diversity, Phylogeny and Taxonomy, Prokaryotic Diversity, Human-Microbe Interactions, Biotechnology.

**Objective**: Teaching of basic knowledge in microbiology.

**Content**: Der Schwerpunkt liegt auf den Themen: Bakterielle Zellbiologie, Molekulare Genetik, Wachstumsphysiologie, Biochemische Diversität, Phylogenie und Taxonomie, Prokaryotische Vielfalt, Interaktion zwischen Menschen und Mikroorganismen sowie Biotechnologie.

**Lecture notes**: Horton et al. (Pearson) serves as lecture notes.

**Prerequisites / notice**: Basic knowledge in biology and chemistry is a precondition.

### Examination Block 2

**752-4001-00L Microbiology**

**Abstract**: Teaching of basic knowledge in microbiology with main focus on Microbial Cell Structure and Function, Molecular Genetics, Microbial Growth, Metabolic Diversity, Phylogeny and Taxonomy, Prokaryotic Diversity, Human-Microbe Interactions, Biotechnology.

**Objective**: Teaching of basic knowledge in microbiology.

**Content**: Der Schwerpunkt liegt auf den Themen: Bakterielle Zellbiologie, Molekulare Genetik, Wachstumsphysiologie, Biochemische Diversität, Phylogenie und Taxonomie, Prokaryotische Vielfalt, Interaktion zwischen Menschen und Mikroorganismen sowie Biotechnologie.

**Lecture notes**: Wird von den jeweiligen Dozenten ausgegeben.

**Literature**: Die Behandlung der Themen erfolgt auf der Basis des Lehrbuchs Brock, Biology of Microorganisms

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**701-0023-00L Atmosphere**

**Abstract**: Basic principles of the atmosphere, physical structure and chemical composition, trace gases, atmospheric cycles, circulation, stability, radiation, condensation, clouds, oxidation capacity and ozone layer.

**Objective**: Basic principles of the atmosphere, physical structure and chemical composition, trace gases, atmospheric cycles, circulation, stability, radiation, condensation, clouds, oxidation capacity and ozone layer.

**Content**: Basic principles of the atmosphere, physical structure and chemical composition, trace gases, atmospheric cycles, circulation, stability, radiation, condensation, clouds, oxidation capacity and ozone layer.

**Lecture notes**: Written information will be supplied.

**Literature**: 

**701-0071-00L Mathematics III: Systems Analysis**

**Abstract**: The objective of the systems analysis course is to deepen and illustrate the mathematical concepts on the basis of a series of very concrete examples. Topics covered include: linear box models with one or several variables, non-linear box models with one or several variables, time-discrete models, and continuous models in time and space.

**Objective**: Learning and applying of concepts (models) and quantitative methods to address concrete problems of environmental relevance. Understanding and applying the systems-analytic approach, i.e., Recognizing the core of the problem - simplification - quantitative approach - prediction.

**Content**: http://www.up.ethz.ch/education/systems-analysis.html

**Lecture notes**: Overhead slides will be made available through Ilias.


**701-0401-00L Hydrosphere**

**Abstract**: Qualitative and quantitative understanding of the physical processes that control the terrestrial water cycle. Energy and mass exchange, mixing and transport processes are described and the coupling of the hydrosphere with the atmosphere and the solid Earth are discussed.

**Objective**: Qualitative and quantitative understanding of the physical processes that control the terrestrial water cycle. Energy and mass exchange, mixing and transport processes are described and the coupling of the hydrosphere with the atmosphere and the solid Earth are discussed.

**Content**: Topics of the course.
- Physical properties of water (i.e. density and equation of state)
- Global water resources
- Exchange at boundaries
- Energy (thermal & kinetic), gas exchange
- Mixing and transport processes in open waters
- Vertical stratification, large scale transport
- Turbulence and mixing
- Mixing and exchange processes in rivers
- Groundwater and its dynamics
- Ground water as part of the terrestrial water cycle
- Ground water hydraulics, Darcy's law
- Aquifers and their properties
- Hydrochemistry and tracer
- Ground water use

**Case studies**: 1. Water as resource, 2. Water and climate

**Lecture notes**: In addition to the suggested literature handouts are distributed.

**Suggested literature**:
Prerequisites / notice  The case studies and the analysis of the questions and problems are integral part of the course.

701-0501-00L Pedosphere  O  3 credits  2V  R. Kretzschmar

Abstract  Introduction to the formation and properties of soils as a function of parent rock, landscape position, climate, and soil organisms. Complex relationships between soil forming processes, physical and chemical soil properties, soil biota, and ecological soil properties are explained and illustrated by numerous examples.

Objective  Introduction to the formation and properties of soils as a function of parent rock, landscape position, climate, and soil organisms. Complex relationships between soil forming processes, physical and chemical soil properties, soil biota, and ecological soil properties are explained and illustrated by numerous examples.

Content  Definition of the pedosphere, soils, functions, rocks as parent materials, minerals and weathering, soil organisms, soil organic matter, physical soil properties and functions, chemical soil properties and functions, soil formation, principles of soil classification, global soil regions, soil fertility, land use and soil degradation.

Lecture notes  Lecture notes can be purchased during the first lecture (15.- SFr)


Prerequisites / notice  Prerequisites: Basic knowledge in chemistry, biology and geology.

Additional Compulsory Courses

Number  Title  Type  ECTS  Hours  Lecturers

701-0033-00L Laboratory Course in Physics for Students of Environmental Sciences  O  2 credits  4P  M. Münnich, A. Biland, N. Gruber

Abstract  The course provides an individual experience of physical phenomena and the basic principles of experiments. By carrying out simple physical experiments the students learn the proper use measuring instruments, the correct evaluation of report of the measured data and how to interpret the final results.

Objective  This laboratory course aims to provide basic knowledge of
- the setup of a physics experiment,
- the use of measurement instruments,
- various measuring techniques,
- the analysis or measurement errors,
- and the interpretations of the measured quantities.

Content  The students select 8 out of 20 experiments which they like to conduct. For each of these experiments the students will analyze the data they measure estimate the error of there measurements and compare these with the physical theory. Additionally each student will present one of their experiments in a seminar.

Lecture notes  Manuals for the experiments are provided online.

701-0035-00L Integrated Practical Observation Networks  O  1.5 credits  4P  J. Henneberger, T. Tormann

Abstract  Observation networks - the combination of individual instruments - are the starting point of quantitative environmental studies. The structure and idiosyncrasies of existing observation networks are shown. When working in individual experiments on practical problems, various types of observation networks are dealt with; questions related to data quality and data availability are discussed.

Objective  Getting acquainted with existing networks. Insight into problems related to measuring and interpreting multi-dimensional fields of atmospheric physical, atmospheric chemical, and geophysical parameters.

Content  Observation networks for atmospheric physical, atmospheric chemical, geophysical, hydrological and climatological parameters on different scales (synoptic: 1000 km; mesoscale: 100 km, and microscale: 100 m). Combination of surface observation with remotely sensed data (satellite, radar). Solving interpolation problems in multi-dimensional fields of the observed variables. Assessing the representativity of local values, i.e., the directly observed variable in an observation network.

Lecture notes  The script is published anew every year. Apart from the description of the scientific problems to be worked on in individual experiments, it contains some theoretical chapters on observation networks, as well as guidelines for writing and publishing scientific papers. The script can be downloaded as pdf from the course webpage.

Literature  Literature is listed in the script.

Social Sciences and Humanities Module

Module Economics

Compulsory Courses

Number  Title  Type  ECTS  Hours  Lecturers

363-0387-00L Corporate Sustainability  O  3 credits  2G  V. Hoffmann

Abstract  The lectures addresses the assessment of corporate sustainability and its links to strategy, technology, and finance. Students learn why sustainability matters for managers and how businesses can act towards it. E-modules allow students to train critical thinking skills. In the 2nd half of the semester, sustainability challenges on water, energy, mobility, and food are explored in group projects.

Objective  Understand the limits and the potential of corporate sustainability for sustainable development

Content  Develop critical thinking skills (argumentation, communication, evaluative judgment) that are useful in the context of corporate sustainability using an innovative writing and peer review method.

Be able to recognize and realize opportunities for corporate sustainability in a business environment

Overview of the key concepts of corporate sustainability and topics related to Water, Energy, Mobility, and Food

Business implications of sustainable development, in particular for the assessment of sustainability performance, strategic change towards sustainability, technological innovations and sustainability, and finance and corporate sustainability.

Critical thinking skills for corporate sustainability.

In-depth case studies of corporate sustainability challenges in the track phase: How to deal with environmental pressure groups? How to use the strengths of business to solve pressing sustainability problems? How to catalyze technological innovations for sustainability? How to invest money in a sustainable way?

Lecture notes  Presentation slides will be made available on moodle prior to lectures.

Literature  Literature recommendations will be distributed during the lecture

751-1551-00L Ressourcen- und Umweltökonomie  O  3 credits  2V  L. Bretschger, A. Müller
Abstract
Relationship between economy and environment, market failure, external effects and public goods, contingent valuation, internalisation of externalities; economics of non-renewable resources, economics of renewable resources, cost-benefit analysis, sustainability, and international aspects of resource and environmental economics.

Objective
Understanding of the basic issues and methods in resource and environmental economics; ability to solve typical problems in the field using the appropriate tools, which are concise verbal explanations, diagrams or mathematical expressions.

Topics are:
- Introduction to resource and environmental economics
- Importance of resource and environmental economics
- Main issues of resource and environmental economics
- Normative basis
- Utilitarianism
- Feasibility according to Rawls
- Economic growth and environment
- Externalities in the environmental sphere
- Governmental internalisation of externalities
- Private internalisation of externalities: the Coase theorem
- Free rider problem and public goods
- Types of public policy
- Efficient level of pollution
- Tax vs. permits
- Command and Control Instruments
- Empirical data on non-renewable natural resources
- Optimal price development: the Hotelling-rule
- Effects of exploration and Backstop-technology
- Effects of different types of markets.
- Biological growth function
- Optimal depletion of renewable resources
- Social inefficiency as result of over-use of open-access resources
- Cost-benefit analysis and the environment
- Measuring environmental benefit
- Measuring costs
- Concept of sustainability
- Technological feasibility
- Conflicts sustainability / optimality
- Indicators of sustainability
- Problem of climate change
- Cost and benefit of climate change
- Climate change as international ecological externality
- International climate policy: Kyoto protocol
- Implementation of the Kyoto protocol in Switzerland

Content
- Economy and natural environment, welfare concepts and market failure, external effects and public goods, measuring externalities and contingent valuation, internalising external effects and environmental policy, economics of non-renewable resources, renewable resources, cost-benefit-analysis, sustainability issues, international aspects of resource and environmental problems, selected examples and case studies.

Lecture notes
The script and lecture material are provided at: https://moodle-app2.let.ethz.ch/course/view.php?id=140

Literature

Core Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-0763-00L</td>
<td>Basic Concepts of Management</td>
<td>W</td>
<td>2 credits</td>
<td>2V</td>
<td>R. Schwarzenbach</td>
</tr>
</tbody>
</table>

Abstract
This course deals with fundamental and proven management concepts. The lecturers emphasize the practical applicability of concepts. The course was designed in close cooperation with practitioners; e.g. Mr. S. Baldenweg, mechanical engineer ETH, MBA Insead, share his experience in several guest lectures.

Objective
Students:
will be familiar with basic general management concepts.
learn about the fundamental concepts of strategy development with practical examples.
will get to know the basic organisational issues and the essential types of organisations.
get a rough overview on the concepts of financial management.
will learn about the strategic positioning of small departments within larger organisations.
will learn about the fundamental mechanisms for handling change, and will be able to recognise these situations.
will learn the basic principles of project management and of successful self-management.
will reflect on customer oriented information representation.

Content


Lecture notes
Skriften werden elektronisch zur Verfügung gestellt.

Literature
Empfohlen werden folgende Titel für die Vertiefung einzelner Themen:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Objective</th>
<th>Content</th>
<th>Literature</th>
<th>Prerequisites / notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0757-00L</td>
<td>Environmental Management</td>
<td>Overview on environmental management and environmental management systems, general methods and principles.</td>
<td>Introduction to environmental management / environmental management systems, energy and material flows; economical and ecological problems in industry; characterization of an enterprise (incl. management handbook); structure and contents of an environmental management system; overview on the ISO 14001 ff. series; methods for environmental evaluation and assessment; integrated management systems; planning methodology and life-cycle-design design; planning example</td>
<td>Information about environmental management and environmental management systems will be provided by a CD or mail.</td>
<td>Delivery of a case study, worked out in groups. Language: Teaching in English on request.</td>
</tr>
<tr>
<td>351-0778-00L</td>
<td>Discovering Management</td>
<td>Discovering Management combines in an innovative format a set of lectures and an advanced business game. The learning model for Discovering Management involves 'learning by doing'. The objective is to introduce the students to the relevant topics of the management literature and give them a good introduction in entrepreneurship topics too. The course is a series of lectures on the topics of strategy, innovation, corporate finance, leadership, design thinking and corporate social responsibility. While the 14 different lectures provide the theoretical and conceptual foundations, the experiential learning outcomes result from the interactive business game. The purpose of the business game is to analyse the innovative needs of a large multinational company and develop a business case for the company to grow. This business case is as relevant to someone exploring innovation within an organisation as it is if you are planning to start your own business. By discovering the key aspects of entrepreneurial management, the purpose of the course is to advance students' understanding of factors driving innovation, entrepreneurship, and company success.</td>
<td>Discovering Management aims to broaden the students' understanding of the principles of business management, emphasizing the interdependence of various topics in the development and management of a firm. The lectures introduce students not only to topics relevant for managing large corporations, but also touch upon the different aspects of starting up your own venture. The lectures will be presented by the respective area specialists at D-MTEC. The course broadens the view and understanding of technology by linking it with its commercial applications and with society. The lectures are designed to introduce students to topics related to strategy, corporate innovation, leadership, corporate and entrepreneurial finance, value chain analysis, corporate social responsibility, and business model innovation. Practical examples from industry experts will stimulate the students to critically assess these issues. Creative skills will be trained by the business game exercise, a participant-centered learning activity, which provides students with the opportunity to place themselves in the role of Chief Innovation Officer of a large multinational company. As they learn more about the specific case and identify the challenge they are faced with, the students will have to develop an innovative business case for this multinational corporation. Doing so, this exercise will provide an insight into the context of managerial problem-solving and corporate innovation, and enhance the students' appreciation for the complex tasks companies and managers deal with. The business game presents a realistic model of a company and provides a valuable learning platform to integrate the increasingly important development of the skills and competencies required to identify entrepreneurial opportunities, analyse the future business environment and successfully respond to it by taking systematic decisions, e.g. critical assessment of technological possibilities.</td>
<td>Discovering Management is designed to suit the needs and expectations of Bachelor students at all levels as well as Master and PhD students not belonging to D-MTEC. By providing an overview of Business Management, this course is an ideal enrichment of the standard curriculum at ETH Zurich. No prior knowledge of business or economics is required to successfully complete this course.</td>
<td></td>
</tr>
<tr>
<td>351-0778-01L</td>
<td>Discovering Management (Exercises)</td>
<td>Complementary exercises for the module Discovering Management.</td>
<td>This course is offered complementary to the basis course 351-0778-00L, &quot;Discovering Management&quot;. The course offers additional exercises and case studies.</td>
<td>This course is offered to complement the course 351-0778-00L. The course offers additional exercises and case studies.</td>
<td>Please refer to the course website for further information on the content, credit conditions and schedule of the module: <a href="http://www.dm.ethz.ch">www.dm.ethz.ch</a></td>
</tr>
<tr>
<td>363-0503-00L</td>
<td>Principles of Microeconomics</td>
<td>The course introduces basic principles, problems and approaches of microeconomics.</td>
<td>(1) Students must be able to discuss basic principles, problems and approaches in microeconomics. (2) Students can analyse and explain simple economic principles in a market using supply and demand graphs. (3) Students can contrast different market structures and describe firm and consumer behaviour. (4) Students can identify market failures such as externalities related to market activities and illustrate how these affect the economy as a whole. (5) Students can apply simple mathematical treatment of some basic concepts and can solve utility maximization and cost minimization problems.</td>
<td>Lecture notes, exercises and reference material can be downloaded from Moodle.</td>
<td></td>
</tr>
</tbody>
</table>
Module Political and Social Sciences

Core Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-0727-00L</td>
<td>Politics of Environmental Problem Solving in Developing Countries</td>
<td>W</td>
<td>2 credits</td>
<td>2G</td>
<td>U. Scheidegger</td>
</tr>
</tbody>
</table>

Abstract

The course focuses on processes and decision-making on natural resources management issues in developing countries. It gives insights into the relevance of ecological aspects in developing countries. It covers concepts, instruments, processes and actors in environmental politics at the example of specific environmental challenges of global importance.

Prerequisites / notice

Students attending this course and passing the required tests (one in the middle, the other at the end of the semester) will obtain 4 ECTS credit points.
### Objective
After completion of the module, students will be able to:
- Identify and appraise ecological aspects in development cooperation, development policies and developing countries\' realities
- Analyze the forces, components and processes, which influence the design, the implementation and the outcome of ecological measures
- Characterize concepts, instruments and drivers of environmental politics and understand, how policies are shaped, both at national level and in multilateral negotiations
- Study changes (improvements) in environmental politics over time as the result of the interaction of processes and actors, including international development organizations
- Analyze politics and design approaches to influence them, looking among others at governance, social organization, legal issues and institutions

### Content
Key issues and basic concepts related to environmental politics are introduced. Then the course predominantly builds on case studies, providing information on the context, specifying problems and potentials, describing processes, illustrating the change management, discussing experiences and outcomes, successes and failures. The analysis of the cases elucidates factors for success and pitfalls in terms of processes, key elements and intervention strategies.

Different cases not only deal with different environmental problems, but also focus on different levels and degrees of formality. This ranges from local interventions with resource user groups as key stakeholders, to country level policies, to multi- and international initiatives and conventions. Linkages and interaction of the different system levels are highlighted. Special emphasis is given to natural resources management.

The cases address the following issues:
- Land use and soil fertility enhancement: From degradation to sustainable use
- Common property resource management (forest and pasture): Collective action and property rights, community-based management
- Ecosystem health (integrated pest management, soil and water conservation)
- Payment for environmental services: Successes in natural resources management
- Climate change and agriculture: Adaptation and mitigation possibilities
- Biodiversity Convention: Implications for conservations and access to genetic resources
- Biodiversity as a means for more secure livelihoods: Agroforestry and intercropping
- The Millennium Development Goals: Interactions between poverty and the environment
- Poverty and natural resources management: Poverty reduction strategies, the view of the poor themselves
- Food security: Policies, causes for insecurity, the role of land grabbing
- Biofuels and food security: Did politics misfire?
- Strategy development at global level: IAASTD and World Development Report 2008

### Literature

### Prerequisites / notice
The performance assessment will consist of an individual essay to be written by each student based on at least five references in addition to the sources provided in the course. Students can choose from a list of topics. Criteria for assessment will be communicated at the beginning of the course.

### 701-0731-00L Environmental Behavior in Social Context

<table>
<thead>
<tr>
<th>Content</th>
<th>Objective</th>
<th>Prerequisites / notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overview on current fields of research and their relevance for practical application</td>
<td>This introductory class in the environmental social sciences covers topics such as environmental behavior, environmental concern, social dilemmas and social norms.</td>
<td>The central findings of sociological studies.</td>
</tr>
</tbody>
</table>

### 701-0985-00L Social Intercourse with Current Environmental Risks

<table>
<thead>
<tr>
<th>Content</th>
<th>Objective</th>
<th>Lecture notes</th>
<th>Prerequisites / notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic knowledge of the environmental social sciences</td>
<td>Getting acquainted to the extended risk concept</td>
<td>Copies of slides and selected documents will be distributed</td>
<td>The lecture is held biweekly (for 2 hours). The dates are 26.9., 3.10. (out of schedule), 24.10, 7.11, 21.11, 5.12, 19.12</td>
</tr>
<tr>
<td>Overview on current fields of research and their relevance for practical application</td>
<td>Evaluation of the risks caused by technology within the societal context</td>
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</tbody>
</table>

### 227-0802-02L Sociology

<table>
<thead>
<tr>
<th>Content</th>
<th>Objective</th>
<th>Prerequisites / notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Various studies are used to introduce basic sociological concepts, theories and empirical research methods, along with selected sociological topics. The goal of the course is to provide participants with an understanding of working practice in empirical sociology and the central findings of sociological studies.</td>
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</table>

- **Data: 06.03.2019 12:57**
- **Autumn Semester 2016**
- **Page 1471 of 1571**
**Objective**

To learn about methods of empirical social research and key results of classic and modern sociological studies.

**Content**


Folgende Themen werden behandelt:

3. Der Beitrag der Sozialtheorie. Vorstellung und Diskussion ausgewählter Studien zu einzelnen Themenbereichen, z.B.: (1) Die Entstehung sozialer Kooperation, (2) Reputations- und Märkte, (3) Soziale Netzwerke u.a.m.

**Lecture notes**

Folien der Vorlesung und weitere Materialien (Fachartikel, Kopien aus Büchern) werden auf der Webseite der Vorlesung zum Download gestellt.

**Literature**

Folien der Vorlesung und weitere Materialien (Fachartikel, Kopien aus Büchern) werden auf der Webseite der Vorlesung zum Download zur Verfügung gestellt.

**Prerequisites / notice**

Interesse am Thema und Bereitschaft zum Mitdenken.

---

**Digital Sustainability in the Knowledge Society**

At the heart of the discourse is the handling of digital goods and intellectual property in society. Digitization and the Internet allow handling of digital goods of knowledge or culture (as text, audio, video, images) within minutes. You can make perfect copies of high-value digital goods of knowledge or culture (as text, audio, video, image or software) and distribute them around the globe for free. "Digitization plus Internet" allows for the first time in humankind's history the (theoretically) free access and global exchange of knowledge at minimal cost. A tremendous opportunity for societal development, in north and south. «Cool, so what's the problem?»

The problem is, that this reality poses a fundamental threat to today's business models of the knowledge and culture industries (starting from the music label and Hollywood, via publishers, up to software vendors). Powerful commercial interests are at stake as «knowledge» (the fourth factor of production) will become even more important in the 21st century. Accordingly, «piracy» and «file-sharing» are attacked with all means. At the core lies the question about the design of property in digital assets. For that, we apply a concept of «intellectual property», which is several hundred years old and does not address digital reality in an adequate manner, sometimes leading to absurd situations. Its original goal seems to get forgotten: to help society develop by spreading knowledge as much as possible. But exactly these invisible difficulties in recognizing these, often hidden, restrictions and in evaluating their societal relevance. But exactly these invisible restrictions and in evaluating their societal relevance.

Which cooperate and the respective public policies are effective and/or efficient.

Particularly suitable for students of D-ITET, D-USYS.

**Lecture notes**

Technical reality: Within minutes you can make perfect copies of high-value digital goods of knowledge or culture (as text, audio, video, image or software) and distribute them around the globe for free. «Digitization plus Internet» allows for the first time in humankind's history the (theoretically) free access and global exchange of knowledge at minimal cost. A tremendous opportunity for societal development, in north and south. «Cool, so what's the problem?»

The problem is, that this reality poses a fundamental threat to today's business models of the knowledge and culture industries (starting from the music label and Hollywood, via publishers, up to software vendors). Powerful commercial interests are at stake as «knowledge» (the fourth factor of production) will become ever more important in the 21st century. Accordingly, «piracy» and «file-sharing» are attacked with all means. At the core lies the question about the design of property in digital assets. For that, we apply a concept of «intellectual property», which is several hundred years old and does not address digital reality in an adequate manner, sometimes leading to absurd situations. Its original goal seems to get forgotten: to help society develop by spreading knowledge as much as possible. But exactly these invisible difficulties in recognizing these, often hidden, restrictions and in evaluating their societal relevance. But exactly these invisible restrictions and in evaluating their societal relevance.

Which cooperate and the respective public policies are effective and/or efficient.

Particularly suitable for students of D-ITET, D-USYS.

**Prerequisites / notice**

Interesse am Thema und Bereitschaft zum Mitdenken.

---

**International Environmental Politics**

This course focuses on the conditions under which cooperation in international environmental politics emerges and the conditions under which such cooperation and the respective public policies are effective and/or efficient.

**Lecture notes**

Slides and other material (both usually in English) will be made available on a weekly basis as the lecture proceeds.

Content of the following books is covered in the course (PDFs freely available online):


Other recommended books are:

1. (general) Chris DiBona et al., Open Sources: Voices from the Open Source Revolution, O'Reilly, 1999.

For administrative and didactic reasons (high level of interaction and credit group assignments on current hot topics), the number of participants is limited to 45.

Of course, any interested person is invited to attend the lecture without doing the group assignment. The website is actively used for the preparation.

**Prerequisites / notice**

Interesse am Thema und Bereitschaft zum Mitdenken.
The objectives of this course are to (1) gain an overview of relevant questions in the area of international environmental politics from a social sciences viewpoint; (2) learn how to identify interesting/innovative questions concerning this policy area and how to answer them in a methodologically sophisticated way; (3) gain an overview of important global and regional environmental problems. The course is open to all ETH students. Participation does not require previous coursework in the social sciences. After passing an end-of-semester test (requirement: grade 4.0 or higher) students will receive 3 ECTS credit points. The workload is around 90 hours (meetings, reading assignments, preparation of test).

Visiting students (e.g., from the University of Zurich) are subject to the same conditions. Registration of visiting students in the web-based system of ETH is compulsory.

Assigned reading materials and slides will be available at http://www.ib.ethz.ch/teaching.html (select link ‘Registered students, please click here for course materials’ at top of that page). Log in with your nethz name and password. Questions concerning access to course materials can be addressed to Mike Hudecheck (Mike Hudecheck <michaehu@student.ethz.ch>). All assigned papers must be read ahead of the respective meeting. Following the course on the basis of on-line slides and papers alone is not sufficient. Physical presence in the classroom is essential. Many books and journals covering international environmental policy issues can be found at the D-GESS library at the IFW building, Haldeneggsteig 4, B-floor, or in the library of D-USYS.

Einführung in die psychologische Forschung und Modellbildung unter besonderer Berücksichtigung der kognitiven Psychologie und des Verhaltensmodells. In the classroom, students will learn to formulate a problem for psychological investigation and apply basic forms of psychological experiment. Students are able to:

- describe the areas, concepts, theories, methods and findings of psychology.
- structure the conclusions and significance of an experiment. according to a theory of psychology.
- formulate a problem for psychological investigation.  
- apply basic forms of psychological experiment.

Einführung in die psychologische Forschung und Modellbildung unter besonderer Berücksichtigung der kognitiven Psychologie und des Verhaltensmodells. Themen sind u. a.: Wahrnehmung; Lernen und Entwicklungen; Denken und Problemlösung; Kognitive Sozialpsychologie; Risiko und Entscheidung. 

We will discuss new trends in environmental communication with the focus on integral solutions. We will discuss how to handle tools and concepts in environmental communication. And you can evaluate communication projects. We also discuss the evolution of consciousness.

**Module Individual Sciences**

**Core Courses**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-0771-00L</td>
<td>Environmental Conciousness and Public Relations</td>
<td>W</td>
<td>2 credits</td>
<td>2G</td>
<td>R. Locher</td>
</tr>
</tbody>
</table>

*Number of participants limited to 60.*

Sign in until 29.09.2016. Please describe your expectations. Why do want to attend this special topic? Do you have any pre-information about the integral model? Do you have any practical experience in environmental communication?

*Abstract* 

"Environmental Conciousness and Public Relations" shows how to communicate about environment and sustainability successfully. We look at campaigns, exhibitions and other public relations measures to learn, how to design and realize good communication.

*Objective* 

You learn how to handle tools and concepts in environmental communication. And you can evaluate communication projects. We also discuss the evolution of consciousness.

*Content* 

- Methods and tools in environmental communication.
- Marketing mix
- Examples of campaigns, events, print products, media relations.
- Integral sustainability

*Notice* 

We will discuss new trends in environmental communication with the focus on integral solutions.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
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<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-0785-00L</td>
<td>Environmental and Science Communication</td>
<td>W</td>
<td>4 credits</td>
<td>2V</td>
<td>M. Schäfer</td>
</tr>
</tbody>
</table>

*Number of participants limited to 120.* 60 ETH students and 60 UZH students. The time (date and exact time) of enrolment is decisive. If there are less than 60 enrolments of one group either ETH or UZH students then the available spaces will be given to the other group.

ATTENTION: Enrolment of this course unit is only possible from August 31 until September 14, 2016.
The course gives an introductionary overview in research questions, theoretical perspectives and empirical results of science communication and environmental communication. They will be illustrated by concrete examples and via lectures from external guests.

Abstract

The course gives an introductionary overview in research questions, theoretical perspectives and empirical results of science communication and environmental communication. They will be illustrated by concrete examples and via lectures from external guests.

Objective

Goals: Learning to understand structures and processes of environmental and science communication, becoming more sensitive for problems of science public relations, getting an insight into public debates about environmental issues.

Methods: invitation of media practitioners and experts, discussions, lectures on key theoretical concepts of communication.

Topics: Concrete communication instruments like media conferences, theoretical perspectives of public relations, basic principles and examples of information campaigns, environment and science as media topics, functions and structures of science communication, relations between science, media and politics.

Content

I. Introduction
- Topics: Environment, Science, Risks, Media
- Forms, Functions, Effects of Public and Mass Communication

II. Stakeholders and their Public Relations Efforts
- Public Relations and Science PR: Theoretical Perspectives, Instruments

III. Science and Environmental Issues in the Media
- Forms and Functions of Science Journalism
- Problems of Selection, Interpretation, Quality
- Media Content Analysis
- Online Communication

IV. Uses and Effects of Science and Environmental Communication
- Extent of Media Use
- Effects on Knowledge, Risk Perceptions, Environmental Attitudes
- Effects on Science itself

Lecture notes

Literature

Rödder, Simone / Franzen, Martina / Weingart, Peter (Hg.): The Sciences’ Media Connection - Public Communication and its Repercussions. Dordrecht, S. 95-89.

Prerequisites / notice

Voraussetzungen: Die Vorlesung hat einführenden Charakter.
A list of introductory literature and handbooks will be distributed to the students.

Further optional exercises accompany the lecture and offer the opportunity for an in-depth discussion of selected texts from the reader. Students receive an additional credit point. They have to sign up separately for the exercises for the course 701-0701-01 U.

### 701-0703-00L Environmental Ethics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-0703-00L</td>
<td>Environmental Ethics</td>
<td>O</td>
<td>2</td>
<td>V</td>
<td>M. Huppenbauer</td>
</tr>
</tbody>
</table>

**Abstract**

The lecture begins with an introduction to applied ethics in general. The main focus is on environmental ethics. Students learn to handle important concepts and positions of environmental ethics. They achieve a deeper understanding of these concepts and positions in applying them to ecological problems and discussing them in case studies.

**Objective**

On completion of this lecture course you will have acquired the ability to identify and process general and environmental ethical problems. You will be capable of recognising and analysing environmental ethical problems and of working towards a solution. You will have acquired a fundamental knowledge of standpoints and argumentations to be found within the field of environmental ethics and will have practised these in small case studies.

**Content**

- Introduction to general and applied ethics.
- Overview and discussion of ethical theories relevant to the environment.
- Familiarisation with various basic standpoints within environmental ethics.
- Cross-section topics, such as sustainability, intergenerational justice, protection of species, etc.
- Practising of newly acquired knowledge in case studies (protection of species, climate change, etc.).

**Lecture notes**

Summaries of the individual sessions will be distributed, including the most important theories and keywords; reading list.

- Andrew Light/Holmes Rolston III, Environmental Ethics: An Anthology, 2003
- John O'Neill et al., Environmental Values, 2008
- Klaus Peter Rippe, Ethik im ausserhumanen Bereich, Paderborn (mentis) 2008

Generel introductions:

- Johann S. Ach et. al (Hrsg.), Grundkurs Ethik 1. Grundlagen, Paderborn (mentis) 2008

**Literature**

- Uekötter, Frank (Ed.) 2010. The turning points of environmental history, Pittsburgh: University of Pittsburgh Press.

**Prerequisites / notice**

The procedure for accumulating CP will be explained at the start of term.

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### Core Courses

#### Number

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>701-0701-01L</td>
<td>Philosophy of Science: Exercises</td>
<td>W</td>
<td>1</td>
<td>U</td>
<td>G. Hirsch Hadorn. C. J. Baumberger</td>
</tr>
<tr>
<td>701-0791-00L</td>
<td>Environmental History - Introduction and Overview</td>
<td>W</td>
<td>2</td>
<td>V</td>
<td>D. Speich Chassé</td>
</tr>
</tbody>
</table>

**Abstract**

The exercises in philosophy of science serve to develop skills in critical thinking by discussing seminal texts about the rationality of science. Topics discussed include the significance and limits of empirical, mathematical and logical methods, as well as problems and ethical issues raised by the use of science in society.

**Objective**

Students can engage with problems in the philosophy of science and to relate them to natural and environmental sciences. They learn to analyze and summarize philosophical texts. In this way, they develop their skills in critical thinking with a focus on the rationality of science.

**Content**

The optional exercises accompany the lecture and serve to develop skills in critical thinking with a focus on the rationality of science, based on discussing seminal texts. The texts cover important positions in the philosophy of science and their critics. Topics discussed include the significance and limits of empirical, mathematical and logical methods, as well as problems and ethical issues raised by the use of science in society.

**Lecture notes**

A reader will be available for students.

**Literature**

A list of literature will be distributed to the students together with the reader.

**Prerequisites / notice**

Students that want to subscribe for this course also have to subscribe for the lecture 701-0701-00 V "Wissenschaftsphilosophie". Credit points are given for preparing a structure and a summary of one of the texts.

#### Number

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<tr>
<th>Number</th>
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</thead>
<tbody>
<tr>
<td>701-0791-00L</td>
<td>Environmental History - Introduction and Overview</td>
<td>W</td>
<td>2</td>
<td>V</td>
<td>D. Speich Chassé</td>
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</tbody>
</table>

**Abstract**

Our society faces a serious ecological crisis. Of what historical dimension is this crisis? How have human societies already in earlier times changed their environment, and, consequently, perhaps also ours? What were the main ecological challenges for societies and how did they change over time? And how did societies adapt to changing environmental conditions?

**Objective**

Introduction into environmental history; survey of long-term development of human-nature-interrelations; discussion of selected problems. Improved ability to assess current problems from a historical perspective and to critically interrogate one’s own standpoint.

**Lecture notes**

Course material is provided on OLAT.

**Literature**


**Prerequisites / notice**


Students are asked to write an exam during the second last session (11.12.2015).

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### Compulsory Electives D-GESS SIP (For All Modules Eligible)

- Political Science
- Law
- Sociology
- Economy
- Psychology, Pedagogics
- History
- Philosophy
- Science Research

### Natural Science and Technical Electives

#### Natural Science Modules
## Biomedicine

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>227-0399-10L</td>
<td>Physiology and Anatomy for Biomedical Engineers</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>H. Niemann</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td></td>
<td>This course offers an introduction into the structure and function of the human body, and how these are interlinked with one another. Focusing on physiology, the visualization of anatomy is supported by 3D-animation, Computed Tomography and Magnetic Resonance imaging. To understand basic principles and structure of the human body in consideration of the clinical relevance and the medical terminology used in medical work and research.</td>
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<td><strong>Objective</strong></td>
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<td>To introduce the students to the both macro- and micronutrients in relation to food and metabolism. Prof. Zimmermann discusses the micronutrients, including fat-soluble vitamins, water-soluble vitamins, minerals and trace elements. Prof. Wolfrum introduces basic nutritional aspects of proteins, fats, carbohydrates and energy metabolism. The nutrients are described in relation to digestion, absorption and metabolism. Special aspects of homeostasis and homeorhesis are emphasized.</td>
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<tr>
<td></td>
<td><strong>Content</strong></td>
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<tr>
<td></td>
<td>- The Human Body: nomenclature, orientations, tissues</td>
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<td></td>
<td>- Musculoskeletal system, Muscle contraction</td>
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<td></td>
<td>- Blood vessels, Heart, Circulation</td>
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<td>- Blood, Immune system</td>
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<td>- Respiratory system</td>
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<td>- Acid-Base-Homeostasis</td>
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<td></td>
<td><strong>Lecture notes</strong></td>
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<td></td>
<td>Lecture notes and handouts</td>
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<tr>
<td></td>
<td><strong>Literature</strong></td>
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<tr>
<td></td>
<td>Silbernagl S., Despopoulos A. Color Atlas of Physiology; Thieme 2008</td>
<td></td>
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<td></td>
<td>Faller A., Schuenke M. The Human Body; Thieme 2004</td>
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<td></td>
<td>Nettet F. Atlas of human anatomy; Elsevier 2014</td>
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<tr>
<td>551-0317-00L</td>
<td>Immunology I</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>A. Oxenius, M. Kopf</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td></td>
<td>Introduction into structural and functional aspects of the immune system. Basic knowledge of the mechanisms and the regulation of an immune response.</td>
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<td></td>
<td><strong>Objective</strong></td>
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<td>- Introduction and historical background</td>
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<td>- Innate and adaptive immunity, Cells and organs of the immune system</td>
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<td>- B cells and antibodies</td>
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<td>- Generation of diversity</td>
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<td>- Antigen presentation and Major Histoincompatibility (MHC) antigens</td>
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<td>- Thymus and T cell selection</td>
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<td>- Autoimmunity</td>
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<td>- Cytotoxic T cells and NK cells</td>
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<td>- Th1 and Th2 cells, regulatory T cells</td>
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<td>- Allergies</td>
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<td>- Hypersensitivities</td>
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<td>- Vaccines, immune-therapeutic interventions</td>
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<td><strong>Lecture notes</strong></td>
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<td>Electronic access to the documentation will be provided. The link can be found at “Lernmaterialien”</td>
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<td><strong>Literature</strong></td>
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<td>Immunology I (WS) and Immunology II (SS) will be examined as one learning entity in a “Sessionsprüfung”.</td>
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<tr>
<td>752-6001-00L</td>
<td>Introduction to Nutritional Science</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>M. B. Zimmermann, C. Wolfrum</td>
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<td></td>
<td><strong>Abstract</strong></td>
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<td>This course introduces basic concepts of micro- and macronutrient nutrition. Macronutrients studied include fat-soluble and water-soluble vitamins, minerals and trace elements. Macronutrients include proteins, fat and carbohydrates. Special attention is given to nutrient digestion, bioavailability, metabolism and excretion with some focus on energy metabolism.</td>
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<td>To introduce the students to the both macro- and micronutrients in relation to food and metabolism. Prof. Zimmermann discusses the micronutrients, including fat-soluble vitamins, water-soluble vitamins, minerals and trace elements. Prof. Wolfrum introduces basic nutritional aspects of proteins, fats, carbohydrates and energy metabolism. The nutrients are described in relation to digestion, absorption and metabolism. Special aspects of homeostasis and homeorhesis are emphasized.</td>
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<td>- The course is divided into two parts. The lectures on micronutrients are given by Prof. Zimmermann and the lectures on macronutrients are given by Prof. Wolfrum. Prof. Zimmermann discusses the micronutrients, including fat-soluble vitamins, water-soluble vitamins, minerals and trace elements. Prof. Wolfrum introduces basic nutritional aspects of proteins, fats, carbohydrates and energy metabolism. The nutrients are described in relation to digestion, absorption and metabolism. Special aspects of homeostasis and homeorhesis are emphasized.</td>
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<td>There is no script. Powerpoint presentations will be made available.</td>
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<td></td>
<td>Elmadfa I &amp; Leitzmann C. Ernährung des Menschen</td>
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<td></td>
<td>UTB Ulmer, Stuttgart, 4. überarb. Ausgabe 2004</td>
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<tr>
<td></td>
<td>Garrow JS and James WPT: Human Nutrition and Dietetics</td>
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<td>Churchill Livingstone, Edinburgh, 11th rev. ed. 2005</td>
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## Soil Sciences

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<tr>
<td>701-0533-00L</td>
<td>Soil Chemistry</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>R. Kretzschmar, D. I. Christl</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td>This course discusses chemical and biogeochemical processes in soils and their influence on the behavior and cycling of nutrients and pollutants in terrestrial systems. Approaches for quantitative modeling of the processes are introduced.</td>
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<td>Understanding of important chemical soil properties and processes and their influence on the behavior (e.g., speciation, bioavailability, mobility) of nutrients and pollutants.</td>
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<td>Important topics include the structure and properties of clays and oxides, the chemistry of the soil solution, gas equilibria, dissolution and precipitation of mineral phases, cation exchange, surface complexation, chemistry of soil organic matter, redox reactions in flooded soils, soil acidification and soil salinization.</td>
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<td><strong>Lecture notes</strong></td>
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<td>Handouts in lectures.</td>
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<td>701-0535-00L</td>
<td>Environmental Soil Physics/Vadose Zone Hydrology</td>
<td>W</td>
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<td>2G+2U</td>
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<td><strong>Abstract</strong></td>
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<td>The course provides theoretical and practical foundations for understanding and characterizing physical and transport properties of soils/near-surface earth materials, and quantifying hydrological processes and fluxes of mass and energy at multiple scales. Emphasis is given to land-atmosphere interactions, the role of plants on hydrological cycles, and biophysical processes in soils.</td>
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Autumn Semester 2016
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Objective

Students are able to
- characterize quantitative knowledge needed to measure and parameterize structural, flow and transport properties of partially-saturated porous media.
- quantify driving forces and resulting fluxes of water, solute, and heat in soils.
- apply modern measurement methods and analytical tools for hydrological data collection
- conduct and interpret a limited number of experimental studies
- explain links between physical processes in the vadose-zone and major societal and environmental challenges

Content

Weeks 1 to 3: Physical Properties of Soils and Other Porous Media Units and dimensions, definitions and basic mass-volume relationships between the solid, liquid and gaseous phases; soil texture; particle size distributions; surface area; soil structure. Soil colloids and clay behavior

Soil Water Content and its Measurement - Definitions; measurement methods - gravimetric, neutron scattering, gamma attenuation; and time domain reflectometry; soil water storage and water balance.

Weeks 4 to 5: Soil Water Retention and Potential (Hydrostatics) - The energy state of soil water; total water potential and its components; properties of water (molecular, surface tension, and capillary rise); modern aspects of capillarity in porous media; units and calculations and measurement of equilibrium soil water potential components; soil water characteristic curves definitions and measurements; parametric models; hysteresis. Modern aspects of capillarity

Demo-Lab: Laboratory methods for determination of soil water characteristic curve (SWC), sensor pairing

Weeks 6 to 9: Water Flow in Soil - Hydrodynamics:
Part 1 - Laminar flow in tubes (Poiseuille's Law); Darcy's Law, conditions and states of flow; saturated flow; hydraulic conductivity and its measurement.

Lab #1: Measurement of saturated hydraulic conductivity in uniform and layered soil columns using the constant head method.

Part 2 - Unsaturated steady state flow; unsaturated hydraulic conductivity models and applications; non-steady flow and Richards Eq.; approximate solutions to infiltration (Green-Ampt, Philip); field methods for estimating soil hydraulic properties.
Midterm exam

Lab #2: Measurement of vertical infiltration into dry soil column - Green-Ampt, and Philip's approximations; infiltration rates and wetting front propagation.

Part 3 - Use of Hydrus model for simulation of unsaturated flow

Week 10 to 11: Energy Balance and Land Atmosphere Interactions - Radiation and energy balance; evapotranspiration definitions and estimation; transpiration, plant development and transpiration coefficients small and large scale influences on hydrological cycle; surface evaporation.

Week 12 to 13: Solute Transport in Soils Transport mechanisms of solutes in porous media; breakthrough curves; convection-dispersion eq.; solutions for pulse and step solute application; parameter estimation; salt balance.

Lab #3: Miscible displacement and breakthrough curves for a conservative tracer through a column; data analysis and transport parameter estimation.

Additional topics:

- Temperature and Heat Flow in Porous Media - Soil thermal properties; steady state heat flow; nonsteady heat flow; estimation of thermal properties; engineering applications.
- Biological Processes in the Vadose Zone An overview of below-ground biological activity (plant roots, microbial, etc.); interplay between physical and biological processes. Focus on soil-atmosphere gaseous exchange; and challenges for bio- and phytoremediation.

Lecture notes

Written course documentation available under "Kursunterlagen".


Methods of Statistical Data Analysis

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<th>Number</th>
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<tbody>
<tr>
<td>701-0105-00L</td>
<td>Applied Statistics for Environmental Sciences</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>C. Bigler, U. Brändle, M. Kalisch, L. Meier</td>
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</table>
Students are able to:
- use suitable statistical methods for data analysis in their subject area.
- characterize data sets using explorative methods.
- check the suitability of data sets to answer a given question, prepare data sets for import to a statistics program and conduct the analysis.
- interpret statistical analyses and process them graphically for use in presentations and publications.
- describe the basics of statistical methods used in current publications.
- use the software package R for statistical analysis.

**Content**

Statistische Methoden: Regression (lineare Modelle; generalisierte lineare Modelle; GLMs); Varianzanalyse: gemischte Modelle für gruppierte Daten (mixed-effects models); Fragebogenstatistik; Tests (T Test; Chiquadrat Test; Fisher Test); Power-Analyse

Werkzeuge: Explorative Datenanalyse für Hypothesenbildung; Auswahlverfahren für geeignete statistische Verfahren; Datenaufbereitung (Excel -> R; Datenbereinigung); graphische Darstellung von Resultaten; statistische Verfahren in Publikationen erkennen

Wir arbeiten mit dem Softwarepaket R.

**Prerequisites / notice**

Form: Im Wochenrhythmus finden alternierend Einführungen in eine neue Methode und Übungsstunden zum Thema statt.

Besuch von "Mathematik IV: Statistik" oder vergleichbare Lehrveranstaltung

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**401-0625-01L**  
Applied Analysis of Variance and Experimental Design  
W 5 credits  2V+1U  L. Meier

**Abstract**


**Objective**

Participants will be able to plan and analyze efficient experiments in the fields of natural sciences. They will gain practical experience by using the software R.

**Content**


**Literature**


**Prerequisites / notice**

The exercises, but also the classes will be based on procedures from the freely available, open-source statistical software R, for which an introduction will be held.

---

**401-0649-00L**  
Applied Statistical Regression  
W 5 credits  2V+1U  M. Dettling

**Abstract**

This course offers a practically oriented introduction into regression modeling methods. The basic concepts and some mathematical background are included, with the emphasis lying in learning "good practice" that can be applied in every student's own projects and daily work life. A special focus will be laid in the use of the statistical software package R for regression analysis.

**Objective**

The students acquire advanced practical skills in linear regression analysis and are also familiar with its extensions to generalized linear modeling.

**Content**

The course starts with the basics of linear modeling, and then proceeds to parameter estimation, tests, confidence intervals, residual analysis, model choice, and prediction. More rarely touched but practically relevant topics that will be covered include variable transformations, multicollinearity problems and model interpretation, as well as general modeling strategies.

The last third of the course is dedicated to an introduction to generalized linear models: this includes the generalized additive model, logistic regression for binary response variables, binomial regression for grouped data and poisson regression for count data.

**Lecture notes**

A script will be available.

**Literature**

Faraway (2005): Linear Models with R
Faraway (2006): Extending the Linear Model with R
Draper & Smith (1998): Applied Regression Analysis
Fox (2008): Applied Regression Analysis and GLMs
Montgomery et al. (2006): Introduction to Linear Regression Analysis

**Prerequisites / notice**

The exercises, but also the classes will be based on procedures from the freely available, open-source statistical software package R, for which an introduction will be held.

In the Mathematics Bachelor and Master programmes, the two course units 401-0649-00L "Applied Statistical Regression" and 401-3622-00L "Regression" are mutually exclusive. Registration for the examination of one of these two course units is only allowed if you have not registered for the examination of the other course unit.

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**401-6215-00L**  
Using R for Data Analysis and Graphics (Part I)  
W 1 credit  1G  A. Drewek, A. J. Papritz

**Abstract**

The course provides the first part an introduction to the statistical software R for scientists. Topics covered are data generation and selection, graphical and basic statistical functions, creating simple functions, basic types of objects.

**Objective**

The students will be able to use the software R for simple data analysis.
Content

The course provides the first part of an introduction to the statistical software R for scientists. R is free software that contains a huge collection of functions with focus on statistics and graphics. If one wants to use R one has to learn the programming language R - on very rudimentary level. The course aims to facilitate this by providing a basic introduction to R.

Part I of the course covers the following topics:
- What is R?
- R Basics: reading and writing data from/to files, creating vectors & matrices, selecting elements of dataframes, vectors and matrices, arithmetics;
- Types of data: numeric, character, logical and categorical data, missing values;
- Simple (statistical) functions: summary, mean, var, etc., simple statistical tests;
- Writing simple functions;
- Introduction to graphics: scatter-, boxplots and other high-level plotting functions, embellishing plots by title, axis labels, etc., adding elements (lines, points) to existing plots.

The course focuses on practical work at the computer. We will make use of the graphical user interface RStudio: www.rstudio.org

Lecture notes

An Introduction to R. http://stat.ethz.ch/CRAN/doc/contrib/Lam-IntroductionToR_LHL.pdf

Prerequisites / notice

The course resources will be provided via the Moodle web learning platform
Please login (with your ETH (or other University) username+password) at
https://moodle-app2.let.ethz.ch/enrol/users.php?id=1145
Choose the course "Using R for Data Analysis and Graphics" and follow the instructions for registration.

401-6217-00L Using R for Data Analysis and Graphics (Part II) W 1 credit 1G A. Drewek, A. J. Papritz

Abstract

The course provides the second part an introduction to the statistical software R for scientists. Topics are data generation and selection, graphical functions, important statistical functions, types of objects, models, programming and writing functions.

Note: This part builds on "Using R... (Part I)", but can be taken independently if the basics of R are already known.

Objective

The students will be able to use the software R efficiently for data analysis.

Content

The course provides the second part of an introduction to the statistical software R for scientists. R is free software that contains a huge collection of functions with focus on statistics and graphics. If one wants to use R one has to learn the programming language R - on very rudimentary level. The course aims to facilitate this by providing a basic introduction to R.

Part II of the course builds on part I and covers the following additional topics:
- Elements of the R language: control structures (if, else, loops), lists, overview of R objects, attributes of R objects;
- More on R functions;
- Applying functions to elements of vectors, matrices and lists;
- Object oriented programming with R: classes and methods;
- Tayloring R: options
- Extending basic R: packages

Lecture notes

The course focuses on practical work at the computer. We will make use of the graphical user interface RStudio: www.rstudio.org

Prerequisites / notice

Basic knowledge of R equivalent to "Using R .. (part 1)" ( = 401-6215-00L ) is a prerequisite for this course.

The course resources will be provided via the Moodle web learning platform
Please login (with your ETH (or other University) username+password) at
https://moodle-app2.let.ethz.ch/enrol/users.php?id=1145
Choose the course "Using R for Data Analysis and Graphics" and follow the instructions for registration.

ECOLOGY AND CONSERVATION BIOLOGY

Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
701-0305-00L | Vertebrate Ecology | W | 2 credits | 2G | W. Suter, J. Senn

Abstract

The course offers an overview on the ecology and conservation biology of birds and mammals. Important concepts from physiology, behavioural ecology, population biology, biogeography and community ecology will be linked to applications in conservation and management. A worldwide perspective will be complemented by a focus on the Central European fauna and its dynamics.

Objective

The students are familiar with important topics in animal ecology, with an emphasis on birds and mammals. They are able to link theoretical concepts with visible ecological phenomena, and view them against an evolutionary backdrop. They can thus appraise applied aspects of the conservation and the use of animal populations, such as the influence of larger predators on prey populations or of herbivores on vegetation, the effects of hunting, landscape change, or of other human influences on animal populations. They understand the biogeographical characteristics of the Central European vertebrate fauna and its temporal and spatial dynamics.

Content

The course deals with a number of main topics that include feeding and resource use, spatial behaviour and migrations, reproduction, population dynamics, competition and predation, biodiversity and distributions, and dynamics of the Central European fauna. There is an emphasis on linking theory with management issues in conservation and management of wildlife populations. During the first half of the course, examples will be drawn worldwide whereas during the second half, the course will focus more strongly on the European fauna, particularly of the Alpine region. Although the course is not designed to teach natural history of the native species, examples will cover much of the taxonomic breadth of the European fauna. Students are expected to read one paper and to present it to the audience. In addition, two optional field trips will be offered on weekends during the semester (2 days in the Swiss National Park: probably 10-11 October, one day in an important wetland for waterbirds: a Saturday in Nov./Dec., by arrangement).

For the detailed program, see the German text.

Lecture notes

Lecture notes will be available.

Literature

Literature will be listed in the lecture notes, and papers to be presented will be distributed if needed. Some books relevant to the course are (optional reading):

- Everybody will be expected to present a scientific paper in class, to be chosen from a list given.


Autumn Semester 2016
Abstract
In this course the important freshwater ecosystems, on a global perspective, will be presented. The foci of the lectures are basic ecological properties of those aquatic systems, their anthropogenic influences and subsequent modifications. The learning is organized along case studies, for which conflicting interests, as well as concepts and methods for sustainable management will be discussed.

Objective
basics concerning the functioning of the most important freshwater ecosystems
basics of the sustainable management of aquatic ecosystems
application of these principles with case studies
critical analyses, organization of discussion groups

Content
1) Einführung, Gewässerschutzgesetz
2) Biodiversität
3) Sedimenthaushalt
4) Moore - Verbreitung, Schutz und Regeneration
5) Flussrevitalisierung
6) Flussaufweitungen und Blockkrempe
7) Auenenschutz und Revitalisierung
8) Schutz von Fließgewässern
9) Pumpenpfeilerwerke
10) Sedimentdynamik
11) Fischwanderung und Kraftwerke
12) Wasser und Gesundheit, Auswirkungen des Klimawandels
13) Schlussdiskussion

Lecture notes
thermenspezifische Unterlagen werden verteilt und auf
http://www.wsl.ch/info/mitarbeitende/scheideg/vorlesung_binnengewaesser_DE
zugänglich gemacht.

Literature
...literaturlisten zu den Fallbeispielen werden abgegeben und auf
http://www.wsl.ch/info/mitarbeitende/scheideg/vorlesung_binnengewaesser_DE
zugänglich gemacht.

Prerequisites / notice
Basic ecology lectures of the first four semesters. Students will organize discussion groups.

701-0225-00L Organic Chemistry W 2 credits 2V K. McNeill

Environmental Chemistry/Ecotoxicology

701-0201-00L Introduction to Environmental Organic Chemistry W 5 credits 4G M. Sander, K. McNeill

Abstract
This course presents significant organic environmental pollutants and the physical-chemical bases required to understand their environmental behavior, and deepens this knowledge through exercises. The most important analytical methods for the qualitative and quantitative determination of organic pollutants in environmental samples are discussed.

Objective
The students are able to
- name and recognise the most important classes of environmentally-relevant anthropogenic chemicals.
- explain, on the basis of physical-chemical foundations, the most important processes which determine the environmental behavior of organic pollutants.
- name fundamental methods of trace analysis of organic pollutants in environmental sampling.
- propose experimental methods for determining substance-specific properties.
- identify, on the basis of chemical structure, the processes relevant for the environmental behavior of a compound, critically evaluated published work and data.

Content
- Overview of the most important classes of environmental organic pollutants
- Molecular interactions that determine the partitioning behavior (adsorption and absorption processes) of organic compounds between different environmental compartments (gas, liquid, solid)
- Physical-chemical properties (vapor pressure, aqueous solubility, air-water partition constant, organic solvent-water partition constants, etc) and partitioning behavior of organic compounds between environmentally relevant phases (air, aerosols, soil, water, biota)
- Basics of trace analytical methods to determine organic compounds (enrichment techniques, separation (chromatography), detection)
- Chemical transformation reactions of organic pollutants in aquatic and in terrestrial systems (reactions with nucleophiles incl. hydrolysis, elimination, addition)

Lecture notes
Script will be distributed

Literature

Prerequisites / notice
Die Lehrveranstaltung richtet sich nicht nur an jene Studierenden, welche sich später chemisch vertiefen wollen, sondern ausdrücklich auch an alle jene, welche sich mit der Problematik von organischen Schadstoffen in der Umwelt vertraut machen wollen, um dieses Wissen in anderen Verleihungen anzuwenden.
Abstract
Introduction to Isomerism. Reaction mechanisms in organic chemistry (substitutions, additions, eliminations condensations) Biosynthesis of Terpenes.

Objective
The students are able to differentiate between structural and stereoisomers. The students know the basic reaction mechanisms in organic chemistry. They are able to understand and formulate simple biochemical reactions. They know the basics of the biosynthesis of terpenes.

Content
Isomerism (structural isomers, stereoisomers). Descriptive chemistry of natural products (glycerides, peptides, saccharides). Reaction mechanisms (substitutions, additions, eliminations, condensations). The citric acid cycle, the glyoxylate cycle. Biosynthesis of terpenes.

Literature
Carsten Schmuck, Basisbuch Organische Chemie, Pearson

Prerequisites / notice
Der Stoff der Basischmied wird vorausgesetzt.

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**Environmental Physics**

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<td>Environmental Fluid Dynamics</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>H. Wernli, M. Croci-Maspoll</td>
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<tr>
<td>101-0203-01L</td>
<td>Hydraulics I</td>
<td>W</td>
<td>5</td>
<td>3V+1U</td>
<td>R. Stocker</td>
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</tbody>
</table>

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**Analytical Chemistry I**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>529-0051-00L</td>
<td>Analytical Chemistry I</td>
<td>W</td>
<td>3</td>
<td>3G</td>
<td>D. Günther, M.O. Ebert, R. Zenobi</td>
</tr>
</tbody>
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**Environmental Fluid Dynamics**

This course covers the basic physical concepts and mathematical equations used to describe environmental fluid systems on the rotating Earth. Fundamental concepts (e.g. vorticity dynamics and waves) are formally introduced, applied quantitatively and illustrated using examples. Exercises help to deepen knowledge of the material.

Objective
Students are able to:
- name the bases, concepts and methods of environmental fluid dynamics.
- understand and discuss the components of the basic physical equations in fluid dynamics.
- apply basic mathematical equations to simple problems of environmental fluid dynamics.

Content
Basic physical terminology and mathematical laws:
- Continuum hypothesis, forces, constitutive laws, state equations and basic principles of thermodynamics, kinematics, laws of mass and momentum on rotating earth.
- Concepts and illustrative flow systems: vorticity dynamics, boundary layers, instability, turbulence - with respect to environmental fluid systems. Scale analysis: dimensionless variables and dynamical similarity, simplification of the fluid system, e.g. shallow water assumption, geostrophic flow.

Lecture notes
In English language.

Lecture notes
Will be presented in class. See also: web-site.
Content
Properties of water, hydrostatics, stability of floating bodies, continuity, Euler equation of motion, Navier-Stokes equations, similarity, Bernoulli principle, momentum equation for finite volumes, potential flows, ideal fluids vs. real fluids, boundary layer, pipe flow, open channel flow, flow measurements, demonstration experiments in the lecture hall

Lecture notes
Script and collection of previous problems

Literature
Bollrich, Technische Hydromechanik 1, Verlag Bauwesen, Berlin

102-0455-01L Groundwater I W 3 credits 2G M. Willmann
Abstract
The course provides an introduction into quantitative analysis of groundwater flow and transport. It is focused on formulating flow and transport problems in groundwater, which are to be solved analytically or numerically.

Objective
a) Students understand the basic concepts of flow and contaminant transport processes and boundary conditions in groundwater.
b) Students are able to formulate simple practical flow and transport problems.
c) Students are able to understand and apply simple analytical solutions to simple flow and transport problems.
d) Students are able to use simple numerical codes to adequately solve simple flow (and transport) problems.

Content
Introduction, aquifers, groundwater use, sustainability, porosity.
Properties of porous media.
Exercises: Groundwater use, porosity, grain size analysis.

Flow properties, Darcy's law, filter.
Flow equations, stream function.
Exercises: Darcy's law.

Analytical solutions, confined aquifers, steady-state flow.
Exercises: Head isolines.

Use of superposition principles, transient flow, free surface flow.
Exercises: Analytical solutions to flow problems.

Finite difference solutions to flow problems I.
Exercises: Analytical solutions to flow problems.

Finite difference solutions to flow problems II.
Exercises: Finite difference formulations to flow problems.

Transport processes.
Exercises: Computer workshop using PMWIN.

Analytical solutions to transport problems I.
Exercises: Computer workshop using PMWIN.

Analytical solutions to transport problems II.
Exercises: Analytical solutions to transport problems.

Path lines, groundwater protection.
Exercises: Analytical solutions to transport problems.

Groundwater remediation, groundwater management.
Exercises: Groundwater remediation.

Lecture notes
Folien auf Internet unter www.ihw.ethz.ch/GWH/education/index
Altes Skript auf Internet www.ihw.ethz.ch/GWH/education/index
Weitere Texte auf Internet www.ihw.ethz.ch/GWH/education/index
Didaktische Software auf Internet unter www.ihw.ethz.ch/GWH/education/index

Literature


W. Kinzelbach, R. Rausch, Grundwassermodellierung, Gebrüder Bornträger, Stuttgart, 1995

Kruisemann, de Ridder, Untersuchung und Anwendung von Pumpversuchen, Verl. R. Müller, Köln, 1970

G. de Marsily, Quantitative Hydrogeology, Academic Press, 1986

651-3561-00L Cryosphere W 3 credits 2V M. Funk, M. Huss, K. Steffen
Abstract
This course introduces the different parts of the cryosphere - snow, glaciers, sea ice, permafrost - and their role in the climate system. A significant physical aspect is the focus in each part. Those completing the course are able to describe the dynamics of cryosphere components both formally and using examples.

Objective
Students are able
- to qualitatively describe the main components of the cryosphere and their role in the climate system
- to formally describe the relevant physical processes which determine the state of cryosphere components

Content
Introduction into the different components of the Cryosphere: Snow, glaciers, sea ice and permafrost, and their roles in the climate system. Each part is used to emphasize one of the following physical aspects: material properties of ice, mass balance and dynamics of glaciers and energy balance of sea ice.

Lecture notes
handouts will be distributed during the teaching semester

Module Engineering and Planning
Spacial and Transport Planning

Number Title Type ECTS Hours Lecturers
701-0951-00L GIS - Introduction into Geoinformation Science and W 5 credits 2V+3P M. A. M. Niederhuber, S. Salvini
The course covers the following topics:
- What is GIS? What are spatial data?
- The representation of reality by means of spatial data models: vector, raster, TIN
- The four phases of data modelling: Spatial, conceptual, logical and physical model
- Basic concepts of database management systems and spatial databases
- Possibilities of data collection
- Transition of reference frame
- Spatial Analysis I: query and manipulation of vector data
- Spatial Analysis II: operators and functions with raster data
- Digital elevation models and derived products
- Process modelling with vector and raster data
- Presentation possibilities of spatial data

Abstract

Students are able to
- elucidate the theoretical and conceptional foundations of geographic information systems (GIS)
- independently perform normal GIS work using commercial software and practical examples

Objective

The course covers the following topics:
- What is GIS? What are spatial data?
- The representation of reality by means of spatial data models: vector, raster, TIN
- The four phases of data modelling: Spatial, conceptual, logical and physical model
- Basic concepts of database management systems and spatial databases
- Possibilities of data collection
- Transition of reference frame
- Spatial Analysis I: query and manipulation of vector data
- Spatial Analysis II: operators and functions with raster data
- Digital elevation models and derived products
- Process modelling with vector and raster data
- Presentation possibilities of spatial data

Prerequisites

Upon the Grösse of the available EDV-Schulungsraumes is the Teilnehmerzahl on 60 Studierende beschränkt! Für die Übungen werden die Studierenden auf verschiedene Zeitenfenster aufgeteilt. Pro Zeitenfenster können maximal 20 Studierende betreut werden.

Literature


Prerequisites / notice

One Friday is reserved for a field trip or guest speaker;

References to technical literature will be included in the course script. An additional list of literature will be given during the course.

Number of participants limited to 30.

Lecture notes

Course notes will be provided in German. Slides are made available some days before each lecture.

Number of participants limited to 60.

Lecture notes

PPT presentation will be distributed (in German)

special frames:

http://www.rechsteiner-basel.ch/Lecturemittel.27.html

Data: 06.03.2019 12:57 Autumn Semester 2016 Page 1483 of 1571
The ETH Week is an innovative one-week course designed to foster critical thinking and creative learning. Students from all departments and as professors and external experts will work together in interdisciplinary teams. They will develop interventions that could play a role in solving some of our most pressing global challenges. In 2016, ETH Week will focus on the topic of water.

Abstract
Scenarios for world energy demand and CO2 emissions, implications for climate. Methods for the assessment of energy chains. Potential and technology of renewable energies: Biomass (heat, electricity, biofuels), solar energy (low temp. heat, solar thermal and photovoltaic electricity, solar chemistry). Wind and ocean energy, heat pumps, geothermal energy, energy from waste. CO2 sequestration.

Objective
Scenarios for the development of world primary energy consumption are introduced. Students know the potential and limitations of renewable energies for reducing CO2 emissions, and their contribution towards a future sustainable system that respects climate protection goals.

Content

Lecture notes
Lecture notes will be distributed electronically during the course.


Prerequisites / notice
For group exercise and presentation reasons the number of participants is limited to 35 students. For exercises students build learning and presentational groups.

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<tr>
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<tbody>
<tr>
<td>701-0317-00L</td>
<td>Identification of Woody Plants in Winter</td>
<td>W</td>
<td>1 credit</td>
<td>1G</td>
<td>A. Rudow</td>
</tr>
</tbody>
</table>

Abstract
Identification of Woody Plants in Winter
Woody plants are important elements of forest ecosystems and landscapes. The practical characterization of forest stands often requires the identification of woody plants in winter. The course focuses on the practical identification of native tree and shrub species to be used for the characterization of forest stands.

Objective
Knowledge of selected native tree and shrub species in winter. Understanding relationships of trees and forest ecosystems by in situ observation of woody plants and forest stands. Introduction into the characterization of forest stands.

Content
Four half-day excursions in the surroundings of Zurich and Baden the identification of native tree and shrub species is treated. The course aims at broadening and application of species knowledge towards the identification of woody plants during the leafless phase and their identification from distance (selected native species). Besides that the relationships of trees and forest ecosystems as well as forestry aspects are elucidated. In the context of an individual work the students will practically train and deepen their acquired knowledge.

Lecture notes
Rudow, A., 2013: Dendrologie Grundlagen - Bestimmungshilfe (in German, will be provided for registered students on an online-platform)

Literature
Rudow 2011 (betaversion): EBot Dendrologie.E-learning-Tool for the support of dendrology courses at ETHZ, integrated into online-application eBot.

An overview of the most adequate literature will be given at the introduction (sept 28).

Prerequisites / notice
Half-day excursions into forests. Weatherproof clothes are presupposed. The course is based on the Introduction into Dendrology (spring sem, 2nd sem).

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Abstract
The ETH Week is an innovative one-week course designed to foster critical thinking and creative learning. Students from all departments as well as professors and external experts will work together in interdisciplinary teams. They will develop interventions that could play a role in solving some of our most pressing global challenges. In 2016, ETH Week will focus on the topic of water.
How can a glossary of tools be used as a basis for reading cities and recognizing in them current trends and urban phenomena? The development of cities into the cities we live in now? Which urban plans, instruments, visions, political decisions, economic reasonings, and actions and policies are necessary to understand the diversity and instability present in the contemporary city and to understand how urban form evolved to its current state. This lecture series will introduce urban knowledge and the way it has introduced urban models and scenarios to tell the fundamental story of our cities from today and provide information, analysis and knowledge to help students prepare for justifiable own contributions and interventions in the future. Also the aspect of knowledge transfer will be considered in order to sensibilize the students to understand how to operate in an international context.

While deepening their knowledge about how the food system works, students will be introduced to various methods and tools for generating creative ideas and understand how different people are affected by each part of the system. In addition to lectures and literature, students will acquire knowledge via excursions into the real world, empirical observations, and conversations with researchers and experts. A panel of experts will judge your presentations at the end of the week. The winning teams will receive attractive prizes.

How did cities develop into the cities we live in now? Which urban plans, instruments, visions, political decisions, economic reasonings, cultural inputs and social organization have been used to operate in urban settlements in specific moments of change? Which cities are categorized as "unbenotete Semesterleistung" (ungraded semester performance). Well as exchange students must submit a research paper, which will be subject to the performance assessment: "Bestanden" (pass) or "Semesterkurs" (semester course) students from other departments or students taking this lecture as GESS / Studium Generale course as according to the given template. Each student has one week to prepare each exercise, and it should be delivered, in form of a physical copy, in the next lecture. (Language: preferably English, German). The Exercise tasks are a valuable preparation for the Exam (Exam only relevant for the "Jahreskurs" students) therefore it is highly recommended to finalize all weekly Exercise tasks, as an individually conducted piece of work.

| Objective | - Domain specific knowledge: Students have immersed knowledge about a certain complex, societal topic which will be selected every year. They understand the complex system context of the current topic, by comprehending its scientific, technical, political, social, ecological and economic perspectives. The focus in 2016 is on challenging water systems.  
- Analytical skills The ETH Week participants are able to structure complex problems systematically using selected methods. They are able to acquire further knowledge and to critically analyze the knowledge in interdisciplinary groups and with experts and the help of team tutors.  
- Design skills: The students are able to use their knowledge and skills to develop concrete approaches for problem solving and decision making to a selected problem statement, critically reflect these approaches, assess their feasibility, to transfer them into a concrete form (physical model, prototypes, strategy paper,...) and to present this work in a creative way (role-plays, videos, exhibitions, etc.).  
- Self-competence: The students are able to plan their work effectively, efficiently and autonomously. By considering approaches from different disciplines they are able to make a judgment and form a personal opinion. In exchange with non-academic partners from business, politics, administration, nongovernmental organizations and media they are able to communicate appropriately, present their results professionally and creatively and convince a critical audience.  
- Social competence: The students are able to work in multidisciplinary teams, i.e. they can reflect critically their own discipline, debate with students from other disciplines and experts in a critical-constructive and respectful way and can relate their own positions to different intellectual approaches. They can assess how far they are able to actively make a contribution to society by using their personal and professional talents and skills and as "Change Agents".  

| Content | This week is mainly about design thinking applied to the complex world of water. During ETH Week students will have the opportunity to work in small interdisciplinary groups, allowing them to critically analyze both their own approaches and those of other disciplines, and to integrate these into their work.  

While deepening their knowledge about how the food system works, students will be introduced to various methods and tools for generating creative ideas and understand how different people are affected by each part of the system. In addition to lectures and literature, students will acquire knowledge via excursions into the real world, empirical observations, and conversations with researchers and experts. A panel of experts will judge your presentations at the end of the week. The winning teams will receive attractive prizes.

| Prerequisites / notice | No prerequisites. Program is open to Bachelor and Masters from all ETH Departments. All students must apply through a competitive application process that will open in March 2016 at www.ethz.ch/ETHWeek. Participation is subject to successful selection through this competitive process.

| 051-0159-00L Urban Design I | W  1 credit  2V  H. Klumper, A. Brillembourg  
| Objective | How can a glossary of tools be used as a basis for reading cities and recognizing in them current trends and urban phenomena? The lectures series will produce a glossary of operational urban tools with collected urban knowledge that provides students with an 'improved' mental map in navigating them. Urban Stories is a lecture series that aims to amplify your repertoire of urban instruments and empowers you to read cities and to critically reflect on the urban environment. The course will approach a series of case studies, employing an analytical, research-based model for crosscutting scale, political, economical and social components. Through this lens, and with our toolbox, we aim to tell the fundamental story of our cities from today and provide information, analysis and knowledge to help students prepare for justifiable own contributions and interventions in the future. Also the aspect of knowledge transfer will be considered in order to sensibilize the students to understand how to operate in an international context.  

| Content | How did cities develop into the cities we live in now? Which urban plans, instruments, visions, political decisions, economic reasonings, cultural inputs and social organization have been used to operate in urban settlements in specific moments of change? Which cities are categorized as "unbenotete Semesterleistung" (ungraded semester performance). Well as exchange students must submit a research paper, which will be subject to the performance assessment: "Bestanden" (pass) or "Semesterkurs" (semester course) students from other departments or students taking this lecture as GESS / Studium Generale course as according to the given template. Each student has one week to prepare each exercise, and it should be delivered, in form of a physical copy, in the next lecture. (Language: preferably English, German). The Exercise tasks are a valuable preparation for the Exam (Exam only relevant for the "Jahreskurs" students) therefore it is highly recommended to finalize all weekly Exercise tasks, as an individually conducted piece of work.

- Self-competence: The students are able to plan their work effectively, efficiently and autonomously. By considering approaches from different disciplines they are able to make a judgment and form a personal opinion. In exchange with non-academic partners from business, politics, administration, nongovernmental organizations and media they are able to communicate appropriately, present their results professionally and creatively and convince a critical audience.  
- Social competence: The students are able to work in multidisciplinary teams, i.e. they can reflect critically their own discipline, debate with students from other disciplines and experts in a critical-constructive and respectful way and can relate their own positions to different intellectual approaches. They can assess how far they are able to actively make a contribution to society by using their personal and professional talents and skills and as "Change Agents".

- Design skills: The students are able to use their knowledge and skills to develop concrete approaches for problem solving and decision making to a selected problem statement, critically reflect these approaches, assess their feasibility, to transfer them into a concrete form (physical model, prototypes, strategy paper,...) and to present this work in a creative way (role-plays, videos, exhibitions, etc.).  

| Lecture notes | The skript can be downloaded from the student-server.  
| Literature | The learning material can be downloaded from the student-server: atp://brillembourg-klumper-server.ethz.ch  
| Prerequisites / notice | EXERCISE  
After each lecture, students are asked to produce an exercise based on the presented tools. The format of the exercise is an A3 or an A4, according to the given template. Each student has one week to prepare each exercise, and it should be delivered, in form of a physical copy, in the next lecture. (Language: preferably English, German). The Exercise tasks are a valuable preparation for the Exam (Exam only relevant for the "Jahreskurs" students) therefore it is highly recommended to finalize all weekly Exercise tasks, as an individually conducted piece of work.

| 751-3401-00L Plant Nutrition | W  2 credits  2V  E. Frossard  

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The aim of these lecture is to present the processes controlling the uptake and transport of nutrients and water by the plant, the assimilation of nutrients in the plant, the effect of nutrients on crop yield and quality, the role of the soil as a source of nutrients for crops, and the basic principles of fertilization of different crop types using mineral and organic fertilizers.

At the end of the lecture, students know how mineral nutrients and water are taken up through roots and circulate in the plants and what their roles in plants are. They understand the importance of nutrients for yield formation and for crop product quality. They are able to propose fertilization plans adapted for field crops growing under Swiss conditions.

We will distribute a script for the part dealing with the physiology of plant nutrition. For the part on fertilization we will use the booklet of ACW and ART presenting the recommendations for the fertilization of crops and grassland in Switzerland (GRUDAF/DBF).

**Abstract**

**Objective**

**Content**

**Lecture notes**

**Literature**

- Schubert S 2006 Pflanzenernährung Grundwissen Bachelor UTB.
- Pictures of nutrients deficiency symptoms.
- http://www.tlf.de/visuplant/vp_idx.htm
- Water balance.

**Courses of the Specialisation in an Environmental System**

**Specialization in an Environmental System**

**Biogeochemistry**

<table>
<thead>
<tr>
<th>Number</th>
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<tr>
<td>701-0216-00L</td>
<td>Biogeochemical Cycles</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>B. Wehrli</td>
</tr>
<tr>
<td>701-0419-01L</td>
<td>Seminar for Bachelor Students: Biogeochemistry</td>
<td>O</td>
<td>2 credits</td>
<td>2S</td>
<td>G. Furrer, R. Kretzschmar, B. Wehrli</td>
</tr>
<tr>
<td>701-0423-00L</td>
<td>Chemistry of Aquatic Systems</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>L. Winkel</td>
</tr>
<tr>
<td>701-0533-00L</td>
<td>Soil Chemistry</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>R. Kretzschmar, D. I. Christl</td>
</tr>
</tbody>
</table>

**Prerequisites / notice**

Basic knowledge in chemistry and systems analysis

Deadline for enrollment is the FIRST day of the semester. Later enrollment can only be accepted in exceptional cases and under certain conditions (e.g., restricted choice of topics and dates).

- System-Oriented Management of Herbivore Insects I
- Biogeochemical cycles are discussed from global or regional perspectives, important methods to determine reaction rates and pathways are introduced and typical reaction mechanisms are discussed at a molecular level.
- The students will be able to interpret concentration changes in time and space and deduce rates of biogeochemical processes.
- Literature
  - Lecture notes and assignments will be available in German

**Seminar for Bachelor Students: Biogeochemistry**

- The seminar provides an introduction to the literature in biogeochemistry of aquatic and terrestrial systems. The students present their summary and review of recent or classical papers. Therefore they get familiar with online-access tools and improve their communication and presentation skills.
- Objective
- Content
- Lecture notes
- Literature

**Chemistry of Aquatic Systems**

- This course gives an introduction to chemical processes in aquatic systems and shows applications to various systems. The following topics are treated: acid-base reactions and carbonate system; solubility of solids and weathering, redox reactions, complexation of metals, reactions at the solid-water interface, applications to lakes, rivers and groundwater.
- Objective

**Soil Chemistry**

- Understanding of chemical processes in aquatic systems. Quantitative application of chemical equilibria to processes in natural waters.
- Evaluation of analytical data from aquatic systems.

**Introduction to the chemistry of aquatic systems. Regulation of the composition of natural waters by chemical, geochemical and biological processes. Quantitative application of chemical equilibria to processes in natural waters. The following topics are treated: acid-base reactions, carbonate system; solubility of solid phases and weathering; complexation of metals and metal cycling in natural waters; redox reactions; reactions at the interface solid phase-water; applications to lakes, rivers, groundwater.

**Lecture notes**

- Script is distributed.
- Literature
This course discusses chemical and biogeochemical processes in soils and their influence on the behavior and cycling of nutrients and pollutants in terrestrial systems. Approaches for quantitative modeling of the processes are introduced.

**Objective**

Understanding of important chemical soil properties and processes and their influence on the behavior (e.g., speciation, bioavailability, mobility) of nutrients and pollutants.

**Content**

Important topics include the structure and properties of clays and oxides, the chemistry of the soil solution, gas equilibria, dissolution and precipitation of mineral phases, cation exchange, surface complexation, chemistry of soil organic matter, redox reactions in flooded soils, soil acidification and soil salinization.

**Lecture notes**

Handouts in lectures.

**Literature**

- Supplemental textbook (not mandatory) - Environmental Soil Physics, by: D. Hillel
- Classnotes on website: Vadose Zone Hydrology, by Or D., J.M. Wraith, and M. Tuller
The students will understand the basics of gas phase and heterogeneous reactions and will know the most relevant atmospheric chemical processes taking place in the gas phase as well as between different phases including aerosols and clouds.

The students are able to...

Three obligatory exercises, each two hours in length, are integrated into the lecture. The implementation language is Matlab (previous experience not necessary: a Matlab introduction is given). Example programs and graphics tools are supplied.

Attendence of the course's web page.

There is a additional tutorial right after each lecture to give you the chance to ask further questions and discuss the exercises. The participation is recommended but voluntary.
This course provides the ecological systems' knowledge needed to question applied solutions to current environmental issues. Our central aim is to balance participants' respect for complexity with a sense of possibility by providing examples from the vast solution space offered by ecological systems, such as e.g. green infrastructure to manage water.

At the end of the course...
...you know how to structure your inquiry and how to proceed the analysis when faced with a complex environmental issue. You can formulate the relevant questions, find answers (supported by discussions, input from the lecturers and the literature), and you are able to present your conclusions clearly and cautiously.
...you understand the complexity of interactions and structures in ecosystems. You know how ecosystem processes, functions and services interact and feed back across multiple spatio-temporal scales (in general, plus in depth case examples).
...you understand that biodiversity and the interaction between organisms are an integral part of ecosystems. You are aware that the link between biodiversity and process/function/service is rarely fully understood. You know how to honestly deal with this lack of understanding and can nevertheless find, critically analyse and communicate solutions.
...you understand the importance of ecosystem services for society.
...you have an overview of the methods of ecosystem research and have a deeper insight into some of them, e.g. ecosystem observation, manipulation and modelling.
...you have reflected on ecology as a young discipline at the heart of significant applied questions.

This course provides the ecological systems' knowledge needed to question applied sustainability solutions. We will critically assess the complexity of current environmental issues, illustrating basic ecological concepts and principles. Our central aim is to balance participants' respect for complexity with a sense of possibility by providing examples from the vast solution space offered by ecological systems, such as e.g. green infrastructure to manage water.

The course is structured around four larger topical areas: (1) Integrated Water Management -- Green infrastructure (land management options) as an alternative to engineered solutions (e.g. large reservoirs) in flood and drought management; (2) Fire dynamics, the water cycle and biodiversity -- The surprising dynamics of species life cycles and populations in arid landscapes; (3) Rewilding, e.g. re-introducing apex predators (e.g. wolves), or large ungulates (e.g. bisons) in protected areas -- A nature conservation trend with counterintuitive effects; (4) Coupling of aquatic and terrestrial systems: carbon, nitrogen and phosphorus transfers of global importance on landscape scale.

Case descriptions, commented glossary and a list of literature and further resources per case.

It is not essential to borrow/buy the following books. We will continuously provide excerpts and other literature during the course.


The course combines elements of a classic lecture, group discussions and problem based learning. It is helpful, but not essential to be familiar with the "seven stages" method (see e.g. course 701-0352-00L "Analysis and Assessment of Environmental Sustainability" by Christian Pohl et al.).

Students will acquire skills in:
- finding literature in scientific databases
- structuring a scientific topic through research questions
- giving a clear scientific presentation
- contributing constructively to a scientific discussion

Students will acquire skills in:
- proposing methods to study ecological processes involved with plant life, and how these processes depend on internal and external factors;
- analyse benefits and costs of plant adaptations;
- explain plant strategies with relevant traits and trade-offs;
- explain and predict the assembly of plant communities;
- explain implications of plant strategies for animals, microbes and ecosystem functions;
- evaluate studies in plant ecology regarding research questions, assumptions, methods, as well as the reliability and relevance of results.

Weekly course summaries familiarise students with research questions and methods; they learn to evaluate results and interpretations.

Week 1: Choice of topics and tutors
Week 2 & 3: Literature search
Week 4: course for presentation techniques
Weeks 1 - 7: Meetings with tutors, preparation of presentations
Weeks 8 - 14: Presentations and discussions
Will be handed out during classes

Handouts and further reading will be available electronically at the beginning of the semester.
This course provides the ecological systems’ knowledge needed to question applied sustainability solutions. We will critically assess the general ecological concepts, from a systems view, the complex interactions, population and quantitative genetics, and the evolution of species in biologically relevant environments. Students are able to understand the importance of ecosystem services for society.

Objective
- Students are able to formulate the relevant questions, find answers (supported by discussions, input from the lecturers and the literature), and you are able to present your conclusions clearly and cautiously.
- You understand the complexity of interactions and structures in ecosystems. You know how ecosystem processes, functions and services interact and feed back across multiple spatio-temporal scales (in general, plus in depth case examples).
- You understand that biodiversity and the interaction between organisms are an integral part of ecosystems. You are aware that the link between biodiversity and process/function/service is rarely fully understood. You know how to honestly deal with this lack of understanding and can nevertheless find, critically analyse and communicate solutions.
- You understand the importance of ecosystem services for society.
- You have an overview of the methods of ecosystem research and have a deeper insight into some of them, e.g. ecosystem observation, manipulation and modelling.
- You have reflected on ecology as a young discipline at the heart of significant applied questions.

Content
- General ecological concepts
- Basic knowledge of plant systematics
- General ecological concepts
- Types and sources of genetic variation; randomly mating populations and the Hardy-Weinberg equilibrium; effects of inbreeding; natural selection; random genetic drift and effective population size; gene flow and hierarchical population structure; molecular population genetics; neutral theory of molecular evolution and basics of coalescent theory.

Literature
- Schulze et al. (2005) Plant Ecology; Springer.

The course combines elements of a classic lecture, group discussions and problem based learning. It is helpful, but not essential to be familiar with the “seven stages” method (see e.g. course 701-0352-00L "Analysis and Assessment of Environmental/ Sustainability" by Christian Pohli et al.).
Abstract
Analysis of central mechanisms of the anthroposphere: ecological economics, theory of institutions and innovation, development economics.

Objective
Introduction to the theoretical foundations of the analysis of central mechanisms of the anthroposphere in a sustainable development perspective.

Knowledge of the different scientific and political discussions on sustainable development.

Knowledge of selected analytical tools (Ecological Economics, economic analysis of institutions, innovation theory, Örundnungstheorie, Theory of liberal economic policy).

Ability to identify central non sustainable mechanisms and policies, to formulate adequate research questions, to choose and to use adequate analytical tools, and to elaborate solutions.

Content
Sustainable development-update: origins, conceptions, state of the discussion. What's left after 25 years of discussion?


Market Economy:
Its Critics, Reforms and new Developments.

An Inquiry into the Nature and Causes of ...Non-Sustainability:
Selected mechanisms and trends. The neo-mercantilism-syndrom

New Trends in the Growth Debate:
The Growth-spiral (Hans Chr. Binswanger), Prosperity without growth? (T. Jackson), Intelligent Growth (R. Fücks)

The Internet of Things and Collaborative Commons - on the road to "The Zero Marginal Cost Society"?

Sufficiency: Perspectives of a resource-light society

Corporation 2020 - Transforming Business for Tomorrow's World (Remarks on Pavan Sukhdev's bestseller)

Finance Crash and Debt Crisis - new challenges for Democracy & Market Economy

Resourcecurse: Resources, democracy, and economic development

Globalization: Facts and elements of a fair globalization

It's the software! Institutional Innovations for Sustainable Development. Let's continue writing The Federalist Papers!

On the way to the second "Great Transformation"

Perspectives for further, deeper analysis

Lecture notes
skript and additional texts are distributed in the course

Literature
A first selection:
- Ralf Dahrendorf (2003): Auf der Suche nach einer neuen Ordnung, München
- Friedrich A. von Hayek (1972): Theorie komplexer Phänomene, Tübingen
- Karl Polanyi (1944): The Great Transformation
- Jeremy Rifkin (2014): The Zero Marginal Cost Society: The Internet of things, the Collaborative Commons, and the Eclipse of Capitalism, palgrave macmillan
- Uwe Schneidewind / Angelika Zahnt (2013): Damit gutes Leben einfacher wird. Perspektiven einer Suffizienzpolitik, München

Further reading and citations are listed in the skript and mentioned in the course.

Prerequisites / notice
Willingness to prepare intensively the topics and to participate actively in the course

701-0659-00L Tropical Forests, Agroforestry and Complex Socio-Ecological Systems

The course will focus on integrated landscape approaches for the management of tropical forest landscapes, by addressing the complex interactions between ecological processes, stakeholders’ strategies and public policies. Dedicated tools such as games and simulation models to improve knowledge and foster collective decision-making processes will be explored.
Objective

Through the course the students will learn:

Section 1: Concepts and Methods
1. To master definitions and concepts: SES; Vulnerability; Resilience, Environmentalist Paradox.
2. To gain exposure to methods for assessing stakeholders perceptions/practices/knowledge.

Section 2: Recognising diversity & Interdisciplinarity
1. To understand points of views/normative views and how these shape management objectives and practices.
3. To explore interdisciplinary approaches to natural resources management.

Section 3: Topics and Arenas
1. To understand links between Forest, Trees and Livelihoods - poverty, food security & well-being.
2. Gain familiarity with drivers of deforestation; degradation; reforestation.
3. Knowledge of global arenas affecting the international forest regime, and their impact at the local level.
4. To recognise and understand trade-offs between conservation and development in a forest/agroforest context;

A major objective of the course is to encourage students to develop a critical analysis of existing conservation and development narratives within the frame of agroforestry and forested agricultural landscapes. The course will also provide students with methods and tools to assess stakeholders perceptions/practices and knowledge, that will be of use in their professional life.

Content

The course will address:

1. Definitions of forests and agroforests, deconstructing the rigid historical divisions between these two, and showing the complexities and implications legal definitions will have on the management systems. We will also address the definitions of Social and Ecological System (SES), and Resilience, useful for the entire course. We will provide insights on how to describe the SES using the ARDI methodology (Actors, Resources, Dynamics and Interactions)
2. Methodological frameworks to understand drivers and coping strategies of stakeholders (Sustainable livelihood framework & Vulnerability; Ecosystem Services & trade-offs; Companion Modelling and Adaptive Management; Surveys and Participatory Appraisals)

Building upon this, and introducing the Forest Transition curve as guiding framework for the course, a series of case studies will be presented, highlighting the different drivers and issues at each stage of the transition curve (Kanninen et al. 2007).

1. Tropical Forestry - including Reduced Impact Logging, Forest Certification, and International Timber Market.
2. Secondary forests and Agroforests - landscape mosaics, forest fragments, non timber forest products, slash and burn systems, small holder production systems.
3. Conversions and Deforestation: Global trends, Biofuel extensions.
5. Conclusion - Future trends; Global Arenas and Local Governance.

The course will tackle new and emerging topics such as the role of forests and trees in adaptation to climate change, the links between forest, poverty and food security, and the need to mainstream conservation of biodiversity outside protected areas. The course will draw from diverse disciplines, from ecology, economy, sociology, political sciences and legal studies as the most preeminent ones.

The course will enlarge the scope of the students from the ecological process to the social and political components of tropical social and ecological systems. It will address topics and case studies that the students will have little opportunity to address elsewhere, linking them to issues of global relevance in environmental sciences.

Literature


The lecture Energy and Mobility deals with the intersection of energy and transportation with focus on motorized individual transport. The lecture deals with the question, how the energy demand, or greenhouse gas emissions, of mobility can be reduced. A five step approach provides a common framework:

a) Status quo and Scope: Definition of the system boundary (whole transport system, or only road transport) and of the status quo of that system (energy demand and energy carrier mix for this system, current technology mix, transportation services provided);

b) Trends and Targets: Analysis of trend development of the mobility system under consideration, establishment of a trend scenario (baseline scenario). Definition of the reduction targets (expressed in terms of energy demand or greenhouse gas emissions; base year and target year: absolute or relative reduction target)

c) Potential Analysis: Analysis of currently employed technologies and of upcoming technologies. Identification of the reduction potential of current, conventional technologies and of future, alternative technologies. Technologies cover both the fuel and the vehicle side.

d) Policy Measures: Possible policy measures, direct, indirect and macro-level effects of policies, psychological aspects of decision making, elements of behavioral economics and prospect theory, combination of policies into policy mixes.

e) Effects and Side Effects: Forecasting the effects of policy measures, differentiation between effects that can be quantified and those that cannot. Identification of unintended (side) counter-effects like rebound effects and perverse incentives.

**Forest and Landscape**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-0553-00L</td>
<td>Landscape Ecology</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>F. Kienast, L. Pellissier</td>
</tr>
</tbody>
</table>

**Abstract**
The course is an introduction to Landscape Ecology and Landscape Modelling and provides various practical applications of Landscape Ecology in nature and landscape management.

**Objective**
The students are able to:
- explain and apply the concepts and methods of landscape analysis using examples,
- explain causes and effects of changes in landscape using examples and simulations,
- describe practical applications of Landscape Ecology in the management of nature and landscape.

**Content**
Contents of the lecture:
- important terms and concepts of Landscape Ecology,
- analysis of landscape pattern (metrics),
- landscape modelling,
- perception of landscapes,
- landscape inventories used for nature and landscape protection.

**Lecture notes**
There is no script. Slides and other materials are provided on Moodle.

**Literature**
Master students seeking recognition of this course in the Bologna process have to show adequate knowledge of the landscape ecology topics described above and have to read selected chapters of


**Prerequisites / notice**
Introduction, chapter 2, 3, 4, 5, 7, 10
Contact hours (approx. every 2nd week) deepen and complement the content with additional case studies, examples and discussions. It is advantageous but not required to have some GIS knowledge for this lecture and the practical 'Praktikum Wald und Landschaft' (spring semester) which is loosely linked with this lecture.

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<tr>
<th>Number</th>
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<tbody>
<tr>
<td>701-0559-00L</td>
<td>Seminar for Bachelor Students: Forest and Landscape O</td>
<td>2</td>
<td>2S</td>
<td>H. Bugmann, E. Lieberherr, P. Rotach</td>
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</table>

**Abstract**
Interdisciplinary seminar on forest and landscape issues with particular emphasis on the key processes shaping the development of forest ecosystems and landscapes.

**Objective**
- To analyze scientific original articles and other complex materials critically and to present the results in an understandable way.
- To understand selected processes, cases and methods related to forest and landscape issues.
- To be able to analyze problems related to forest ecosystems and landscape from the viewpoint of various disciplines.

**Content**
Biological, ecological, physical and technical processes with impacts on the community, ecosystem and landscape scale. Social processes and institutions with relation to land use. Products and services of forest ecosystems and landscapes. Forest management systems. The contributions will be organized around topical clusters.

**Lecture notes**
No script available. The seminar papers will be made available to all participants in electronic form.

**Literature**
Literature references will be provided by the lecturers.

**Prerequisites / notice**
The credits are given if the following requirements are met
a) oral presentation (15-20 Min + discussion)
b) seminar paper (up to approx. 5 pages, with references, no powerpoint printout).

The contributions can be presented in German or English. We expect a regular and active participation.

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<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>701-0561-00L</td>
<td>Forest Ecology</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>H. Bugmann</td>
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</tbody>
</table>

**Abstract**
This course conveys the basics of forest ecology with an emphasis on trees as those organisms that dominate the physiognomy and the dynamics of forest ecosystems. Based on this course, students have a good grasp of the qualitative and quantitative importance of forest ecosystems at the global and regional scales, with a focus on central Europe.

**Objective**
Students are able to
- summarize the fundamentals of forest ecology at the autecological, demeological and synecological level
- explain how trees dominate the physiognomy and dynamics of forest ecosystems
- describe the qualitative and quantitative importance of forest ecosystems at the global and regional scales, with an emphasis on central Europe and Alpine region.

**Content**
Introduction and overview of the forests of the world
Forest ecosystem ecology: Production ecology of forests
Auteology: light, temperature, wind, water, and nutrients
Demecology: regeneration ecology, forest growth, mortality
Synecology: Fundamentals of trophic interactions (forest-ungulate interactions), succession

**Lecture notes**
Handouts (mixture of overhead slides and full text chapters) are sold at cost
Relevant chapters from textbooks will be indicated.

**Literature**

**Prerequisites / notice**
The contents of the following courses of the 2nd year of the USYS BSc are required:


Knowledge from the following courses of the 2nd year of the USYS BSc are an asset:

701-0312-00L Pflanzen- und Vegetationsökologie
701-0314-00L Systematische Botanik
Diseases and abiotic damage influence the use and maintenance of forest ecosystems, tree populations and individual trees. This course provides a basic overview of important infectious diseases and abiotic damage in woody plants, with a focus on Central Europe. Students are able to:
- describe the basic processes of pathogenesis in trees.
- explain methods of disease diagnosis and control.
- name and identify ecologically or economically significant tree and forest diseases.

The concept of 'Forest Health', history of forest pathology, environment and disease, explanation of disease-pathogenesis, basics of epidemiology, principles of tree management. Morphology, biology, diagnosis and control of selected pathogens (parasitic phanerogams, fungi, bacteria, viruses and viroids). Morphology of mycorrhiza. Damages to woody plants caused by abiotic environmental factors.

Lectures
H. R. Heinimann

Concepts will be explained step-by-step through a set of case studies, and applied in lab by the students. The following principal steps are:

1) Einführung ins Vorgehenskonzept (1W)
- Risikobewertung (2W)
- Expositions- und Folgenanalyse
- Gefahrenbeurteilung
2) Risikoanalyse (6W + Exkursion) mit:
- Systemabgrenzung
- Gefahrenbeurteilung
- Expositions- und Folgenanalyse
- Risikobewertung (2W)
3) Risikomanagement (2W + Exkursion)
4) Abschlussbesprechung (1W)

A short bachelor's thesis should consist of a text, with graphs and figures, of 15-20 pages. The course includes practical work (microscopy).
**Objective**
By developing the bachelor's thesis, students learn to (a) analyse a problem using scientific methods and concepts, (b) write a report according to scientific standards and (c) correctly cite scientific literature.

**Content**
The BA is written either under the “Social sciences and humanities” or the “Natural sciences and technology” modules. The thesis may also be inter- and transdisciplinary.

A bachelor's thesis in the domain “Social sciences and humanities” usually deals with an issue at the interface of those sciences, the environment and sustainability. Methods of data collection, analysis and interpretation stemming from the social sciences are applied. A bachelor's thesis in “Natural sciences” deals with a topic at the interface of natural sciences, the environment and sustainability. The methods of data collection, analysis and interpretation appropriate to the natural sciences are used. A thesis in "Technology" deals with the environmental effects of use and application. The thesis may take the form of an analysis or review of a current technology, or the design of a future technological application. In an inter- or transdisciplinary thesis, knowledge from various fields and disciplines would be merged on the basis of an overarching question, or developed via the input of key societal actors.

A bachelor's thesis should consist of a text, with graphs and figures, of 30-40 pages.

<table>
<thead>
<tr>
<th>Environmental Sciences Bachelor - Key for Type</th>
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<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
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<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
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<tr>
<td>W</td>
<td>Eligible for credits</td>
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<tr>
<th>Key for Hours</th>
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<tbody>
<tr>
<td>V</td>
<td>lecture</td>
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<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
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<td>K</td>
<td>colloquium</td>
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<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
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ECTS European Credit Transfer and Accumulation System
- Special students and auditors need special permission from the lecturers.
Environmental Sciences Master

► Major in Atmosphere and Climate

★★ Prerequisites

<table>
<thead>
<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
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<tbody>
<tr>
<td>701-0471-01L</td>
<td>Atmospheric Chemistry</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>M. Ammann, D. W. Brunner</td>
</tr>
<tr>
<td>Abstract</td>
<td>The lecture provides an introduction to atmospheric chemistry at bachelor level. It introduces the kinetics of gas phase and heterogeneous reactions on aerosols and in clouds and explains the chemical and physical mechanisms responsible for global (e.g. stratospheric ozone depletion) as well as regional (e.g. urban air pollution) environmental problems.</td>
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<tr>
<td>Objective</td>
<td>The students will understand the basics of gas phase and heterogeneous reactions and will know the most relevant atmospheric chemical processes taking place in the gas phase as well as between different phases including aerosols and clouds. The students will also acquire a good understanding of atmospheric environmental problems including air pollution, stratospheric ozone destruction and changes in the oxidative capacity of the global atmosphere.</td>
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<tr>
<td>Lecture notes</td>
<td>Vorlesungsunterlagen (Folien) werden laufend während des Semesters jeweils mind. 2 Tage vor der Vorlesung zur Verfügung gestellt.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Attendance of the lecture &quot;Atmosphäre&quot; LV 701-0023-00L or equivalent is a pre-requisite.</td>
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<tr>
<td>701-0473-00L</td>
<td>Weather Systems</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>M. A. Sprenger, C. Grams</td>
</tr>
<tr>
<td>Abstract</td>
<td>This lecture introduces the theoretical principles and the observational and analytical methods of atmospheric dynamics. Based on these principles, the following aspects are discussed: the energetics of the global circulation, the basic synoptic- and meso-scale flow phenomena, in particular the dynamics of extratropical cyclones, and the influence of mountains on the atmospheric flow.</td>
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<tr>
<td>Objective</td>
<td>The students are able to - explain up-to-date meteorological observation techniques and the basic methods of theoretical atmospheric dynamics - to discuss the mathematical basis of atmospheric dynamics, based on selected atmospheric flow phenomena - to explain the basic dynamics of the global circulation and of synoptic- and meso-scale flow features - to explain how mountains influence the atmospheric flow on different scales</td>
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<tr>
<td>Content</td>
<td>Satellite observations; analysis of vertical soundings; geostrophic and thermal wind; cyclones at mid-latitude; global circulation; north-atlantic oscillation; atmospheric blocking situations; Eulerian and Lagrangian perspective; potential vorticity; Alpine dynamics (storms, orographic wind); planetary boundary layer</td>
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<tr>
<td>Lecture notes</td>
<td>Lecture notes and slides</td>
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<tr>
<td>Literature</td>
<td>Atmospheric Science, An Introductory Survey</td>
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<tr>
<td>John M. Wallace and Peter V. Hobbs, Academic Press</td>
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<tbody>
<tr>
<td>701-0475-00L</td>
<td>Atmospheric Physics</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>U. Lohmann, A. A. Mensah</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course covers the basics of atmospheric physics, which consist of: cloud and precipitation formation, thermodynamics, aerosol physics, radiation as well as the impact of aerosols and clouds on climate and artificial weather modification.</td>
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<tr>
<td>Objective</td>
<td>Students are able to - to explain the mechanisms of cloud and precipitation formation using knowledge of humidity processes and thermodynamics. - to evaluate the significance of clouds and aerosol particles for climate and artificial weather modification.</td>
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<tr>
<td>Content</td>
<td>Moist processes/thermodynamics; aerosol physics; cloud formation; precipitation processes, storms; importance of aerosols and clouds for climate and weather modification, cloud and precipitation formation,</td>
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<tr>
<td>Lecture notes</td>
<td>Powerpoint slides and script will be made available</td>
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<tr>
<td>Prerequisites / notice</td>
<td>50% of the time we use the concept of &quot;flipped classroom&quot; (en.wikipedia.org/wiki/Flipped_classroom), which we introduce at the beginning. We offer a lab tour, in which we demonstrate with some instruments how some of the processes, that are discussed in the lectures, are measured. There is an additional tutorial right after each lecture to give you the chance to ask further questions and discuss the exercises. The participation is recommended but voluntary.</td>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>701-0461-00L</td>
<td>Numerical Methods in Environmental Sciences</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>C. Schär, O. Fuhrer</td>
</tr>
<tr>
<td>Abstract</td>
<td>This lecture imparts the mathematical basics necessary for the development and application of numerical models in the field of Environmental Science. The lecture material includes an introduction into numerical techniques for solving ordinary and partial differential equations, as well as exercises aimed at the realization of simple models.</td>
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<tr>
<td>Objective</td>
<td>This lecture imparts the mathematical basics necessary for the development and application of numerical models in the field of Environmental Science. The lecture material includes an introduction into numerical techniques for solving ordinary and partial differential equations, as well as exercises aimed at the realization of simple models.</td>
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<tr>
<td>Content</td>
<td>Classification of numerical problems, introduction to finite-difference methods, time integration schemes, non-linearity, conservative numerical techniques, an overview of spectral and finite-element methods. Examples and exercises from a diverse cross-section of Environmental Science. Three obligatory exercises, each two hours in length, are integrated into the lecture. The implementation language is Matlab (previous experience not necessary: a Matlab introduction is given). Example programs and graphics tools are supplied.</td>
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<tr>
<td>Lecture notes</td>
<td>Is provided (CHF 10.- per copy).</td>
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<tr>
<td>Literature</td>
<td>List of literature is provided.</td>
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★★ Weather Systems and Atmospheric Dynamics

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<tbody>
<tr>
<td>701-1221-00L</td>
<td>Dynamics of Large-Scale Atmospheric Flow</td>
<td>W</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>H. Wernli, S. Pfahl</td>
</tr>
<tr>
<td>Abstract</td>
<td>Dynamic, synoptic Meteorology</td>
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Data: 06.03.2019 12:57  Autumn Semester 2016  Page 1496 of 1571
Dynamical Meteorology is concerned with the dynamical processes of the earth's atmosphere. The fundamental equations of motion in the atmosphere will be discussed along with the dynamics and interactions of synoptic system - i.e. the low and high pressure systems that determine our weather. The motion of such systems can be understood in terms of quasi-geostrophic theory. The lecture course provides a derivation of the mathematical basis along with some interpretations and applications of the concept.

Lecture notes: Dynamics of large-scale atmospheric flow

Literature:
- Pichler H., Dynamik der Atmosphäre, Bibliographisches Institut, 456 pp. 1997

Prerequisites / notice: Physics I, II, Environmental Fluid Dynamics

ECTS: 3G

### 651-4053-00L Boundary Layer Meteorology

**Type:** W 3 credits

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<tr>
<th>Number</th>
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</thead>
<tbody>
<tr>
<td>701-1235-00L</td>
<td>Cloud Microphysics</td>
<td>W</td>
<td>4</td>
<td>2+1U</td>
<td>U. Lohmann, Z. A. Kanji</td>
</tr>
</tbody>
</table>

**Abstract:**
The Planetary Boundary Layer (PBL) constitutes the interface between the atmosphere and the Earth's surface. Theory on transport processes in the PBL and their dynamics is provided. This course treats theoretical background and idealized concepts. These are contrasted to real world applications and current research issues.

**Objective:**
Overall goals of this course are given below. Focus is on the theoretical background and idealised concepts. Students have basic knowledge on atmospheric turbulence and theoretical as well as practical approaches to treat Planetary Boundary Layer flows. They are familiar with the relevant processes (turbulent transport, forcing) within, and typical states of the Planetary Boundary Layer. Idealized concepts are known as well as their adaptations under real surface conditions (as for example over complex topography).

**Content:**
- Introduction
- Turbulence
- Statistical tratment of turbulence, turbulent transport
- Conservation equations in a turbulent flow
- Closure problem and closure assumptions
- Scaling and similarity theory
- Spectral characteristics
- Concepts for non-ideal boundary layer conditions

**Lecture notes:**
available (i.e. in English)

**Literature:**

Prerequisites / notice: Umwelt-Fluiddynamik (701-0479-00L) (environment fluid dynamics) or equivalent and basic knowledge in atmospheric science

#### Climate Processes and Feedbacks

**Number** | **Title** | **Type** | **ECTS** | **Hours** | **Lecturers** |
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</thead>
<tbody>
<tr>
<td>701-1235-00L</td>
<td>Cloud Microphysics</td>
<td>W</td>
<td>4</td>
<td>2+1U</td>
<td>U. Lohmann, Z. A. Kanji</td>
</tr>
</tbody>
</table>

**Abstract:**
Clouds are a fascinating atmospheric phenomenon central to the hydrological cycle and the Earth’s climate. Interactions between cloud particles can result in precipitation, glaciation or evaporation of the cloud depending on its microstructure and microphysical processes.

**Objective:**
The learning objective of this course is that students understand the formation of clouds and precipitation and can apply learned principles to interpret atmospheric observations of clouds and precipitation.

**Content:**
see: http://www.iac.ethz.ch/edu/courses/master/modules/cloud-microphysics.html

**Lecture notes:**
This course will be designed as a reading course in 1-2 small groups of 8 students maximum. It will be based on the textbook below. The students are expected to read chapters of this textbook prior to the class so that open issues, fascinating and/or difficult aspects can be discussed in depth.

**Literature:**

**Prerequisites / notice:**
Target group: Master students in Atmosphere and Climate

**Number** | **Title** | **Type** | **ECTS** | **Hours** | **Lecturers** |
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<tbody>
<tr>
<td>701-1251-00L</td>
<td>Land-Climate Dynamics</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>S. I. Seneviratne, E. L. Davin</td>
</tr>
</tbody>
</table>

**Abstract:**
The purpose of this course is to provide fundamental background on the role of land surface processes (vegetation, soil moisture dynamics, land energy and water balances) for the climate system. The course consists of 2 contact hours per week, including 2 computer exercises.

**Objective:**
The students can understand the role of land processes and associated feedbacks for the climate system. Powerpoint slides will be made available

**Lecture notes / notice:**
Prerequisites: Introductory lectures in atmospheric and climate science

**Literature:**
and/or

#### Atmospheric Composition and Cycles

**Number** | **Title** | **Type** | **ECTS** | **Hours** | **Lecturers** |
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<tbody>
<tr>
<td>701-1233-00L</td>
<td>Stratospheric Chemistry</td>
<td>W</td>
<td>4</td>
<td>2+1U</td>
<td>T. Peter, A. Stanke</td>
</tr>
</tbody>
</table>

**Abstract:**

**Objective:**
The lecture gives an overview on the manifold reactions which occur in the gas phase, in stratospheric aerosol droplets and in polar cloud particles. The focus is on the chemistry of stratospheric ozone and its influence through natural and anthropogenic effects. Especially the intercontinental air traffic and the ozone depletion caused by FCKW CFC in the mid-latitude and the polar regions as well as coupling with the greenhouse effect.

**Content:**
Short presentation of thermodynamical and kinetic basics of chemical reactions: bi- and terthermo molecular reactions, photo-dissociation. Introduction to the chemical family concept: active species, their source gases and reservoir gases. Detailed treatment of the pure oxygen family (odd oxygen) according to the Chapman chemistry. Radical reactions of the (oxygen) gases with nitric oxide, active halogens (chlorine and bromine) and odd hydrogen. Ozone depletion cycles. Methane depletion and ozone production in the lower stratosphere (photo-smog reactions). Heterogeneous chemistry on the background aerosol and its significance for heavy air traffic. Chemistry and dynamics of the ozone hole: Formation of polar stratospheric clouds and chloride activation.

**Lecture notes:**
Documents are provided in the contact hours.
The student will have an understanding of evolution of climate and its major forcing factors -orbital, atmosphere chemistry, tectonics-

Conceptual and Quantitative Methods in Climate History and Paleoclimatology gives an overview on climate through geological time and it provides insight into methods materiel is distributed during the lecture

3 credits

O. Bachmann, B. Ausin Gonzalez, M. Gysel

Climate History and Palaeoclimatology

Aerosols I: Physical and Chemical Principles

Abstract
Aerosols I deals with basic physical and chemical properties of aerosol particles. The importance of aerosols in the atmosphere and in other fields is discussed.

Objective
Knowledge of basic physical and chemical properties of aerosol particles and their importance in the atmosphere and in other fields physical and chemical properties of aerosols, aerosol dynamics (diffusion, coagulation...), optical properties (light scattering, -absorption, -extinction), aerosol production, physical and chemical characterization.

Content
Material is distributed during the lecture

Literature

Climate History and Paleoclimatology

Number
Title
651-4049-00L Conceptual and Quantitative Methods in Geochemistry
651-4057-00L Climate History and Palaeoclimatology

Abstract
For this course the successful completion of the BSc-course "Geochemistry" (651-3400-00L) is a condition.

This course will introduce some of the main quantitative methods available for the quantitative treatment of geochemical data, as well as the main modelling tools. Emphasis will both be on conceptual understanding of these methods as well as on their practical application, using key software packages to analyse real geochemical datasets.

Development of a basic knowledge and understanding of the main tools available for the quantitative analysis of geochemical data.

The following approaches will be discussed in detail: major and trace element modelling of magmas, with application to igneous systems; methods and statistics for calculation of isochrons and model ages; reservoir dynamics and one-dimensional modelling of ocean chemistry; modelling speciation in aqueous (hydrothermal, fresh water sea water) fluids.

We will discuss how these methods are applied in a range of Earth Science fields, from cosmochemistry, through mantle and crustal geochemistry, volcanology and igneous petrology, to chemical oceanography.

A special emphasis will be put on dealing with geochemical problems through modelling. Where relevant, software packages will be introduced and applied to real geochemical data.

The student will have an understanding of evolution of climate and its major forcing factors -orbital, atmosphere chemistry, tectonics- through geological time. He or she will understand interaction between life and climate and he or she will be familiar with the use of most common geochemical climate "proxies", he or she will be able to evaluate quality of marine and terrestrial sedimentary palaeoclimatic archives. The student will be able to estimate rates of changes in climate history and to recognize feedbacks between the biosphere and climate.

Climate system and earth history - climate forcing factors and feedback mechanisms of the geosphere, biosphere, and hydrosphere.

Geological time, stratigraphy, geological archives, climate archives, palaeoclimatic proxies

Climate through geological time: "lessons from the past"

Cretaceous greenhouse climate

The Late Paleocene Thermal Maximum (PETM)

Cenozoic Cooling

Onset and Intensification of Southern Hemisphere Glaciation

Onset and Intensification of Northern Hemisphere Glaciation

Pliocene warmth

Glacial and Interglacials

Millennial-scale climate variability during glaciations

The last deglaciation(s)

The Younger Dryas

Holocene climate - climate and societies

Pre-requisites / notice

Prerequisites: Basics in physical chemistry are required and an overview equivalent to the bachelor course in atmospheric chemistry (lecture 701-0471-D1) is expected.

701-1233-00 V starts in the first week of the semester. The exercises 701-1233-00 U will start only in the 2nd week of the semester.

Data: 06.03.2019 12:57

Autumn Semester 2016

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### Hydrology and Water Cycle

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>701-1251-00L</td>
<td>Land-Climate Dynamics</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>S. I. Seneviratne, E. L. Davin</td>
</tr>
<tr>
<td>Abstract</td>
<td>The purpose of this course is to provide fundamental background on the role of land surface processes (vegetation, soil moisture dynamics, land energy and water balances) for the climate system. The course consists of 2 contact hours per week, including 2 computer exercises.</td>
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<tr>
<td>Objective</td>
<td>The students can understand the role of land processes and associated feedbacks for the climate system.</td>
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<tr>
<td>Lecture notes</td>
<td>Powerpoint slides will be made available</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Prerequisites: Introductory lectures in atmospheric and climate science, Numerical methods, Computational fluid dynamics (components and processes). Example of modelling with the PRMS model. Calibration and validation of models. Flood routing (unsteady flow, hydrologic routing, examples). The course contains an extensive semester project.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Prerequisites: Atmosphäre, Mathematik IV: Statistik, Anwendungsnahe Programmieren.</td>
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</table>

| 701-1253-00L | Analysis of Climate and Weather Data | W    | 3    | 2G    | C. Frei                          |
| Abstract     | Observation networks and numerical climate and forcasting models deliver large primary datasets. The use of this data in practice and in research requires specific techniques of statistical data analysis. This lecture introduces a range of frequently used techniques, and enables students to apply them and to properly interpret their results. |
| Objective    | Observation networks and numerical climate and forcasting models deliver large primary datasets. The use of this data in practice and in research requires specific techniques of statistical data analysis. This lecture introduces a range of frequently used techniques, and enables students to apply them and to properly interpret their results. |
| Content      | Introduction into the theoretical background and the practical application of methods of data analysis in meteorology and climatology. Topics: exploratory methods, hypothesis tests, analysis of climate trends, measuring the skill of climate and forcasting models, analysis of extreme events, principal component analysis and maximum covariance analysis. |
| Lecture notes| Documentation and supporting material include:  |
| Literature   | Suggested literature:  |
| Prerequisites / notice | Prerequisites: Atmosphäre, Mathematik IV: Statistik, Anwendungsnahe Programmieren. |

| 102-0237-00L | Hydrology II                       | W    | 3    | 2G    | C. Frei                          |
| Abstract     | The course presents advanced hydrological analyses of rainfall-runoff processes. The course is given in English. |
| Objective    | Tools for hydrological modelling are discussed at the event and continuous scale. The focus is on the description of physical processes and their modelisation with practical examples. |
| Lecture notes| Parts of the script for “Hydrology II” are used. Also available are the overhead transparencies used in the lectures. The semester project consists of a two part instruction manual. |
| Literature   | Additional literature is presented during the course. |

| 651-4053-05L | Boundary Layer Meteorology         | Z    | 4    | 3G    | M. Rotach, P. Calanca            |
| Abstract     | The Planetary Boundary Layer (PBL) constitutes the interface between the atmosphere and the Earth’s surface. Theory on transport processes in the PBL and their dynamics is provided. This course treats theoretical background and idealized concepts. These are contrasted to real world applications and current research issues. |
| Objective    | Overall goals of this course are given below. Focus is on the theoretical background and idealised concepts. Students have basic knowledge on atmospheric turbulence and theoretical as well as practical approaches to treat Planetary Boundary Layer flows. They are familiar with the relevant processes (turbulent transport, forcing) within, and typical states of the Planetary Boundary Layer. Idealized concepts are known as well as their adaptations under real surface conditions (as for example over complex topography). |
| Content      | - Introduction  |
| Literature   | available (i.e. in English)  |
| Prerequisites / notice | Prerequisites: Atmosphäre, Mathematik IV: Statistik, Anwendungsnahe Programmieren. |

### Colloquia and Seminars

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>701-1211-01L</td>
<td>Master's Seminar: Atmosphere and Climate 1</td>
<td>O</td>
<td>3</td>
<td>2S</td>
<td>H. Joos, O. Stebler, F. Tummon, M. A. Wüest</td>
</tr>
</tbody>
</table>

Data: 06.03.2019 12:57 Autumn Semester 2016 Page 1499 of 1571
In this seminar, the process of writing a scientific proposal will be introduced. The essential elements of a proposal, including the peer review process, will be outlined and class exercises will train scientific writing skills. Knowledge exchange between class participants is promoted through the preparation of a master thesis proposal and evaluation of each other’s work.

**Objective**

Training scientific writing skills.

**Content**

In this seminar, the process of writing a scientific proposal will be introduced. The essential elements of a proposal, including the peer review process, will be outlined and class exercises will train scientific writing skills. Knowledge exchange between class participants is promoted through the preparation of a master thesis proposal and evaluation of each other’s work.

**Prerequisites / notice**

Attendance is mandatory.

---

**701-1211-02L**  
**Master’s Seminar: Atmosphere and Climate 2**  
**Abstract**

In this seminar scientific project management is introduced and applied to your master project. The course concludes with a presentation of your project including an overview of the science and a discussion of project management techniques applied to your thesis project.

**Objective**

Apply scientific project management techniques to your master project.

**Content**

In this seminar scientific project management is introduced and applied to your master project. The course concludes with a presentation of your project including an overview of the science and a discussion of project management techniques applied to your thesis project.

**Prerequisites / notice**

Attendance is mandatory.

---

**701-1213-00L**  
**Introduction Course to Master Studies Atmosphere and Climate**  
**Abstract**

New master students are introduced to the atmospheric and climate research field through keynotes given by the programme's professors. In several self-assessment and networking workshops they get to know each other and find their position in the science.

**Objective**

The aims of this course are: i) to welcome all students to the master program and to ETH, ii) to acquaint students with the faculty teaching in the field of atmospheric and climate science at ETH and at the University of Bern, iii) that the students get to know each other and iv) to assess needs and discuss options for training and education of soft-skills during the Master program and to give an overview of the study options in general.

---

**651-4095-01L**  
**Colloquium Atmosphere and Climate 1**  
**Abstract**

The colloquium is a series of scientific talks by prominent invited speakers assembling interested students and researchers from around Zürich. Students take part of the scientific discussions.

**Objective**

The students are exposed to different atmospheric science topics and learn how to take part in scientific discussions.

---

**651-4095-02L**  
**Colloquium Atmosphere and Climate 2**  
**Abstract**

The colloquium is a series of scientific talks by prominent invited speakers assembling interested students and researchers from around Zürich. Students take part of the scientific discussions.

**Objective**

The students are exposed to different atmospheric science topics and learn how to take part in scientific discussions.

---

**651-4095-03L**  
**Colloquium Atmosphere and Climate 3**  
**Abstract**

The colloquium is a series of scientific talks by prominent invited speakers assembling interested students and researchers from around Zürich. Students take part of the scientific discussions.

**Objective**

The students are exposed to different atmospheric science topics and learn how to take part in scientific discussions.

---

### Electives

#### Climate Processes and Feedbacks

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
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<tbody>
<tr>
<td>701-1221-00L</td>
<td>Dynamics of Large-Scale Atmospheric Flow</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>H. Wernli, S. Pfahl</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>Understanding the dynamics of large-scale atmospheric flow</td>
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<tr>
<td><strong>Objective</strong></td>
<td>Dynamical Meteorology is concerned with the dynamical processes of the earth's atmosphere. The fundamental equations of motion in the atmosphere will be discussed along with the dynamics and interactions of synoptic system - i.e. the low and high pressure systems that determine our weather. The motion of such systems can be understood in terms of quasi-geostrophic theory. The lecture course provides a derivation of the mathematical basis along with some interpretations and applications of the concept.</td>
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<tr>
<td><strong>Content</strong></td>
<td>Dynamics of large-scale atmospheric flow</td>
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<tr>
<td><strong>Lecture notes</strong></td>
<td>Dynamics of large-scale atmospheric flow</td>
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<tr>
<td><strong>Prerequisites / notice</strong></td>
<td>Physics I, II, Environmental Fluid Dynamics</td>
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<tr>
<td>651-4057-00L</td>
<td>Climate History and Palaeoclimatology</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>S. Bernasconi, B. Ausin Gonzalez, A. Fernandez Bremer, A. Gilli</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>The course *Climate history and palaeoclimatology gives an overview on climate through geological time and it provides insight into methods and tools used in palaeoclimatic research.</td>
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</tbody>
</table>
The student will have an understanding of evolution of climate and its major forcing factors -orbital, atmosphere chemistry, tectonics-through geological time. He or she will understand interaction between life and climate and he or she will be familiar with the use of most common geochemical climate "proxies", he or she will be able to evaluate quality of marine and terrestrial sedimentary paleoclimatic archives. The student will be able to estimate rates of changes in climate history and to recognize feedbacks between the biosphere and climate.

Content

- Climate system and earth history - climate forcing factors and feedback mechanisms of the geosphere, biosphere, and hydrosphere.
- Geological time, stratigraphy, geological archives, climate archives, paleoclimatic proxies
- Climate through geological time: "lessons from the past"
- Cretaceous greenhouse climate
- The Late Paleocene Thermal Maximum (PETM)
- Cenozoic Cooling
- Onset and Intensification of Southern Hemisphere Glaciation
- Onset and Intensification of Northern Hemisphere Glaciation
- Pliocene warmth
- Glacial and Interglacials
- Millennial-scale climate variability during glaciations
- The last glaciation(s)
- The Younger Dryas
- Holocene climate - climate and societies

- Objective

<table>
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<tr>
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</thead>
<tbody>
<tr>
<td>701-1235-00L</td>
<td>Cloud Microphysics</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>U. Lohmann, Z. A. Kanji</td>
</tr>
<tr>
<td>102-0635-01L</td>
<td>Air Pollution Control</td>
<td>W</td>
<td>6</td>
<td>4G</td>
<td>B. Buchmann, P. Hofer</td>
</tr>
</tbody>
</table>

- Abstract

- Number of participants limited to 16.
- Clouds are a fascinating atmospheric phenomenon central to the hydrological cycle and the Earth’s climate. Interactions between cloud particles can result in precipitation, glaciation or evaporation of the cloud depending on its microstructure and microphysical processes.

- Objective

- The learning objective of this course is that students understand the formation of clouds and precipitation and can apply learned principles to interpret atmospheric observations of clouds and precipitation.

- Content

- see: http://www.iac.ethz.ch/edu/courses/master/modules/cloud-microphysics.html

- Lecture notes

- This course will be designed as a reading course in 1-2 small groups of 8 students maximum. It will be based on the textbook below. The students are expected to read chapters of this textbook prior to the class so that open issues, fascinating and/or difficult aspects can be discussed in depth.

- Literature


- Prerequisites / notice

- Target group: Master students in Atmosphere and Climate
**Boundary Layer Meteorology**

**Number:** 651-4053-05L  
**Title:** Boundary Layer Meteorology  
**Type:** W  
**ECTS:** 4  
**Hours:** 3G  
**Lecturers:** M. Rotach, P. Calanca

**Abstract**
The Planetary Boundary Layer (PBL) constitutes the interface between the atmosphere and the Earth's surface. Theory on transport processes in the PBL and their dynamics is provided. This course treats theoretical background and idealized concepts. These are contrasted to real world applications and current research issues.

**Objective**
Overall goals of this course are given below. Focus is on the theoretical background and idealised concepts. Students have basic knowledge on atmospheric turbulence and theoretical as well as practical approaches to treat Planetary Boundary Layer flows. They are familiar with the relevant processes (turbulent transport, forcing) within, and typical states of the Planetary Boundary Layer. Idealized concepts are known as well as their adaptations under real surface conditions (as for example over complex topography).

**Content**
- Introduction
- Turbulence
- Statistical treatment of turbulence, turbulent transport
- Conservation equations in a turbulent flow
- Closure problem and closure assumptions
- Scaling and similarity theory
- Spectral characteristics
- Concepts for non-ideal boundary layer conditions

**Lecture notes**
available (i.e. in English)

**Literature**

**Prerequisites / notice**
Umwelt-Fluiddynamik (701-0479-00L) (environment fluid dynamics) or equivalent and basic knowledge in atmospheric science

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**Environmental Soil Physics/Vadose Zone Hydrology**

**Number:** 701-0535-00L  
**Title:** Environmental Soil Physics/Vadose Zone Hydrology  
**Type:** W  
**ECTS:** 3  
**Hours:** 2G+2U  
**Lecturers:** D. Or

**Abstract**
The course provides theoretical and practical foundations for understanding and characterizing physical and transport properties of soils/near-surface earth materials, and quantifying hydrological processes and fluxes of mass and energy at multiple scales. Emphasis is given to land-atmosphere interactions, the role of plants on hydrological cycles, and biophysical processes in soils.

**Objective**
Students are able to
- characterize quantitative knowledge needed to measure and parameterize structural, flow and transport properties of partially-saturated porous media.
- quantify driving forces and resulting fluxes of water, solute, and heat in soils.
- apply modern measurement methods and analytical tools for hydrological data collection
- conduct and interpret a limited number of experimental studies
- explain links between physical processes in the vadose-zone and major societal and environmental challenges
Content

Weeks 1 to 3: Physical Properties of Soils and Other Porous Media Units and dimensions, definitions and basic mass-volume relationships between the solid, liquid and gaseous phases; soil texture; particle size distributions; surface area; soil structure. Soil colloids and clay behavior

Soil Water Content and its Measurement - Definitions; measurement methods - gravimetric, neutron scattering, gamma attenuation; and time domain reflectometry; soil water storage and water balance.

Weeks 4 to 5: Soil Water Retention and Potential (Hydrostatics) - The energy state of soil water; total water potential and its components; properties of water (molecular, surface tension, and capillary rise); modern aspects of capillarity in porous media; units and calculations and measurement of equilibrium soil water potential components; soil water characteristic curves definitions and measurements; parametric models; hysteresis. Modern aspects of capillarity

Demo-Lab: Laboratory methods for determination of soil water characteristic curve (SWC), sensor pairing

Weeks 6 to 9: Water Flow in Soil - Hydrodynamics:
Part 1 - Laminar flow in tubes (Poiseuille's Law); Darcy's Law, conditions and states of flow; saturated flow; hydraulic conductivity and its measurement.
Lab #1: Measurement of saturated hydraulic conductivity in uniform and layered soil columns using the constant head method.
Part 2 - Unsaturated steady state flow; unsaturated hydraulic conductivity models and applications; non-steady flow and Richards Eq.; approximate solutions to infiltration (Green-Ampt, Philip); field methods for estimating soil hydraulic properties.
Midterm exam
Lab #2: Measurement of vertical infiltration into dry soil column - Green-Ampt, and Philip's approximations; infiltration rates and wetting front propagation.
Part 3 - Use of Hydrus model for simulation of unsaturated flow

Week 10 to 11: Energy Balance and Land Atmosphere Interactions - Radiation and energy balance; evapotranspiration definitions and estimation; transpiration, plant development and transpiration coefficients small and large scale influences on hydrological cycle; surface evaporation.

Week 12 to 13: Solute Transport in Soils - Transport mechanisms of solutes in porous media; breakthrough curves; convection-dispersion eq.; solutions for pulse and step solute application; parameter estimation; salt balance.
Lab #3: Miscible displacement and breakthrough curves for a conservative tracer through a column; data analysis and transport parameter estimation.

Additional topics:
Temperature and Heat Flow in Porous Media - Soil thermal properties; steady state heat flow; nonsteady heat flow; estimation of thermal properties; engineering applications.

Biological Processes in the Vadose Zone - An overview of below-ground biological activity (plant roots, microbial, etc.); interplay between physical and biological processes. Focus on soil-atmosphere gaseous exchange; and challenges for bio- and phytoremediation.

Lecture notes
Classnotes on website: Vadose Zone Hydrology, by Or D., J.M. Wraith, and M. Tuller (available at the beginning of the semester)
http://www.step.ethz.ch/education/active-courses/vadose-zone-hydrology

Literature
Supplemental textbook (not mandatory) - Environmental Soil Physics, by: D. Hillel

102-0287-00L Fluvial Systems W 3 credits 2G P. Molnar

Abstract
The course presents a view of the processes acting on and shaping the landscape and the fluvial landforms that result. The fluvial system is viewed in terms of the production and transport of sediment on hillslopes, the structure of the river network and channel morphology, fluvial processes in the river, riparian zone and floodplain, and basics of catchment and river management.

Objective
The course has two fundamental aims: (1) it aims to provide environmental engineers with the physical process basis of fluvial system change, using the right language and terminology to describe landforms; and (2) it aims to provide quantitative skills in making simple and more complex predictions of change and the data and models required.

Content
The course consists of three sections: (1) Introduction to fluvial forms and processes and geomorphic concepts of landscape change, including climatic and human activities acting on the system. (2) The processes of sediment production, uplift sheet-rill-gully erosion, basin sediment yield, rainfall-triggered landsliding, sediment budgets, and the modelling of the individual processes involved. (3) Processes in the river, floodplain and riparian zone, including river network topology, channel geometry, aquatic habitat, role of riparian vegetation, including basics of fluvial system management. The main focus of the course is hydrological and the scales of interest are field and catchment scales.

Lecture notes
There is no script.

Literature
The course materials consist of a series of 13 lecture presentations and notes to each lecture. The lectures were developed from textbooks, professional papers, and ongoing research activities of the instructor. All material is on the course webpage.

Prerequisites / notice
Prerequisites: Hydrology 1 and Hydrology 2 (or contact instructor).

651-2915-00L Seminar in Hydrology Z 0 credits 1S P. Burlando, J. W. Kirchner, S. Löw, D. Or, C. Schär, M. Schirmer, S. I. Seneviratne, M. Stedinger, C. H. Stamm, University lecturers

651-4023-00L Groundwater W 4 credits 3G M. O. Saar, X.Z. Kong

Abstract
The course provides an introduction into quantitative analysis of groundwater flow and solute/heat transport. It is focussed on understanding, formulating, and solving groundwater flow and solute/heat transport problems.

Objective
a) Students understand the basic concepts of groundwater flow and solute/heat transport processes and boundary conditions.
b) Students are able to formulate simple, practical groundwater flow and solute/heat transport problems.
c) Students are able to understand and apply simple analytical and/or numerical solutions to fluid flow and solute/heat transport problems.
## Content

1. Introduction to groundwater problems. Concepts to quantify properties of aquifers.
2. Flow equation. The generalised Darcy law.
3. The water balance equation.
5. Analytical solutions to flow problems I
6. Analytical solutions to flow problems II
7. Finite difference solution to flow problems.
12. Analytical solutions to transport problems I.
13. Analytical solutions to transport problems II

### Lecture notes

Handouts of slides.

### Literature

- de Marsily G., Quantitative Hydrogeology, Academic Press, 1986

### Additional Elective Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>701-1237-00L</td>
<td>Solar Ultraviolet Radiation</td>
<td>W</td>
<td>1 credit</td>
<td>1V</td>
<td>J. Gröbner</td>
</tr>
</tbody>
</table>

### Abstract

The lecture will introduce the student to the thematics of solar ultraviolet radiation and its effects on the atmosphere and the biosphere. The lecture will cover the modeling and the measurement of solar ultraviolet radiation. The instruments used for solar radiation measurements will also be introduced.

### Objective

The lecture should enable the student to understand the specific problematics related to solar ultraviolet radiation and its interaction with the atmosphere and the biosphere.
1) Einführung in die Problematik  Motivation
   Begriffe (UV-C, UV-B, UV-A,...)
   Einfluss der UV Strahlung auf Biosphäre (Mensch, Tier, Pflanzen)
   Positive und schädliche Effekte
   Wirkungsspektrum, Konzept, Beispiele
   UVIndex:

2) Geschichtlicher Rückblick
   Rayleigh - Himmelsblau
   1907: Dorno, PMOD
   1970: Bener, PMOD
   1980: Berger, erythematous sunburn meter
   1990-: State of the Art

3) Extraterrestrische UV Strahlung
   Spektrum
   Energieverteilung
   Variabilität (Spektral, zeitlich, relativ zu Totalstrahlung)
   Satellitenmessungen, Übersicht

4) Einfluss der Atmosphäre auf die solare UV Strahlung
   Atmosphärenaufbau
   Beinflussende Parameter (Ozon, Wolken, ...)
   Ozon, Stratosphärisches versus troposphärisches
   Geschichte: Ozondepletion, Polare Ozonlöcher und Einfluss auf die UV Strahlung
   Wolken
   Aerosole
   Rayleighstreuung
   Trends (Ozon, Wolken, Aerosole)
   Radiation Amplification Factor (RAF)

5-6) Strahlungstransfer
   Strahlungsstransfergleichung
   Modellierung, DISORT
   libRadtran, TUV, FASTRT
   Parameter
   Sensitivitätsstudien
   Vergleiche mit Messungen
   3-D Modellierung (MYSTIC)
   Beer-Lambert Gesetz

7) Strahlungsmessungen
   Instrumente zur Strahlungsmessung
   Messgrössen: Irradiance (global, direct, diffus), radiance, aktinischer Fluss
   Horizontale und geneigte Flächen
   Generelle Problematik: Freiluftmessungen...
   Qualitätssicherung

8) Solare UV Strahlungsmessungen
   Problematik: Dynamik, Spektrale Variabilität, Alterung
   Stabilität
   Spezifische Instrumente: Filterradiometer, Spektroradiometer, Dosimetrie
   Übersicht Aufbau und Verwendung

9-10) Solare UV Strahlungsmessgeräte
   Spektroradiometer, Filterradiometer (Breit und schmalbandig)
   Charakterisierung
   Kalibriermethoden (im Labor, im Feld)
   Qualitätssicherung, Messkampagnen

11-12) Auswerteverfahren
   Atmosphärische Parameter aus Strahlungsmessungen
   Ozon, SO2
   Albedo (Effektiv versus Lokal)
   Aerosol Parameter (AOD, SSA, g, Teilchenverteilungen)
   Zusammenspiel Messungen - Modellierung
   Aktinische UV-Strahlungsf läüße und Bestimmung von atmosphärischen Photolysefrequenzen

13) UV Klimatologie
   Trends
   UV Klimatologie durch Messnetze
   UV Klimatologie durch Satellitenmessungen am Beispiel von TOMS
   Modellierung am Beispiel Meteosat-JRC
   UV Rekonstruktionen

14) Aktuelle Forschungen
   Internationale Projekte, Stand der Forschung

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**651-4273-00L Numerical Modelling in Fortran**

**Abstract**

This course gives an introduction to programming in FORTRAN95, and is suitable for students who have only minimal programming experience. The focus will be on Fortran 95, but Fortran 77 will also be covered for those working with already-existing codes. A hands-on approach will be emphasized rather than abstract concepts.

**Objective**

FORTRAN 95 is a modern programming language that is specifically designed for scientific and engineering applications. This course gives an introduction to programming in this language, and is suitable for students who have only minimal programming experience, for example with MATLAB scripts. The focus will be on Fortran 95, but Fortran 77 will also be covered for those working with already-existing codes. A hands-on approach will be emphasized rather than abstract concepts, using example scientific problems relevant to Earth science.

**Lecture notes**

See http://jupiter.ethz.ch/~pjt/FORTRAN/FortranClass.html

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Data: 06.03.2019 12:57  Autumn Semester 2016  Page 1505 of 1571
Numerical Modelling in Fortran (Project)

Prerequisite: 651-4273-00L Numerical Modelling in Fortran

W 1 credit

Abstract

This course gives an introduction to programming in FORTRAN95, and is suitable for students who have only minimal programming experience. The focus will be on Fortran 95, but Fortran 77 will also be covered for those working with already-existing codes. A hands-on approach will be emphasized rather than abstract concepts.

Objective

FORTRAN 95 is a modern programming language that is specifically designed for scientific and engineering applications. This course gives an introduction to programming in this language, and is suitable for students who have only minimal programming experience, for example with MATLAB scripts. The focus will be on Fortran 95, but Fortran 77 will also be covered for those working with already-existing codes. A hands-on approach will be emphasized rather than abstract concepts, using example scientific problems relevant to Earth science.

Content

The project consists of writing a Fortran program to solve a problem agreed upon between the instructor and student; the topic is often related to (and helps to advance) the student's Masters or PhD research. The project is typically started towards the end of the main Fortran class when the student has acquired sufficient programming skills, and is due by the end of Semesterprüfung week.

Lecture notes

See http://jupiter.ethz.ch/~pjt/FORTRAN/FortranProject.html

Major in Biogeochemistry and Pollutant Dynamics

Biogeochemical Processes

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>701-1313-00L</td>
<td>Isotopic and Organic Tracers in Biogeochemistry</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>R. Kipfer, S. Ladd</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course introduces the scientific concepts and typical applications of tracers in biogeochemistry. The course covers stable and radioactive isotopes, geochemical tracers and biomarkers and their application in biogeochemical processes as well as regional and global cycles. The course provides essential background for the lab course &quot;Isotopic and Organic Tracers Laboratory&quot;.</td>
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<tr>
<td>Objective</td>
<td>The course aims at understanding the fractionation of stable isotopes in biogeochemical processes. Students learn to know the origin and decay modes of relevant radionuclides. They discover the spectrum of possible geochemical tracers and biomarkers, their potential and limitations and get familiar with important applications</td>
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<tr>
<td>Content</td>
<td>Geogenic and cosmogenic radionuclides (sources, decay chains); stable isotopes in biogeochemistry (natural abundance, fractionation); geochemical tracers for processes such as erosion, productivity, redox fronts; biomarkers for specific microbial processes.</td>
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<tr>
<td>Literature</td>
<td>A list of relevant books and papers will be provided</td>
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</tr>
<tr>
<td>Prerequisites / notice</td>
<td>Students should have a basic knowledge of biogeochemical processes (BSc course on Biogeochemical processes in aquatic systems or equivalent)</td>
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Biogeochemical Trace Elements

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>701-1315-00L</td>
<td>Biogeochemical Trace Elements</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>A. Voegelin, M. Ettie, L. Winkel</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course addresses the biogeochemical classification and behavior of trace elements, including key processes driving the cycling of important trace elements in aquatic and terrestrial environments and the coupling of abiotic and biotic transformation processes of trace elements. Examples of the role of trace elements in natural or engineered systems will be presented and discussed in the course.</td>
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<tr>
<td>Objective</td>
<td>The students are familiar with the chemical characteristics, the environmental behavior and fate, and the biogeochemical reactivity of different groups of trace elements. They are able to apply their knowledge on the interaction of trace elements with geosphere components and on abiotic and biotic transformation processes of trace elements to discuss and evaluate the behavior and impact of trace elements in aquatic and terrestrial systems.</td>
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<tr>
<td>Content</td>
<td>(i) Definition, importance and biogeochemical classification of trace elements. (ii) Key biogeochemical processes controlling the cycling of different trace elements (base metals, redox-sensitive and chalcophile elements, volatile trace elements) in natural and engineered environments. (iii) Abiotic and biotic processes that determine the environmental fate and impact of selected trace elements.</td>
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</tr>
<tr>
<td>Lecture notes</td>
<td>Selected handouts (lecture notes, literature, exercises) will be distributed during the course.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Students are expected to be familiar with the basic concepts of aquatic and soil chemistry covered in the respective classes at the bachelor level (soil mineralogy, soil organic matter, acid-base and redox reactions, complexation and sorption reactions, precipitation/dissolution reactions, thermodynamics, kinetics, carbonate buffer system).</td>
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</table>

Physical Transport Processes in the Natural Environment

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<tr>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>701-1316-00L</td>
<td>Physical Transport Processes in the Natural Environment</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>J. W. Kirchner</td>
</tr>
<tr>
<td>Abstract</td>
<td>Fluid flows transport all manner of biologically important gases, nutrients, toxins, contaminants, spores and seeds, as well as a wide range of organisms themselves. This course explores the physics of fluids in the natural environment, with emphasis on the transport, dispersion, and mixing of solutes and entrained particles, and their implications for biological and biogeochemical processes.</td>
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<tr>
<td>Objective</td>
<td>Students will learn key concepts of fluid mechanics and how to apply them to environmental problems. Weekly exercises based on real-world data will develop core skills in analysis, interpretation, and problem-solving.</td>
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<tr>
<td>Content</td>
<td>dimensional analysis, similarity, and scaling solute transport in laminar and turbulent flows transport and dispersion in porous media transport of sediment (and adsorbed contaminants) by air and water anomalous dispersion</td>
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</tr>
<tr>
<td>Lecture notes</td>
<td>The course is under development. Lecture materials will be distributed as they become available.</td>
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</tbody>
</table>

Water Resources and Drinking Water

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<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-1341-00L</td>
<td>Water Resources and Drinking Water</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>S. Hug, M. Berg, F. Hammes, U. von Gunten</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course covers qualitative (chemistry and microbiology) and quantitative aspects of drinking water from the resource to the tap. Natural processes, anthropogenic pollution, legislation of groundwater and surface water and of drinking water as well as water treatment will be discussed for industrialized and developing countries.</td>
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<tr>
<td>Objective</td>
<td>The goal of this lecture is to give an overview over the whole path of drinking water from the source to the tap and understand the involved physical, chemical and biological processes which determine the drinking water quality.</td>
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<tr>
<td>Content</td>
<td>The course covers qualitative (chemistry and microbiology) and quantitative aspects of drinking water from the resource to the tap. The various water resources, particularly groundwater and surface water, are discussed as part of the natural water cycle influenced by anthropogenic activities such as agriculture, industry, urban water systems. Furthermore legislation related to water resources and drinking water will be discussed. The lecture is focused on industrialized countries, but also addresses global water issues and problems in the developing world. Finally unit processes for drinking water treatment (filtration, adsorption, oxidation, disinfection etc.) will be presented and discussed.</td>
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<tr>
<td>Lecture notes</td>
<td>Handouts will be distributed</td>
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<tr>
<td>Literature</td>
<td>Will be mentioned in handouts</td>
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</tbody>
</table>

Data: 06.03.2019 12:57 Autumn Semester 2016 Page 1506 of 1571
Future climate change can only be kept within reasonable bounds when CO2 emissions are drastically reduced. In this course, we will discuss a portfolio of options involving the alteration of natural carbon sinks and carbon sequestration. The course includes introductory lectures, presentations from guest speakers from industry and the public sector, and final presentations by the students.

Objective
The goal of this course is to investigate, as a group, a particular set of carbon mitigation/sequestration options and to evaluate their potential, their cost, and their consequences.

Content
From the large number of carbon sequestration/option mitigation, a few options will be selected and then investigated in detail by the students. The results of this research will then be presented to the other students, the involved faculty, and discussed in detail by the whole group.

Lecture notes
None

Literature
Will be identified based on the chosen topic.

Prerequisites / notice
Exam: No final exam. Pass/No-Pass is assigned based on the quality of the presentation and ensuing discussion.

The lecture provides an overview on the behavior and effects of engineered nanomaterials in the environment as far as they are currently understood. The course will cover definitions, analysis, fate in technical and natural systems, effects (nano-ecotoxicology) and environmental risk assessment of nanomaterials.

Objective
- Successful application of knowledge gained in the traditional disciplines of environmental sciences (e.g. biogeochemistry, environmental chemistry) to elucidate nanomaterial fate and behavior in the environment
- Identify key parameters of nanomaterials that potentially influence their environmental fate and behavior
- Get acquainted with the most common analytical tools for the quantification of nanomaterials in the environment
- Critical assessment of current state of research in this juvenile field, including the sometimes controversial literature data

Content
Topics
- Definitions; nano-effects: engineered, natural and incidental nanoparticles
- Sources and release; Material flow modeling
- Analysis in environmental samples
- Fate in technical systems: water treatment, waste incineration
- Fate in the environment: water and soil
- Effects: nano-ecotoxicology
- Environmental risk assessment

Group work
Case studies about specific nanomaterials in environmental systems, topics will be provided
Written report submitted and presentation at the end of the lecture

Lecture notes
Handouts will be provided

Literature
will be provided during lecture

Practices of landfilling and remediation of contaminated sites and disposal of radioactive waste are based on the same concepts that aim to protect the environment. The assessment of contaminants that may leak into the environment as a function of time and how to reduce the rate of their release is key to the design of chemical, technical and geological barriers.

Objective
- Assess the risk posed to the environment of landfills, contaminated sites and radioactive waste repositories in terms of fate and transport of contaminants
- Describe technologies available to minimize environmental contamination
- Describe the principles in handling of contaminated sites and to propose and evaluate suitable remediation techniques
- Explain the concepts that underlie radioactive waste disposal practices

Content
This lecture course comprises lectures with exercises and guided case studies.
- A short overview of the principles of environmental protection in waste management and how this is applied in legislation.
- A overview of the chemistry underlying the release and transport of contaminants from the landfilled/contaminated material/radioactive waste repository focusing on processes that control redox state and pH buffer capacity; mobility of heavy metals and organic compounds
- Technical barrier design and function. Clay as a barrier.
- Contaminated site remediation: Site evaluation, remediation technologies
- Concepts and safety in radioactive waste management
- Role of the geological and engineered barriers and radionuclide transport in geological media.

Lecture notes
Short script plus copies of overheads

Literature
Literature will be made available.

Prerequisites / notice
This is an interdisciplinary course aimed at environmental scientists and environmental engineers.

Methods and Tools: Lab Courses

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>701-1346-00L</td>
<td>Carbon Mitigation</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>N. Gruber</td>
</tr>
<tr>
<td>701-1351-00L</td>
<td>Nanomaterials in the Environment</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>B. Nowack, T. Bucheli</td>
</tr>
<tr>
<td>102-0337-00L</td>
<td>Landfilling, Contaminated Sites and Radioactive Waste Repositories</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>W. Hummel, L. M. Plötzte</td>
</tr>
</tbody>
</table>

Abstract
The course offers a practical introduction into the investigation of the biogeochemistry of trace elements. Laboratory experiments are performed to study a selected environmental process. Advanced techniques for the analysis of total element contents and element speciation are used. The experimental findings are interpreted and discussed in their environmental context.

Objective
The objective of this course, is to offer students a practical introduction into the investigation of the biogeochemistry of trace elements. During the course, students will become familiar with some of the key experimental approaches typically used in the investigation of the biogeochemistry of trace elements in the laboratory. In addition, students will learn to use different advanced analytical techniques to measure the total content and the speciation of trace elements in both liquid and solid samples. The students will interpret and discuss their experimental findings in the context of the studied environmental system.

Content
Laboratory experiments are designed and performed to study the interplay of various biogeochemical processes in a specific environmental system. Moreover, the effect of these processes on the biogeochemical cycling of trace elements in the environment will be considered.

Lecture notes
Selected handouts will be distributed during the course.

Literature
All necessary literature will be uploaded to the ILIAS repository during the course.
This course will illustrate how different tracers and isotopes are used in natural systems. Here especially the processes (transformation, timescales) that take place and can be revealed by tracers/isotopes will be demonstrated but also flux rates will be calculated using different tracers.

Students know how to use tracers/isotopes to investigate/understand ecosystems They will understand the methods and analytical devices related to tracer/isotope work. Students will be able to apply different sampling techniques in aquatic systems.

Basics:
- O,H isotopes as tracers for mixing in aquatic systems
- Carbon isotopes as tracer for methane oxidation
- 210Pb, 137Cs as a tracer for sedimentation rate/mixing
- SF6, Neon, He as tracers for exchange processes at the air/water interface

Case assessment:
- Sampling of a Swiss lake (Rotsee)
- Sampling techniques for different elements
- Sample preparation for different techniques
- Measurements at isotope mass spectrometer/gamma counter

Interpretation of results from the special sampling campaign and in a broader context.

**701-1333-00L**  
**Isotopic and Organic Tracers Laboratory**  

**Abstract**  
This course will illustrate how different tracers and isotopes are used in natural systems. Here especially the processes (transformation, timescales) that take place and can be revealed by tracers/isotopes will be demonstrated but also flux rates will be calculated using different tracers.

**Objective**  
Students know how to use tracers/isotopes to investigate/understand ecosystems They will understand the methods and analytical devices related to tracer/isotope work. Students will be able to apply different sampling techniques in aquatic systems.

**Content**  
Basics:
- O,H isotopes as tracers for mixing in aquatic systems
- Carbon isotopes as tracer for methane oxidation
- 210Pb, 137Cs as a tracer for sedimentation rate/mixing
- SF6, Neon, He as tracers for exchange processes at the air/water interface

Case assessment:
- Sampling of a Swiss lake (Rotsee)
- Sampling techniques for different elements
- Sample preparation for different techniques
- Measurements at isotope mass spectrometer/gamma counter

Interpretation of results from the special sampling campaign and in a broader context.

**701-1337-00L**  
**Forest Soils - Functions and Responses to Environmental Changes**  

**Abstract**  
The students are measuring carbon and nutrient fluxes in forest soils under a changing climate and land-use. In laboratory and field experiments, they are manipulating climatic conditions (temperature, drought) and quantify the response of C and N fluxes in soils, and plant-soil interactions. The results will be interpreted and discussed in the context of changes in climate and land-use.

**Objective**  
The students get first-hand experience with field and laboratory methods to measure carbon and nutrient fluxes. They shall learn about physico-chemical properties of Swiss forest soils and how these properties determine the ecological functions of soils and their response to environmental changes. Finally the students shall interpret, discuss and present their experimental data.

**Content**  
1. Introduction to the ecological functions of Swiss forest soils
2. Measurement of soil CO2 efflux, carbon and nutrient leaching in a forest soil
3. Sampling and preparation of litter and soil samples from selected soil profiles under different land-uses
4. Setting-up laboratory experiments in microcosms. Measurement of soil respiration and leaching of carbon, nutrients and/or contaminants in climate chambers under different environmental conditions.
5. Analyses of litter, soil, and soil water for selected physical and chemical properties
6. Interpretation and final presentation of data

**Lecture notes**  
A manual will be distributed during the course.

**Literature**  
Selected publications will be distributed during the course.

**701-1339-00L**  
**Soil Solids Laboratory**  

**Abstract**  
The main part of the course is the investigation of real samples of soils/sediments in the lab working in groups. A brief theoretical introduction into the overall principle and the meaning of physical, mineralogical and chemical parameters of soils and sediments and into each analytical method for their investigation will be given in advance.

**Objective**  
Upon successful completion of this course students are able to:
- describe structural, mineralogical and chemical properties of the inorganic solid part of soils and sediments,
- propose and apply different advanced methods and techniques to measure these properties,
- critically assess the data and explain the relationships between them,
- communicate the results in a scientific lab report.

**Content**  
Basic introduction to mineralogy and texture of soils
- Analytical techniques
- Practical exercises in sample preparation
- Measurement and evaluation of the data:
  - physical parameters (grain size distribution, surface, densities, porosity, (micro)structure)
  - mineralogical/geochemical parameters (quantitative mineralogical composition, thermal analysis, cation exchange etc.)

**Lecture notes**  
Selected handouts will be distributed during the course.

**Literature**  

**Prerequisites / notice**  
Useful preparatory courses are: "Soil Chemistry", "Clay Mineralogy", and "X-ray powder diffraction".

**701-1673-00L**  
**Environmental Measurement Laboratory**  

**Abstract**  
Measurements are the sole judge of scientific truth and provide access to unpredictable information, enabling the characterization and monitoring of complex terrestrial systems. Based on lectures and field- and laboratory training the students learn to apply modern methods to determine forest inventory parameters and to measure subsurface properties and processes.

**Objective**  
- explain functioning of sensors that are used for characterization of landscapes and terrestrial systems
- select appropriate measurement methods and sampling design to quantify key variables and processes in the subsurface
- deploy sensors in the field and maintain sensor network
- interpret collected laboratory and field data and report main conclusions deduced from measurements
1) Measurement Science: Measurement precision and accuracy; sensing footprint, sampling design and sampling errors, uncertainty reduction, spatial and temporal variability, sampling network design and information costs

2) Electronics: Basic introduction to electronic components, voltage and current measurements, A/D converters, power requirements, power consumption calculations, batteries, storage capacity, solar panels

3) Datalogging (Lecture): Data Logging, data transfer, storage, and sensing technologies; basic data logger programming; overview of soil sensor types and sensor calibration; including programming in the laboratory

4) Geophysical methods on Subsurface Characterization: Basic principles of ERT, GPR, and EM:

5) Soil and Groundwater Direct Sampling (Lab): Soil physical sampling; profile characterization, disturbed and undisturbed soil sampling, direct-push geoprobe sampling; soil water content profiles and transects;

6) Electronics Laboratory: Setup and measurement of simple circuits, selection and use of voltage dividers, batteries and solar panels; pressure and temperature measurements;

7) Deployment of monitoring network: Field installation of TDR, temperature probes, tensiometers, data loggers and power supply

8) Geophysics labs: Demonstration and application of geophysical methods in the field;

9 & 10) Forest characterization/ inventory: Principles of LIDAR; structures and features of the tree crowns, size/volume of the leaf area tree positions and diameters at breast height

11 & 12) Ecological Hydrology and Soil Monitoring Networks- Data management for long term monitoring networks Tereno, and other critical zone observatories

13) Remote Sensing- Basic principles and forest-related examples including data extraction and analysis

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**Semester Paper and Seminar**

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Lecturers</th>
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</table>
| 701-1302-00L | Term Paper 2: Seminar  

**Objective**

This class is the 2nd part of a series and participation is conditional on the successful completion of the Term paper Writing class (701-1303-00L). The results from the term paper written during the winter term are presented to the other students and advisors and discussed.

**Content**

Each student presents the results of the term paper to the other students and advisors and responds to questions and comments from the audience.

**Lecture notes**

None

**Prerequisites / notice**

The term papers will be made publically available after each student had the opportunity to make revisions.

There is no final exam. Grade is assigned based on the quality of the presentation and ensuing discussion.

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</table>
| 701-1303-00L | Term Paper 1: Writing  

**Objective**

The ability to critically evaluate original (scientific) literature and to summarize the information in a succinct manner is an important skill for any student. This course aims to practise this ability, requiring each student to write a term paper on a topic of relevance for research in the areas of Biogeochemistry and Pollutant Dynamics.

**Content**

The goal of the term paper is to train the student’s ability to critically evaluate a well-defined set of research subjects, and to summarize the findings concisely in a paper of scientific quality. The paper will be evaluated based on its ability to communicate an understanding of a topic, and to identify key outstanding questions. Results from this term paper will be presented to the fellow students and involved faculty in the following term (Term paper seminars class).

**Lecture notes**

Guidelines and supplementary material will be handed out at the beginning of the class.

**Prerequisites / notice**

Each term paper will be reviewed by one fellow student and one faculty. The submission of a written review is a prerequisite for obtaining the credit points.

There is no final exam. Grade is assigned based on the quality of the term paper and the submission of another student's review.

Students are expected to take Term Paper Writing and Term Paper Seminar classes in sequence.

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**Major in Ecology and Evolution**

**A. Fundamentals**

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Data: 06.03.2019 12:57  Autumn Semester 2016  Page 1509 of 1571
### 701-1427-00L Experimental Evolution

**Type**: W  
**ECTS**: 4 credits  
**Hours**: 2S  
**Lecturers**: G. Velicer, A. Hall, S. Wielgoss, Y.T.N. Yu

**Abstract**
Students will analyze experimental evolution literature covering a wide range of questions, species and types of analysis and will lead discussions of this literature. Students will develop a written project proposal for a novel evolution experiment (or a novel analysis of a published experiment) to address an unanswered question and will also deliver an oral presentation of the project proposal.

**Objective**

Course objectives:

i) become familiar with a diverse sample of experimental evolution literature,  
ii) gain understanding of the strengths and limitations of experimental evolution for addressing evolutionary questions relative to other forms of evolutionary analysis, and  
iii) gain the ability to effectively design and analyze evolution experiments that address fundamental or applied questions in evolutionary biology.

**Content**
Experimental evolution is a powerful and increasingly prominent approach to investigating evolutionary processes. Students will analyze experimental evolution literature covering a diverse range of topics, species and types of analysis and will lead discussions of this literature. Students will develop a written project proposal for a novel evolution experiment (or a novel analysis of a published experiment) to address an unanswered question and will also deliver an oral presentation of the project proposal. Evaluation will be based on a combination of participation in and leadership of literature discussions, in-class exams, and oral and written presentations of the project proposal.

**Literature**
Primary research papers and review articles.

**Prerequisites / notice**
701-0245-00 Introduction to Evolutionary Biology (or equivalent).

### B. Concept Courses and Applications

#### Applications

### 701-1453-00L Ecological Assessment and Evaluation

**Type**: W  
**ECTS**: 3 credits  
**Hours**: 3G  
**Lecturers**: F. Knaus, U. Bollens Hunziker

**Abstract**
The course provides methods and tools for ecological evaluations dealing with nature conservation or landscape planning. It covers census methods, ecological criteria, indicators, indices and critically appraises objectivity and accuracy of the available methods, tools and procedures. Birds and plants are used as main example guiding through different case studies.

**Objective**
Students will be able to:  
1) critically consider biological data books and local, regional, and national inventories;  
2) evaluate the validity of ecological criteria used in decision making processes;  
3) critically appraise the handling of ecological data and criteria used in the process of evaluation  
4) perform an ecological evaluation project from the field survey up to the decision making and planning.

**Lecture notes**
Powerpoint slides are available on the webpage. Additional documents are handed out as copies.

**Literature**
Basic literature and references are listed on the webpage.

**Prerequisites / notice**
The course structure changes between lecture parts, seminars and discussions. The didactic atmosphere is intended as working group.  
Prerequisites for attending this course are skills and knowledge equivalent to those taught in the following ETH courses:  
- Pflanzen- und Vegetationsökologie  
- Systematische Botanik  
- Raum- und Regionalentwicklung  
- Naturschutz und Stadtbiodiversität

### 701-1613-01L Advanced Landscape Research

**Type**: W  
**ECTS**: 5 credits  
**Hours**: 3G  
**Lecturers**: M. Bürgli, J. Bolliger, U. Gimmi, M. Hunziker

**Abstract**
This course introduces landscapes as socially perceived, spatially and temporally dynamic entities that are shaped by natural and societal factors. Concepts and qualitative and quantitative methods to study landscapes from an ecological, societal and historical perspective are presented. In a term paper students work on a landscape-related topic of their choice.

**Objective**
Students will:  
- learn about concepts and methods to quantify structural and functional connectivity in landscapes, particularly  
- be introduced to the topic of landscape genetics and its benefits and (current) limitations for applied conservation  
- learn about concepts and methods in scenario-based land-use change modelling  
- approach an understanding of landscape as perceived environment  
- be introduced into approaches of actively influencing attitudes and behavior as well as related scientific evaluation  
- make use of various historical sources to study landscapes and their dynamics  
- interpret landscapes as a result of ecological constraints and anthropogenic activities.
Students should be able to
Handouts will be available in the course and for download
The field course in Belize will develop an understanding of, and solutions to, issues of landscape management relevant to conservation and natural resources. Students will be expected to integrate skills in quantitative natural science with social science approaches in real world, and hence highly complex, settings.

1. Encompassing concepts and approaches
   - European Landscape Convention (ELC)
   - Ecosystem Services (ES): introduction and critical evaluation

   Thematic topics
   2. Ecological approach:
      - green infrastructure (e.g., ecological conservation areas)
      - landscape connectivity
      - landscape genetics and management applications
      - concepts of specific quantitative methods: least cost paths, resistance surfaces, Circuitscape, networks (Conefor), land-use change models, various statistical methods

   3. Social-science approach:
      - principle of landscape as perceived and connoted environment
      - theories on landscape preference and place identity
      - role of landscapes for recreation, health and well-being
      - intervention approaches for influencing attitudes and related behavior
      - methods of investigating the human-landscape relationship and evaluating interventions

   4. Historical approach:
      - land use history of Switzerland (agricultural history, forest and woodland history)
      - historical legacies of land use in landscapes and ecosystems
      - historic-ecological approaches and applications

   5. Land change science:
      - modelling future land-use (CLUE, other scenario-based models)
      - landscape functions and services

   Lecture notes
   No Script

   Literature

   701-1631-00L Foundations of Ecosystem Management
   W 5 credits 3G J. Ghazoul, C. Garcia

   Abstract
   This course introduces the broad variety of conflicts that arise in projects focusing on sustainable management of natural resources. It explores case studies of ecosystem management approaches and considers their practicability, their achievements and possible barriers to their uptake.

   Objective
   Students should be able to
   a) propose appropriate and realistic solutions to ecosystem management problems that integrate ecological, economic and social dimensions across relevant temporal and spatial scales.
   b) identify important stakeholders, their needs and interests, and the main conflicts that exist among them in the context of land and resource management.

   Content
   Traditional management systems focus on extraction of natural resources, and their manipulation and governance. However, traditional management frequently resulted in catastrophic failures such as, for example, the collapse of fish stocks and biodiversity loss. These failures have stimulated the development of alternative ecosystem management approaches that emphasise the functionality of human-dominated systems. Inherent to such approaches are system-wide perspectives and a focus on ecological processes and services, multiple spatial and temporal scales, as well as the need to incorporate diverse stakeholder interests in decision making. Thus, ecosystem management is the science and practice of managing natural resources, biodiversity and ecological processes, to meet multiple demands of society. It can be local, regional or global in scope, and addresses critical issues in developed and developing countries relating to economic and environmental security and sustainability.

   This course provides an introduction to ecosystem management, and in particular the importance of integrating ecology into management systems to meet multiple societal demands. The course explores the extent to which human-managed terrestrial systems depend on underlying ecological processes, and the consequences of degradation of these processes for human welfare and environmental well-being. Building upon a theoretical foundation, the course will tackle issues in resource ecology and management, notably forests, agriculture and wild resources within the broader context of sustainability, biodiversity conservation and poverty alleviation or economic development. Case studies from tropical and temperate regions will be used to explore these issues. Dealing with ecological and economic uncertainty, and how this affects decision making, will be discussed. Strategies for conservation and management of terrestrial ecosystems will give consideration to landscape ecology, protected area systems, and community management, paying particular attention to alternative livelihood options and marketing strategies of common pool resources.

   Lecture notes
   No Script

   Literature

   701-1661-00L Conservation and Development in Complex Landscapes
   W 3 credits 6G J. Ghazoul

   Abstract
   The field course in Belize will develop an understanding of, and solutions to, issues of landscape management relevant to conservation and natural resources. Students will be expected to integrate skills in quantitative natural science with social science approaches in real world, and hence highly complex, settings.

   Objective
   To address complex multi-dimensional environmental problems through the application of interdisciplinary and transdisciplinary skills.
### Advanced Concept Classes

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<tr>
<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>701-0263-01L</td>
<td>Seminar in Evolutionary Ecology of Infectious Diseases</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>D. Croll, S. Bonhoeffer, R. R. Regös</td>
</tr>
<tr>
<td>701-1409-00L</td>
<td>Research Seminar: Ecological Genetics</td>
<td>W</td>
<td>2</td>
<td>1S</td>
<td>A. Widmer, S. Fior</td>
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<tr>
<td>701-1471-00L</td>
<td>Ecological Parasitology</td>
<td>W</td>
<td>3</td>
<td>1V+1P</td>
<td>O. E. Seppälä, H. Hartikainen, J. Jokela</td>
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<tr>
<td>701-1676-01L</td>
<td>Landscape Genetics</td>
<td>W</td>
<td>2</td>
<td>3G</td>
<td>R. Holderegger, J. Bolliger, F. Gugerli</td>
</tr>
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</table>

**Objective**

- Students of this course will discuss current topics from the field of infectious disease biology. From a list of publications, each student chooses some themes that he/she is going to explain and discuss with all other participants and under supervision. The actual topics will change from year to year corresponding to the progress and new results occurring in the field.

**Content**

- Minimum number of participants is 4.
- A core set of ~10 classic publications encompassing unifying themes in infectious disease ecology and evolution, such as virulence, resistance, metapopulations, networks, and competition will be presented and discussed. Pathogens will include bacteria, viruses and fungi. Hosts will include animals, plants and humans.
- Publications and class notes can be downloaded from a web page announced during the lecture.

**Prerequisites / notice**

- Active participation in the discussions is a prerequisite for this course.
- Number of participants limited to 20.
The course is not based on any of the textbooks below, but they are excellent choices as accompanying material:

2S Computational Biology

We will cover several topics where evolutionary thinking is relevant to understanding or treating infectious diseases. This includes:

(i) Students will learn to (i) identify evolutionary explanations for the origins and characteristics of infectious diseases in a range of organisms

This course explores infectious disease from both the host and pathogen perspective. Through short lectures, reading and active discussion, students will gain insight into the role of sensory cues and signals in mediating interactions within and between species. There will be a discussion of current literature addressing key conceptual questions and state-of-the-art research techniques and methods.

Lecture notes

Hand-outs will be distributed.

Literature

The course requires 4 hours of preparatory reading of selected papers on landscape genetics. These papers will be distributed by e-mail.

Prerequisites / notice

Grading will be according to a short written report (4 pages) on one of the themes of the course (workload: about 8 hours) and according to student contributions during the course.

Prerequisites: students should have basic knowledge in population genetics, GIS and R.

701-1703-00L Evolutionary Medicine for Infectious Diseases

W 3 credits

2G A. Hall

Abstract

This course explores infectious disease from both the host and pathogen perspective. Through short lectures, reading and active discussion, students will identify areas where evolutionary thinking can improve our understanding of infectious diseases and, ultimately, our ability to treat them effectively.

Objective

Students will learn to (i) identify evolutionary explanations for the origins and characteristics of infectious diseases in a range of organisms and (ii) evaluate ways of integrating evolutionary thinking into improved strategies for treating infections of humans and animals. This will incorporate principles that apply across any host-pathogen interaction, as well as system-specific mechanistic information, with particular emphasis on bacteria and viruses.

Content

We will cover several topics where evolutionary thinking is relevant to understanding or treating infectious diseases. This includes: (i) determinants of pathogen host range and virulence, (ii) dynamics of host-parasite coevolution, (iii) pathogen adaptation to evade or suppress immune responses, (iv) antimicrobial resistance, (v) evolution-proof medicine. For each topic there will be a short (~30 minutes) introductory lecture, before students independently research the primary literature and develop half a page of discussion points and questions, followed by interactive discussion in class.

Literature

Students will read the primary literature on each topic, and in places we will use the following books:

- Schmid Hempel 2011 Evolutionary Parasitology
- Stearns & Medzhitov 2016 Evolutionary Medicine

Prerequisites / notice

A basic understanding of evolutionary biology, microbiology or parasitology will be advantageous but is not essential.

636-0017-00L Computational Biology

W 4 credits

3G T. Stadler, C. Magnus

Abstract

The aim of the course is to provide up-to-date knowledge on how we can study biological processes using genetic sequencing data. Computational algorithms extracting biological information from genetic sequence data are discussed, and statistical tools to understand this information in detail are introduced.

Objective

Attendees will learn which information is contained in genetic sequencing data and how to extract information from them using computational tools. The main concepts introduced are:

- sto...
This course focuses on the interactions between ecology, biogeochemistry and management of agro- and forest ecosystems, thus, coupled
ecosystems. The course contains a lecture part, an experimental part and field excursions.

**Objective**

Students will gain insight into the role of sensory cues and signals in mediating interactions within and between species. There will be a
primary, but not exclusive, focus on chemical signaling in interactions among plants, insects and microbes. The course will focus on the
discussion of recent literature addressing key conceptual questions and state-of-the-art research techniques and methods. Students will
engage in discussion and critical analyses of relevant papers and present their evaluations in a seminar setting.

**751-5100-00L Biogeochemistry and Sustainable Management**

**W 2 credits 2G**

N. Buchmann, L. Hörtnagl

**Abstract**

This course focuses on the interactions between ecology, biogeochemistry and management of agro- and forest ecosystems, thus, coupled
ecosystems. Students learn how human impacts on ecosystems via management or global change are mainly driven by effects on
biogeochemical cycles and thus ecosystem functioning, but also about feedback mechanisms of terrestrial ecosystems.

**Objective**

Students will know and understand the complex and interacting processes of ecology, biogeochemistry and management of agro- and
forest ecosystems, be able to analyze and evaluate the various impacts of different management practices under different environmental
conditions, search literature, write and evaluate scientific reports, and be able to coordinate and work successfully in small
(interdisciplinary) teams.

**Content**

Agroecosystems and forest ecosystems play a major role in all landscapes, either for production purposes, ecological areas or for
recreation. The human impact of any management on the environment is mainly driven by effects on biogeochemical cycles. Effects of
global change impacts will also act via biogeochemistry at the soil-biosphere-atmosphere-interface. Thus, ecosystem functioning, i.e.,
the interactions between ecology, biogeochemistry and management of terrestrial systems, is the science topic for this course.

Students will gain profound knowledge about nutrient cycles and population dynamics in managed and unmanaged grassland, cropland,
and forest ecosystems in the field and in the lab. Responses of agro- and forest ecosystems to the environment, e.g., to climate,
antropogenic deposition, major disturbances, soil nutrients or competition of plants (including invasives) and microorganisms, but also
feedback mechanisms of ecosystems on (micro)climate, soils or vegetation patterns will be studied. Different management practices will be
investigated and assessed in terms of production and quality of yield (ecosystem goods and services), but also in regard to environmental
regulations (including subsidies) and their effect on the environment, e.g., greenhouse gas budgets. Thus, students will learn about the
complex interactions of a coupled human-environmental system.

**Lecture notes**

Handouts will be available on the web-page of the course.

**Literature**

Will be discussed in class.

**Prerequisites / notice**

Prerequisites: Attendance of introductory courses in plant ecophysiology, ecology, and grassland or forest sciences. Course will be taught
in English.

►► C. Scientific skills

►►► Laboratory and Field Expertise

**Number**

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<tr>
<th>Course Code</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>701-1425-01L</td>
<td>Genetic Diversity: Techniques</td>
<td>W</td>
<td>2 credits</td>
<td>2P</td>
<td>A. M. Minder Pfyl</td>
</tr>
</tbody>
</table>

**Abstract**

This course provides training for advanced students (master, doctoral or post-doctoral level) in how to measure and collect genetic diversity
data from populations, experiments, field and laboratory. Different DNA/RNA extraction, genotyping and gene expression techniques will be
addressed. Choice of topic by demand and/or availability of data.

**Objective**

To learn and improve on standard and modern methods of genetic data collection. Examples are: use of pyrosequencing, expression
analysis, SNP-typing, next-generation sequencing, etc.

A course for practitioners.

**Content**

After an introduction (one afternoon), students will have 3 weeks to work independently or in groups through different protocols. At the end
the whole group meets for another afternoon to present the techniques/results and to discuss the advantages and disadvantages of the different
techniques. Techniques adressed are: RNA/DNA extractions and quality control, SNP genotyping, pyrosequencing, real-time qPCR.

**Lecture notes**

Material will be handed out in the course.

**Literature**

Material will be handed out in the course.

**Prerequisites / notice**

Two afternoons are hold in the class. The lab work will be done from the students according to their timetable, but has to be finished after 3
weeks. Effort is roughly 1-2 days per week, depending on the skills of the student.

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<th>Course Code</th>
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<tr>
<td>701-1437-00L</td>
<td>Limnoecology</td>
<td>W</td>
<td>8 credits</td>
<td>10G</td>
<td>P. Spaak, F. Altermatt, T. Gonser, K. J. Räsänen, C. T. Robinson</td>
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</tbody>
</table>

**Abstract**

This course combines Limnology (the study of inland waters in its broad sense) with ecological and evolutionary concepts. It deals with
rivers, groundwater and lakes.

This course contains a lecture part, an experimental part as well as 1-day excursions.

**Objective**

During this course you will get an overview of the world's typical freshwater ecosystems. After this course you will be able to understand
how aquatic organisms have adapted to their habitat and how the interactions (e.g. food web) between organisms work.

During the experimental part of this course you will learn the principles of doing research to observe interrelations in aquatic ecosystems.

You will measure and interpret biological and physical data (e.g. during experiments, field work) and present the collected knowledge.

In short: apply the theoretical / lecture knowledge to field situations in a lake and river.

The course contains a lecture part, an experimental part and field excursions.

The lecture part covers ecology and evolution of aquatic organisms in lentic and lotic waters. Topics include: Adaptations, distribution
patterns, biotic interactions, and conceptual paradigms in freshwater ecosystems. Important aspects regarding ecosystem metabolism and
habitat properties of freshwaters. Applied case studies and experiments testing ecological and evolutionary processes in freshwaters.

The lectures are given by Piet Spaak (Eawag), Florian Altermatt (UNI, Eawag), Tom Gonser (Eawag), Katja Rasänen (Eawag) and Chris
Robinson (Eawag), specialists from the Aquatic Ecology department of Eawag and University of Zurich.

**Practical part:**

The practical part contains 1-day excursions to a lake (Greifensee) and rivers (Sense, Töss) as well as research projects in small groups
within research groups at Eawag.

**Lecture notes**

Course notes and power point presentations provided during the course.

**Prerequisites / notice**

This course can only be taken together with "701-1437-01 Bestimmungskurs aquatische Makroinvertebraten" and "701-1437-02
Bestimmungskurs aquatische Mikroinvertebraten und Kryptogamen".

The maximal participating number of students is 8 from D-USYS and 14 from D-BIOL (ETH & UNI).

Registration for the course until Thu 15.9.2016, free places will be distributed Fri 16.9.2016.

The course includes mandatory field trips to Greifensee (22.09.2016), to the Sense River floodplain (6.10.2016) and to the Töss River
(20.10.2016).
### Expertise in Biological Diversity

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<tr>
<th>Number</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>701-1437-01L</td>
<td>Practical Course Macroinvertebrates</td>
<td>W</td>
<td>2</td>
<td>2P</td>
<td>J. Jokela</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<tr>
<td></td>
<td>This course gives an overview of the typical aquatic macroinvertebrate groups in Switzerland. Beside a theoretical background on the different groups the focus is laid on the determination of the most important species groups and their identification traits, also using identification keys. Practical experience in bentic sampling techniques is collected during an excursion. During this course you will get an overview of the typical aquatic macroinvertebrates in Switzerland and the common sampling techniques. During an excursion, you will apply the theoretical identification knowledge to field situations.</td>
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<td>The taxonomic part will cover macroinvertebrates (e.g. Crustacean, aquatic insects). The goal is to get to know the most common aquatic taxa in Switzerland, to identify them with commonly used identification literature, and to get an idea how these organisms are used in research and practice. (language: German, translation of the most important things during the course possible)</td>
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<td><strong>Content</strong></td>
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<td></td>
<td>The maximal participating number of students is 8 from D-USYS and 14 from D-BIOL. In case of too many students, those that simultaneously participate in the courses &quot;701-1437-00 Limnoecology&quot; and &quot;701-1437-02 Bestimmungskurs aquatischer Makroinvertebraten und Kryptogamen&quot; are given priority. Sign in until 15.9.2016, free places will be distributed 16.9.2016.</td>
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<td><strong>Lecture notes</strong></td>
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<td>Course notes and power point presentations provided during the course.</td>
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<td><strong>Prerequisites / notice</strong></td>
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<tr>
<td></td>
<td>The field excursion takes place Tuesday 25.10.2016 from 13-17.</td>
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<tr>
<td>701-1437-02L</td>
<td>Practical Course Microinvertebrates and Cryptogames</td>
<td>W</td>
<td>2</td>
<td>2P</td>
<td>J. Jokela</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td></td>
<td>This course gives an overview of the typical aquatic microinvertebrate groups and cryptogames in Switzerland. Beside a theoretical background the different groups the focus is laid on the recognition of the most important species groups and their identification traits. Practical experience is collected during an excursion.</td>
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<td><strong>Objective</strong></td>
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<tr>
<td></td>
<td>During this course you will get an overview of the typical aquatic microinvertebrate groups and algae in Switzerland. After this course you will know the most important aquatic species groups and the most important identification traits. You will apply the theoretical knowledge during an excursion.</td>
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<td></td>
<td><strong>Content</strong></td>
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<td>The field excursion takes place Thursday 13.10.2016 from 13-17.</td>
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### Quantitative and Computational Expertise

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>701-1419-00L</td>
<td>Analysis of Ecological Data</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>S. Güsewell</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td></td>
<td>This class provides students with an overview of techniques for data analysis used in modern ecological research, as well as practical experience in running these analyses with R and interpreting the results. Topics include linear models, generalized linear models, mixed models, model selection and randomization methods. Students will be able to: - describe the aims and principles of important techniques for the analysis of ecological data - choose appropriate techniques for given problems and types of data - evaluate assumptions and limitations - implement the analyses in R - represent the relevant results in graphs, tables and text - interpret and evaluate the results in ecological terms</td>
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<td></td>
<td><strong>Objective</strong></td>
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<td>Students will be able to: - Linear models for experimental and observational studies - Model selection - Introduction to likelihood inference and Bayesian statistics - Analysis of counts and proportions (generalised linear models) - Models for non-linear relationships - Grouping and correlation structures (mixed models) - Randomisation methods</td>
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<tr>
<td></td>
<td><strong>Content</strong></td>
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<tr>
<td></td>
<td>Time schedule</td>
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<td>The course takes place over a period of nine days from Thursday 12.01 to Friday 20.01, with classes on 12, 13, 16, 17 and 18.01. and an exam in the morning of 20.01.</td>
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<td><strong>Prerequisites / notice</strong></td>
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<td></td>
<td>- Basic statistical training (e.g. Mathematik IV in D-USYS): Data distributions, descriptive statistics, hypothesis testing, linear regression, analysis of variance - Basic experience in data handling and data analysis in R</td>
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<td></td>
<td><strong>Individual preparation</strong></td>
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<td>Students without the required knowledge are asked to contact the lecturer before Christmas for support with individual preparation.</td>
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<tr>
<td>701-1677-00L</td>
<td>Quantitative Vegetation Dynamics: Models from Tree to Globe</td>
<td>W</td>
<td>3</td>
<td>3G</td>
<td>H. Bugmann, M. Huber, H. Lischke</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td></td>
<td>The course provides hands-on experience with models of vegetation dynamics across temporal and spatial scales. The underlying principles, assets and trade-offs of the different approaches are introduced, and students work in a number of small projects with these models to gain first-hand experience.</td>
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</tbody>
</table>

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Data: 06.03.2019 12:57  Autumn Semester 2016  Page 1515 of 1571
Objective

Students will:
- be able to understand, assess and evaluate the fundamental properties of dynamic systems using vegetation models as case studies
- obtain an overview of dynamic modelling techniques from the individual plant to the global level
- understand the basic assumptions of the various model types, which dictate the skill and limitations of the respective model
- be able to work with such model types on their own
- appreciate the methodological basis for impact assessments of future climate change and other environmental changes on ecosystems.

Content

Models of individuals
- Deriving single-plant models from inventory measurements
- Plant models based on 'first principles'

Models at the stand scale
- Simple approaches: matrix models
- Competition for light and other resources as central mechanisms
- Individual-based stand models: distance-dependent and distance-independent

Models at the landscape scale
- Simple approaches: cellular automata
- Dispersal and disturbances (windthrow, fire, bark beetles) as key mechanisms
- Landscape models

Global models
- Sacrificing local detail to attain global coverage: processes and entities
- Dynamic Global Vegetation Models (DGVMs)
- DGVMs as components of Earth System Models

Lecture notes

Handouts will be available in the course and for download

Literature

Will be indicated at the beginning of the course

Prerequisites / notice

- Basic training in modelling and systems analysis
- Good knowledge of general ecology, vegetation dynamics, and forest systems

701-1679-00L Spatial Modelling: From Climate & Land Use Change to Biodiversity Conservation

Abstract

The course provides the student with the spatial tools to address societal challenges toward ensuring the sustainable use of terrestrial ecosystems and the conservation of biodiversity. Students learn theory, tools and models during a few introductory sessions and apply this knowledge to solve a practical problem in groups related to climate change, land use change and biodiversity conservation.

Objective

- Theoretical foundations of the species ecological niche
- Biodiversity concepts and global change impacts
- Basic concepts of spatial (and macro-) ecology
- Environmental impact assessment and planning
- Advanced statistical methods (GLM, GAM, CART) and basic programming (loops, functions, advanced scripting) in the statistical environment R.
- The use of GIS functionality in R

Content

1. The basics:
   - Introduction to the concept of the ecological niche, and biodiversity theories. Overview of the knowledge on expected biodiversity response to global changes and conservation planning methods.
   - Introduction to the statistical methods of Generalized Linear (GLM) and Generalized Additive models (GAM), and Classification and Regression Trees (CART).
   - Introduction to basic GIS and programming elements in the statistical environment R.

2. The class project:
   - Students form groups of two, and each group solves a series of applied questions independently in R using the techniques taught in the introductory classes. The students then prepare a presentation and report of the obtained results that will be discussed during a mini-symposium. Each team chooses one of the following topics for the class project:
     a) Linking climate change velocities to species' migration capacities
     b) Explaining and modelling land use change in Switzerland
     c) Explaining and modelling biodiversity changes in Switzerland
     d) Designing biodiversity conservation strategies under global changes.

Prerequisites / notice

Basic knowledge in statistics (OLS regression, test statistics), and basic knowledge in geographic information science.

Term Paper and Seminar

Number Title Type ECTS Hours Lecturers

Abstract

Individual writing of an essay-type review paper about a specialized topic in the field of ecology and evolution, based on substantial reading of original literature and discussions with a senior scientist.

Objective

- Students acquire a thorough knowledge on a topic in which they are particularly interested
- They learn to assess the relevance of original literature and synthesize information
- They make the experience of becoming "experts" on a topic and develop their own perspective
- They practise academic writing according to professional standards in English

Content

Topics for the essays are proposed by the professors and lecturers of the major in Ecology and Evolution at a joint meeting at the beginning of the semester (the date will be communicated by e-mail to registered students). Students will:
- choose a topic
- search and read appropriate literature
- develop a personal view on the topic and structure their arguments
- prepare figures and tables to represent ideas or illustrate them with examples
- write a clear, logical and well-structured text
- refine the text and present the paper according to professional standards

In all steps, they will benefit from the advice and detailed feedback given by a senior scientist acting as personal tutor of the student.

Electives

Number Title Type ECTS Hours Lecturers

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<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Type</th>
<th>Credits</th>
<th>Semester</th>
<th>Instructor(s)</th>
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<tbody>
<tr>
<td>701-0290-00L</td>
<td>Seminar in Microbial Evolution and Ecology (HS)</td>
<td>Z</td>
<td>0</td>
<td>2S</td>
<td>S. Bonhoeffer</td>
</tr>
<tr>
<td>Abstract</td>
<td>Seminar of the groups Molecular Microbial</td>
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<tr>
<td></td>
<td>Ecology, Theoretical Biology, Experimental Biology, Evolutionary Biology. Talks given by members of these groups and external visitors. The course is interdisciplinary and the various approaches are designed to help understand the past, present and future of mountain ecosystems.</td>
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<tr>
<td>Objective</td>
<td>In-depth introduction into microbial evolution and ecology, especially the aspects that are the focus of on-going research in this area at Department of Environmental Systems Science.</td>
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<tr>
<td>701-1441-00L</td>
<td>Alpine Ecology and Environments</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>S. Dietz, D. Ramseier</td>
</tr>
<tr>
<td>Abstract</td>
<td>The online course ALPECOle provides a global overview of the complex ecosystems of mountain regions, and of their great diversity of habitats and organisms. The course is interdisciplinary and the various approaches are designed to help understand the past, present and future of mountain ecosystems.</td>
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<tr>
<td>Objective</td>
<td>Knowledge of alpine environments worldwide and their ecology</td>
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<tr>
<td>Content</td>
<td>The online course is subdivided into</td>
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<td></td>
<td>- 5 lessons on abiotic factors: geology, soils and their forming processes, climate, and disturbance factors</td>
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<td></td>
<td>- 12 lessons on plants: diversity, patterns and processes, treelines, water &amp; nutrients, carbon cycle, atmospheric influences, sexual and clonal reproduction, and one specific lesson on aquatic environments</td>
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<td>- 5 lessons on animals: habitats and adaptations, origin of species, food ecology and impact of domestic livestock</td>
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<td></td>
<td>- 3 lessons on landscape evolution: quaternary paleoenvironments, methods like radiocarbon dating, pollen records, dendrochronology, stable isotopes, and historical data</td>
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<td></td>
<td>- 1 lesson on global change</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Students prepare for the seminar by working through particular lessons. Each student has to present some special aspect of one lesson. The seminar contribution is part of the performance assessment.</td>
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<tr>
<td>Course language</td>
<td>is English</td>
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<tr>
<td>551-0205-00L</td>
<td>Challenges in Plant Sciences</td>
<td>W</td>
<td>2</td>
<td>2K</td>
<td>W. Gruissem, C. Sánchez-Rodríguez, further lecturers</td>
</tr>
<tr>
<td>Abstract</td>
<td>The colloquium introduces students to the disciplines in plant sciences and provides integrated knowledge from the molecular level to ecosystems and from basic research to applications, making use of the synergies between the different research groups of the PSC. The colloquium offers a unique chance to approach interdisciplinary topics as a challenge in the field of plant sciences.</td>
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<td>Objective</td>
<td>Major objectives of the colloquium are:</td>
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<td>introduction of graduate students and Master students to the broad field of plant sciences</td>
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<td></td>
<td>promotion of an interdisciplinary and integrative teaching program</td>
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<td>promotion of active participation and independent work of students</td>
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<td>promotion of presentation and discussion skills</td>
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<td></td>
<td>increased interaction among students and professors</td>
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<tr>
<td>Content</td>
<td>Challenges in Plant Sciences will cover the following topics:</td>
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<tr>
<td></td>
<td>Chemical communication among plants, insect and pathogens.</td>
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<td>Specificity in hormone signaling.</td>
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<td></td>
<td>Genetic networks.</td>
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<td></td>
<td>Plant-plant interactions.</td>
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<td></td>
<td>Resilience of tropical ecosystems.</td>
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<td></td>
<td>Regulatory factors controlling cell wall formation.</td>
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<td></td>
<td>Chlorophyll breakdown.</td>
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<td></td>
<td>Innate immunity.</td>
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<td></td>
<td>Disease resistance genes.</td>
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<td></td>
<td>Sustainable agroecosystems.</td>
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<tr>
<td>751-4504-00L</td>
<td>Plant Pathology I</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>B. McDonald</td>
</tr>
<tr>
<td>Abstract</td>
<td>Plant Pathology I will focus on pathogen-plant interactions, epidemiology, disease assessment, and disease development in agroecosystems. Themes will include: 1) how pathogens attack plants and; 2) how plants defend themselves against pathogens; 3) factors driving the development of epidemics in agroecosystems.</td>
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<tr>
<td>Objective</td>
<td>Students will understand: 1) how pathogens attack plants and; 2) how plants defend themselves against pathogens; 3) factors driving the development of epidemics in agroecosystems as a basis for implementing disease management strategies in agroecosystems.</td>
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</tbody>
</table>
Course description: Plant Pathology I will focus on pathogen-plant interactions, epidemiology, disease assessment, and disease development in agroecosystems. Themes will include: 1) how pathogens attack plants and; 2) how plants defend themselves against pathogens; 3) factors driving the development of epidemics in agroecosystems. Topics under the first theme will include pathogen life cycles, disease cycles, and an overview of plant pathogenic nematodes, viruses, bacteria, and fungi. Topics under the second theme will include plant defense strategies, host range, passive and active defenses, and chemical and structural defenses. Topics under the third theme will include the disease triangle and cultural control strategies.

Lecture Topics and Tentative Schedule

Week 1  No Lecture: First day of autumn semester

Week 2  The nature of plant diseases, symbiosis, parasites, mutualism, biotrophs and necrotrophs, disease cycles and pathogen life cycles. Nematode attack strategies and types of damage.


Week 5  Symptoms and signs of fungal infection. Example fungal diseases: potato late blight, wheat stem rust, grape powdery mildew, wheat Septoria leaf blotch.

Week 6  Plant defense mechanisms, host range and non-host resistance. Passive structural and chemical defenses, preformed chemical defenses. Active structural defense, papillae, active chemical defense, hypersensitive response, pathogenesis-related (PR) proteins, phytoalexins and disease resistance.

Week 7  Pisatin and pisatin demethylase. Local and systemic acquired resistance, signal molecules.

Week 8  Pathogen effects on food quality and safety.

Week 9  Epidemiology: historical epidemics, disease pyramid, environmental effects on epidemic development. Plant effects on development of epidemics, including resistance, physiology, density, uniformity.

Week 10  Disease assessment: incidence and severity measures, keys, diagrams, scales, measurement errors. Correlations between incidence and severity.

Week 11  Molecular detection and diagnosis of pathogens. Host indexing, serology, monoclonal and polyclonal antibodies. ELISA, PCR, rDNA and rep-PCR.

Week 12  Strategies for minimizing disease risks: principles of disease control and management.

Week 13  Disease control strategies: economic thresholds, physical control methods.

Week 14  Cultural control methods: avoidance, tillage practices, crop sanitation, fertilizers, crop rotation.

Lecture notes

Details lecture notes (~160 pages) will be available for purchase at the cost of reproduction at the start of the semester.

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**Major in Human-Environment-Systems**

*Students starting their Master programme in autumn semester 2016 or later cannot choose the Major Human-Environment Systems. Students who registered for the Major Human-Environment Systems autumn semester 2015 or before can finish this Major.*

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**Natural and Technological Systems**

**Environmental Assessment**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>102-0317-00L</td>
<td>Advanced Environmental Assessments</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>S. Hellweg, R. Frischknecht</td>
</tr>
</tbody>
</table>

**Abstract**

This course deepens students' knowledge of the environmental assessment methodologies and their various applications.

**Objective**

This course has the aim of deepening students' knowledge of the environmental assessment methodologies and their various applications. In particular, students completing the course should have the following skills:

- Ability to judge the scientific quality and reliability of environmental assessment studies, the appropriateness of inventory data and modelling, and the adequacy of life cycle impact assessment models and factors
- Knowledge about the current state of the scientific discussion and new research developments
- Ability to properly plan, conduct and interpret environmental assessment studies
- Knowledge of how to use LCA as a decision support tool for companies, public authorities, and consumers

**Content**

- Inventory developments, transparency, data quality, data completeness, and data exchange formats
- Allocation (multioutput processes and recycling)
- Hybrid LCA methods.
- Consequential and marginal analysis
- Recent development in impact assessment
- Spatial differentiation in Life Cycle Assessment
- Workplace and indoor exposure in Risk and Life Cycle Assessment
- Uncertainty analysis
- Subjectivity in environmental assessments
- Multicriteria analysis
- Case Studies

**Lecture notes**

No script. Lecture slides and literature will be made available on the lecture homepage.

**Literature**

Literature will be made available on the lecture homepage.

**Prerequisites / notice**

Basic knowledge of environmental assessment tools is a prerequisite for this class. Students that have not done classwork in this topic before are required to read an appropriate textbook before or at the beginning of this course (e.g. Jolliet, O et al. 2016: Environmental Life Cycle Assessment. CRC Press, Boca Raton - London - New York. ISBN 978-1-4398-8766-0 (Chapters 2-5.2)).
### Landscape and Ecosystems

#### 701-1453-00L Environmental Assessment and Evaluation
**Abstract**
The course provides methods and tools for ecological evaluations dealing with nature conservation or landscape planning. It covers census methods, ecological criteria, indicators, indices and critically appraises objectivity and accuracy of the available methods, tools and procedures. Birds and plants are used as main example guiding through different case studies.

**Objective**
Students will be able to:
1. critically consider biological data books and local, national, and regional inventories;
2. evaluate the validity of ecological criteria used in decision making processes;
3. critically appraise the handling of ecological data and criteria used in the process of evaluation;
4. perform an ecological evaluation project from the field survey up to the decision making and planning.

**Lecture notes**
Powerpoint slides are available on the webpage. Additional documents are handed out as copies.

**Literature**
Basic literature references are listed on the webpage.

**Prerequisites / notice**
The course structure changes between lecture parts, seminars and discussions. The didactic atmosphere is intended as working group.

**Prerequisites for attending this course are skills and knowledge equivalent to those taught in the following ETH courses:**
- Pflanzen- und Vegetationsökologie
- Systematische Botanik
- Raum- und Regionalentwicklung
- Naturschutz und Stadtbiodiversität

#### 701-1631-00L Foundations of Ecosystem Management
**Abstract**
This course introduces the broad variety of conflicts that arise in projects focusing on sustainable management of natural resources. It explores case studies of ecosystem management approaches and considers their practicability, their achievements and possible barriers to their uptake.

**Objective**
Students should be able to:
1. identify important stakeholders, their needs and interests, and the main conflicts that exist among them in the context of land and resource management.
2. identify important stakeholders, their needs and interests, and the main conflicts that exist among them in the context of land and resource management.
3. critically appraise the handling of ecological data and criteria used in the process of evaluation.

**Content**
Traditional management systems focus on extraction of natural resources, and their manipulation and governance. However, traditional management has frequently resulted in catastrophic failures such as, for example, the collapse of fish stocks and biodiversity loss. These failures have stimulated the development of alternative ecosystem management approaches that emphasise the functionality of human-dominated systems. Inherent to such approaches are system-wide perspectives and a focus on ecological processes and services, multiple spatial and temporal scales, as well as the need to incorporate diverse stakeholder interests in decision making. Thus, ecosystem management is the science and practice of managing natural resources, biodiversity and ecological processes, to meet multiple demands of society. It can be local, regional or global in scope, and addresses critical issues in developed and developing countries relating to economic and environmental security and sustainability.

**Lecture notes**
No Script

**Literature**

### Social Systems (Micro, Macro)

#### Psychology

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>376-1177-00L</td>
<td>Human Factors I</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>M. Menozzi Jäckli, R. Huang, M. Siegrist</td>
</tr>
</tbody>
</table>

Data: 06.03.2019 12:57  Autumn Semester 2016  Page 1519 of 1571
Abstract
Every day humans interact with various systems. Strategies of interaction, individual needs, physical & mental abilities, and system properties are important factors in controlling the quality and performance in interaction processes. In the lecture, factors are investigated by basic scientific approaches. Discussed topics are important for optimizing people's satisfaction & overall performance.

Objective
The goal of the lecture is to empower students in better understanding the applied theories, principles, and methods in various applications. Students are expected to learn how to enable an efficient and qualitatively high standing interaction between human and the environment, considering costs, benefits, health, and safety as well. Thus, an ergonomic design and evaluation process of products, tasks, and environments may be promoted in different disciplines. The goal is achieved in addressing a broad variety of topics and embedding the discussion in macroscopic factors such as the behavior of consumers and objectives of economy.

Content
- Physiological, physical, and cognitive factors in sensation and perception
- Body spaces and functional anthropometry, Digital Human Models
- Experimental techniques in assessing human performance and well-being
- Human factors and ergonomics in system designs, product development and innovation
- Human information processing and biological cybernetics
- Interaction among consumers, environments, behavior, and tasks

Literature
- Gavriel Salvendy, Handbook of Human Factors and Ergonomics, 4th edition (2012), is available on NEBIS as electronic version and for free to ETH students
- Further textbooks are introduced in the lecture
- Brouchures, checklists, key articles etc. are uploaded in ILIAS

Political Sciences, Policy and Sociology

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>851-0594-00L</td>
<td>International Environmental Politics</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>T. Bernauer</td>
</tr>
</tbody>
</table>

Abstract
This course focuses on the conditions under which cooperation in international environmental politics emerges and the conditions under which such cooperation and the respective public policies are effective and/or efficient.

Objective
The objectives of this course are to (1) gain an overview of relevant questions in the area of international environmental politics from a social sciences viewpoint; (2) learn how to identify interesting/innovative questions concerning this policy area and how to answer them in a methodologically sophisticated way; (3) gain an overview of important global and regional environmental problems.

Content
This course deals with how and why international cooperation in environmental politics emerges, and under what circumstances such cooperation is effective and efficient. Based on theories of international political economy and theories of government regulation various examples of international environmental politics are discussed: the management of international water resources, the problem of unsafe nuclear power plants in eastern Europe, political responses to global warming, the protection of the stratospheric ozone layer, the reduction of long-range transboundary air pollution in Europe, the prevention of pollution of the oceans, etc.

The course is open to all ETH students. Participation does not require previous coursework in the social sciences.

After passing an end-of-semester test (requirement: grade 4.0 or higher) students will receive 3 ECTS credit points. The workload is around 90 hours (meetings, reading assignments, preparation of test).

Visiting students (e.g., from the University of Zurich) are subject to the same conditions. Registration of visiting students in the web-based system of ETH is compulsory.
The aim of this course is to equip students with a legal and regulatory skill-set that allows them to translate their technical knowledge into a policy brief directed at legally trained regulators. More generally, it aims to inform students with a technical scientific background of the legal and political context of environmental policy. The focus of the course will be on international and European issues and regulatory frameworks - where relevant, the position of Switzerland within these international networks will also be discussed.

Lectures
- Environmental Regulation: Law and Policy
- Transdisciplinary Methods and Applications

Assessment:
(i) Class participation (25%): Students will be expected to contribute to class discussions and prepare short memos on class readings.
(ii) Exam (75%) consisting of three parts:
   a. Policy brief - a maximum of 2 pages (including graphs and tables);
   b. Background document to the policy brief - this document sets out a more detailed and academic overview of the topic (maximum 8 pages including graphs and tables);
   c. Presentation of the policy brief: presentations can use a maximum of 5 slides and can last 7 minutes.

Number of participants limited to 15.

Prerequisites / literature
- Environmental Politics: Part I (851-0594-00 V), Environmental Governance (701-1651-00 G), Policy and Economics of Ecosystem Services (701-1653-00 G), International Environmental Law (751-1551-00 V), Umweltrecht: Konzepte und Rechtsgebiete (851-0705-01 V), Rechtlicher Umgang mit natürlichen Ressourcen (701-0708-00 V) or an equivalent course.

During the second week of the teaching period, students will have individual 30-minute meetings with the lecturer to discuss their project.

Teaching will take place over two weeks in September and October. The exam date will be in December.

The course is taught as a small interactive seminar and significant participation is expected from the students. Participation will be capped at 15 in order to maintain the interactive nature of the classes. All classes, readings, and assignments, are in English.

Assessment:
(i) Class participation (25%): Students will be expected to contribute to class discussions and prepare short memos on class readings.
(ii) Exam (75%) consisting of three parts:
   a. Policy brief - a maximum of 2 pages (including graphs and tables);
   b. Background document to the policy brief - this document sets out a more detailed and academic overview of the topic (maximum 8 pages including graphs and tables);
   c. Presentation of the policy brief: presentations can use a maximum of 5 slides and can last 7 minutes.

Lecture notes
- The course is taught as a small interactive seminar and significant participation is expected from the students. Participation will be capped at 15 in order to maintain the interactive nature of the classes. All classes, readings, and assignments, are in English.
- Teaching will take place over two weeks in September and October. The exam date will be in December.

Literature
- Environmental Regulation: Law and Policy
- Transdisciplinary Methods and Applications

Prerequisites / notice
- Environmental Politics: Part I (851-0594-00 V), Environmental Governance (701-1651-00 G), Policy and Economics of Ecosystem Services (701-1653-00 G), International Environmental Law (751-1551-00 V), Umweltrecht: Konzepte und Rechtsgebiete (851-0705-01 V), Rechtlicher Umgang mit natürlichen Ressourcen (701-0743-01 V), Environmental Governance (701-1651-00 G), Policy and Economics of Ecosystem Services (701-1653-00 G), International Environmental Politics: Part I (851-0594-00 V).

The course deals with transdisciplinary (td) methods, concepts and their applications in the context of case studies and other problem oriented research projects. Td methods are used in research at the science-society interface and when collaborating across scientific disciplines. Students learn to apply methods within a functional framework. The format of the course is seminar-like, interactive.

At the end of the course students should:
- Know:
  - Function, purpose and algorithm of a selected number of transdisciplinary methods
- Understand:
  - Functional application in case studies and other problem oriented projects
- Be able to reflect on:
  - Potential, limits, and necessity of transdisciplinary methods
- Be prepared for:
  - Transdisciplinary Case Study 2017

Objective
- At the end of the course students should:
  - Know:
    - Function, purpose and algorithm of a selected number of transdisciplinary methods
  - Understand:
    - Functional application in case studies and other problem oriented projects
  - Be able to reflect on:
    - Potential, limits, and necessity of transdisciplinary methods
  - Be prepared for:
    - Transdisciplinary Case Study 2017

Number of participants limited to 15.

Prerequisites / literature
- Environmental Politics: Part I (851-0594-00 V), Environmental Governance (701-1651-00 G), Policy and Economics of Ecosystem Services (701-1653-00 G), International Environmental Law (751-1551-00 V), Umweltrecht: Konzepte und Rechtsgebiete (851-0705-01 V), Rechtlicher Umgang mit natürlichen Ressourcen (701-0743-01 V), Environmental Governance (701-1651-00 G), Policy and Economics of Ecosystem Services (701-1653-00 G), International Environmental Politics: Part I (851-0594-00 V).

The course is (inter)related to materials discussed in Politikwissenschaft: Grundlagen (851-0577-00 V), Ressourcen- und Umweltökonomie (751-1551-00 V), Umweltrecht: Konzepte und Rechtsgebiete (851-0705-01 V), Rechtlicher Umgang mit natürlichen Ressourcen (701-0743-01 V), Environmental Governance (701-1651-00 G), Policy and Economics of Ecosystem Services (701-1653-00 G), International Environmental Politics: Part I (851-0594-00 V).
Politics of Environmental Problem Solving in Developing Countries

The course focuses on processes and drivers of decision-making on natural resources management issues in developing countries. It gives insights into the relevance of ecological aspects in developing countries. It covers concepts, instruments, processes and actors in environmental politics at the example of specific environmental challenges of global importance.

Different cases not only deal with different environmental problems, but also focus on different levels and degrees of formality. This ranges from local interventions with resource user groups as key stakeholders, to country level policies, to multi- and international initiatives and conventions. Linkages and interaction of the different system levels are highlighted. Special emphasis is given to natural resources management.

The cases address the following issues:
- Land use and soil fertility enhancement: From degradation to sustainable use
- Common property resource management (forest and pasture): Collective action and property rights, community-based management
- Ecosystem health (integrated pest management, soil and water conservation)
- Payment for environmental services: Successes in natural resources management
- Climate change and agriculture: Adaptation and mitigation possibilities
- Biodiversity Convention: Implications for conservations and access to genetic resources
- Biodiversity as a means for more secure livelihoods: Agroforestry and intercropping
- The Millennium Development Goals: Interactions between poverty and the environment
- Poverty and natural resources management: Poverty reduction strategies, the view of the poor themselves
- Food security: Policies, causes for insecurity, the role of land grabbing
- Biofuels and food security: Did politics misfire?
- Strategy development at global level: IAASTD and World Development Report 2008

Information concerning the case studies and specific issues illustrated therein will be provided during the course (uploaded on Moodle)


### Prerequisites / notice
The performance assessment will consist of an individual essay to be written by each student based on at least five references in addition to the sources provided in the course. Students can choose from a list of topics. Criteria for assessment will be communicated at the beginning of the course.

### 701-1651-00L Environmental Governance

<table>
<thead>
<tr>
<th>Number of participants limited to 30.</th>
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</thead>
<tbody>
<tr>
<td>Objective</td>
</tr>
<tr>
<td>To understand how an environmental problem may (not) become a policy and explain political processes, using basic concepts and techniques from political science.</td>
</tr>
</tbody>
</table>

To analyze the evolution as well as the key elements of environmental governance.

To be able to identify the main challenges and opportunities for environmental governance and to critically discuss them with reference to various practical policy examples.

**Content**
Improvements in environmental quality and sustainable management of natural resources cannot be achieved through technical solutions alone. The quality of the environment and the achievement of sustainable development strongly depend on human behavior and specifically the human uses of nature. To influence human behavior, we rely on public policies and other societal rules, which aim to steer the way humans use natural resources and their effects on the environment. Such steering can take place through government intervention alone. However, this often also involves governance, which includes the interplay between governmental and non-governmental actors, the use of public or private means such as emission standards or financial incentives to steer actors’ behavior and can occur at the local, regional, national or international level.

In this course, we will address both the practical aspects of as well as the scientific debate on environmental governance. The course gives future environmental experts a strong basis to position themselves in the governance debate, which does not preclude government but rather involves a spectrum from government to governance.

Key questions that this course seeks to answer: What are the core characteristics of environmental challenges from a policy perspective? What are key elements of ’environmental governance’ and how legitimate and effective are these approaches in addressing persistent environmental challenges?

**Lecture notes**
Lecture slides and additional course material will be provided throughout the semester.

**Literature**
We will mostly work with readings from the following books:

**Prerequisites / notice**
A detailed course schedule will be made available at the beginning of the semester.

We recommend that students have (a) three-years BSc education of a (technical) university; (b) successfully completed Bachelor introductory course to environmental policy (Entwicklungen nationaler Umweltpolitik (or equivalent)) and (c) familiarity with key issues in environmental policy and some fundamental knowledge of one social science or humanities discipline (political science, economics, sociology, history, psychology, philosophy)

### 851-0585-41L Computational Social Science

<table>
<thead>
<tr>
<th>W 3 credits</th>
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<tbody>
<tr>
<td>Objective</td>
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<tr>
<td>Participants of the seminar should understand how tightly connected systems lead to networked risks, and why this can imply systems we do not understand and cannot control well, thereby causing systemic risks and extreme events.</td>
</tr>
</tbody>
</table>

They should also be able to explain how systemic instabilities can be understood by changing the perspective from a component-oriented to an interaction- and network-oriented view, and what fundamental implications this has for the proper design and management of complex dynamical systems.

Computational Social Science and Global Systems Science serve to better understand the emerging digital society with its close co-evolution of information and communication technology (ICT) and society. They make current theories of crises and disasters applicable to the solution of global-scale problems, taking a data-based approach that builds on a serious collaboration between the natural, engineering, and social sciences, i.e. an interdisciplinary integration of knowledge.

**Lecture notes**
Lecture slides and additional course material will be provided throughout the semester.

### 851-0589-00L Technology and Innovation for Development

<table>
<thead>
<tr>
<th>W 3 credits</th>
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<tbody>
<tr>
<td>Objective</td>
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<tr>
<td>- to recognize the challenges and opportunities of technological change in terms of sustainable development</td>
</tr>
<tr>
<td>- to become familiar with policy instruments to promote innovation</td>
</tr>
<tr>
<td>- to improve understanding of political decision-making processes in the regulation of science &amp; technology</td>
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<tr>
<td>- improved understanding of the role of science and technology in the context of human and societal development</td>
</tr>
</tbody>
</table>

Science and Technology Policy is normally associated with the improvement of national competitiveness; yet, it is also an integral part of effective environmental and development policies.

The course will discuss the challenges and opportunities of technological change in terms of sustainable development and show how public policy on the national and the international level is responding to this change.

In this context, students are to become familiar with the basic principles of political economy and New Growth Theory and how such theories help explain political decisions as well as political outcomes in the area of Science, Technology and Innovation. State interventions are either designed to regulate (e.g. environmental regulations, anti-trust law) or facilitate (e.g. intellectual property rights protection, public investment in R&D and technical education, technology transfer) technological change. This will be illustrated by looking at different industries and different national systems of innovation. Subsequently the positive and negative consequences for society and the natural environment will be discussed from a short-term and a long-term perspective.

**Lecture notes**
Reader with issue-specific articles. E-version is partly available under https://www.ethz.ch/content/specialinterest/gess/cis/international-relations/en/teaching/materials/tech.html
Prerequisites / notice

The 2-hour course (5-7 p.m.) will be held as a series of lectures. The course materials will be available in form of an electronic Reader at the beginning of the semester. Students will be asked to give a (a) presentation (15 Minutes) or write a review paper based on a article selected from the electronic script, and (b) they will have to pass a written test at the end of the course in order to obtain 3 credit points in the ECTS System. In the final mark (a) will have a weight of 40% and (b) 60%.
This course deals with how and why international cooperation in environmental politics emerges, and under what circumstances such cooperation is effective and efficient. Based on theories of international political economy and theories of government regulation various examples of international environmental politics are discussed: the management of international water resources, the problem of unsafe nuclear power plants in eastern Europe, political responses to global warming, the protection of the stratospheric ozone layer, the reduction of long-range transboundary air pollution in Europe, the prevention of pollution of the oceans, etc.

The course is open to all ETH students. Participation does not require previous coursework in the social sciences.

After passing an end-of-semester test (requirement: grade 4.0 or higher) students will receive 3 ECTS credit points. The workload is around 90 hours (meetings, reading assignments, preparation of test).

Visiting students (e.g., from the University of Zurich) are subject to the same conditions. Registration of visiting students in the web-based system of ETH is compulsory.

Lecture notes
Assigned reading materials and slides will be available at http://www.ib.ethz.ch/teaching.html (select link ‘Registered students, please click here for course materials’ at top of that page). Log in with your nethz name and password. Questions concerning access to course materials can be addressed to Mike Hudecheck (Mike.Hudecheck@student.ethz.ch). All assigned papers must be read ahead of the respective meeting. Following the course on the basis of on-line slides and papers alone is not sufficient. Physical presence in the classroom is essential. Many books and journals covering international environmental policy issues can be found at the D-GESS library at the IFW building, Haldeneggsteig 4, B-floor, or in the library of D-USYS.

Literature
Assigned reading materials and slides will be available at http://www.ib.ethz.ch/teaching.html (select link ‘Registered students, please click here for course materials’ at top of that page). Log in with your nethz name and password. Questions concerning access to course materials can be addressed to Mike Hudecheck (Mike.Hudecheck@student.ethz.ch).

Prerequisites / notice
None

<table>
<thead>
<tr>
<th>851-0609-06L</th>
<th>Governing the Energy Transition</th>
<th>W</th>
<th>2 credits</th>
<th>2V</th>
<th>T. Schmidt</th>
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<tbody>
<tr>
<td>Number of participants limited to 30.</td>
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Primarily suited for Master and PhD level

Abstract
This course addresses the role of policy and its underlying politics in the transformation of the energy sector. It covers historical, socio-economic, and political perspectives and applies various theoretical concepts to specific aspects of governing the energy transition.

Objective
- To gain an overview of the history of the transition of large technical systems
- To recognize current challenges in the energy system to understand the theoretical frameworks and concepts for studying transitions
- To demonstrate knowledge on policy and politics in energy transitions

Content
Climate change, access to energy and other societal challenges are directly linked to the way we use and create energy. Both the recent United Nations Paris climate change agreement and the UN Sustainable Development Goals make a fast and extensive transition of the energy system necessary.

This course introduces the social and environmental challenges involved in the energy sector and discusses the implications of these challenges for the rate and direction of technical change in the energy sector. It compares the current situation with historical socio-technical transitions and derives the consequences for policy-making. It then introduces theoretical frameworks and concepts for studying innovation and transitions. It then focuses on the role of policy and policy change in governing the energy transition, considering the role of political actors, institutions and policy feedback.

The course has a highly interactive (seminar-like) character. Students are expected to actively engage in the weekly discussions and to give a presentation (15-20 minutes) on one of the weekly topics during that particular session. The presentation (30%) and participation in the discussions (20%) will form one part of the final grade, the remaining 50% of the final grade will be formed by a final exam.

Lecture notes
Slides and reading material will be made available via moodle.ethz.ch (only for registered students).

Literature
A reading list will be provided via moodle.ethz.ch at the beginning of the semester.

Prerequisites / notice
This course is particularly suited for students of the following programmes: MA Comparative International Studies; MSc Energy Science & Technology; MSc Environmental Sciences; MSc Management, Technology & Economics; MSc Science, Technology & Policy; ETH & UZH PhD programmes.

Data: 06.03.2019 12:57 Autumn Semester 2016 Page 1525 of 1571
The main topics of the course are:

1. Introduction to the agent-based paradigm and overview on existing agent-based models in transportation, including MATSim
2. Learn how to setup MATSim for policy analysis
3. Learn about the interfaces available to enhances the software (includes Java programming)
4. Create, run and analyse a policy study

The lectures will introduce students to the principles of quantitative policy analysis, namely the methods to predict and evaluate the social, economic, and environmental effects of alternative strategies to achieve public objectives. A series of graded assignments will give students an opportunity for students to apply those methods to a set of case studies.
The course deals with the concepts and methodologies for the analysis and assessment of sustainable development. A special focus is on problem oriented research projects. Td methods are used in research at the science-society interface and when collaborating across scientific disciplines.

Students learn to apply methods within a functional framework. The format of the course is seminar-like, interactive.

At the end of the course students should:

Know:
- Function, purpose and algorithm of a selected number of transdisciplinary methods

Understand:
- Functional application in case studies and other problem oriented projects

Be able to reflect on:
- Potential, limits, and necessity of transdisciplinary methods

Be prepared for:
- Transdisciplinary Case Study 2017

Content
- Overview of concepts and methods of inter-/transdisciplinary integration of knowledge, values and interests (approx. 20%)
- Analysis of a selected number of transdisciplinary methods focusing problem framing, problem analysis, and impact (approx. 50%)
- Practical application of the methods in a broader project setting (approx. 30%)

Handouts are provided by the lecturers

Selected scientific articles & book chapters

This course is recommended and helpful for students participating in the Transdisciplinary Case Study 2017.

Sustainability Assessment

The course deals with the concepts and methodologies for the analysis and assessment of sustainable development. A special focus is given to the social dimension and to social justice as a guiding principle of sustainability as well as to trade-offs between the three dimensions of sustainability.

At the end of the course students should:

Know:
- core concepts of sustainable development, and;
- the concept of social justice - normatively and empirically - as a core element of social sustainability;
- important empirical methods for the analysis and assessment of local / regional sustainability issues.

Understand and reflect on:
- the challenges of trade-offs between the different goals of sustainable development;
- and the respective impacts on individual and societal decision-making.

The course is seminar-like, interactive.

Content
- Overview of rationale, objectives, concepts and origins of sustainable development;
- Importance and application of sustainability in science, politics, society, and economy;
- Sustainable (local / regional) development in different national / international contexts;
- Analysis and evaluation methods of sustainable development with a focus on social justice;
- Trade-offs in selected examples.

Handouts.

Selected scientific articles & book chapters

Environmental Regulation: Law and Policy

The course will be offered again in the spring semester 2017.

Number of participants limited to 15.

Abstract
The aim of this course is to make students with a technical scientific background aware of the legal and political context of environmental policy in order to place technical solutions in their regulatory context.

Objective
The aim of this course is to equip students with a legal and regulatory skill-set that allows them to translate their technical knowledge into a policy brief directed at legally trained regulators. More generally, it aims to inform students with a technical scientific background of the legal and political context of environmental policy. The focus of the course will be on international and European issues and regulatory frameworks - where relevant, the position of Switzerland within these international networks will also be discussed.

Number of participants limited to 15.

Abstract
The aim of this course is to equip students with a legal and regulatory skill-set that allows them to translate their technical knowledge into a policy brief directed at legally trained regulators. More generally, it aims to inform students with a technical scientific background of the legal and political context of environmental policy. The focus of the course will be on international and European issues and regulatory frameworks - where relevant, the position of Switzerland within these international networks will also be discussed.
Content

Topics covered in lectures:

(1) Environmental Regulation
   a. Perspectives
   b. Regulatory Challenges of Environment Problems
   c. Regulatory Tools

(2) Law: International, European and national laws
   a. International law
   b. European law
   c. National law

(3) Policy: Case studies

Assessment:
(i) Class participation (25%): Students will be expected to contribute to class discussions and prepare short memos on class readings.
(ii) Exam (75%) consisting of three parts:
   a. Policy brief - a maximum of 2 pages (including graphs and tables);
   b. Background document to the policy brief - this document sets out a more detailed and academic overview of the topic (maximum 8 pages including graphs and tables);
   c. Presentation of the policy brief: presentations can use a maximum of 5 slides and can last 7 minutes.

Lecture notes

The course is taught as a small interactive seminar and significant participation is expected from the students. Participation will be capped at 15 in order to maintain the interactive nature of the classes. All classes, readings, and assignments, are in English.

Teaching will take place over two weeks in September and October. The exam date will be in December.

During the second week of the teaching period, students will have individual 30-minute meetings with the lecturer to discuss their project.

The course is (inter)related to materials discussed in Politikwissenschaft: Grundlagen (851-0577-00 V), Ressourcen- und Umweltökonomie (751-1551-00 V), Umweltrecht: Konzepte und Rechtsgebiete (851-0705-01 V), Rechtlicher Umgang mit natürlichen Ressourcen (701-0743-01 V), Environmental Governance (701-1651-00 G), Policy and Economics of Ecosystem Services (701-1653-00 G), International Environmental Politics: Part I (851-0594-00 V).

### Major in Forest and Landscape Management

#### Natural Science Foundations

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-1613-01L</td>
<td>Advanced Landscape Research</td>
<td>W</td>
<td>5 credits</td>
<td>3G</td>
<td>M. Bürgi, J. Bolliger, U. Gimmi, M. Hunziker</td>
</tr>
</tbody>
</table>

**Abstract**

This course introduces landscapes as socially perceived, spatially and temporally dynamic entities that are shaped by natural and societal factors. Concepts and qualitative and quantitative methods to study landscapes from an ecological, societal and historical perspective are presented. In a term paper students work on a landscape-related topic of their choice.

**Objective**

Students will:
- learn about concepts and methods to quantify structural and functional connectivity in landscapes, particularly
- be introduced to the topic of landscape genetics and its benefits and (current) limitations for applied conservation
- learn about concepts and methods in scenario-based land-use change modelling
- approach an understanding of landscape as perceived environment
- understand the role of landscape for human well-being
- be introduced into approaches of actively influencing attitudes and behavior as well as related scientific evaluation
- make use of various historical sources to study landscapes and their dynamics
- interpret landscapes as a result of ecological constraints and anthropogenic activities.

**Content**

1. Encompassing concepts and approaches
   - European Landscape Convention (ELC)
   - Ecosystem Services (ES): introduction and critical evaluation

2. Ecological approach:
   - green infrastructure (e.g., ecological conservation areas)
   - landscape connectivity
   - landscape genetics and management applications
   - concepts of specific quantitative methods: least cost paths, resistance surfaces, Circuitscape, networks (Conefor), land-use change models, various statistical methods

3. Social-science approach:
   - principle of landscape as perceived and connoted environment
   - theories on landscape preference and place identity
   - role of landscapes for recreation, health and well-being
   - intervention approaches for influencing attitudes and related behavior
   - methods of investigating the human-landscape relationship and evaluating interventions

4. Historical approach:
   - land use history of Switzerland (agricultural history, forest and woodland history)
   - historical legacies of land use in landscapes and ecosystems
   - historic-ecological approaches and applications

5. Land change science:
   - modelling future land-use (CLUE, other scenario-based models)
   - landscape functions and services

**Lecture notes**

Handouts will be available in the course and for download

**Prerequisites / notice**

Basic Landscape Ecology courses at Bachelor level
Foundations of Ecosystem Management

This course introduces the broad variety of conflicts that arise in projects focusing on sustainable management of natural resources. It explores studies of ecosystem management approaches and considers their practicability, their achievements and possible barriers to their uptake.

Objective

Students should be able to:

a) propose appropriate and realistic solutions to ecosystem management problems that integrate ecological, economic and social dimensions across relevant temporal and spatial scales.

b) identify important stakeholders, their needs and interests, and the main conflicts that exist among them in the context of land and resource management.

Content

Traditional management systems focus on extraction of natural resources, and their manipulation and governance. However, traditional management has frequently resulted in catastrophic failures such as, for example, the collapse of fish stocks and biodiversity loss. These failures have stimulated the development of alternative ecosystem management approaches that emphasise the functionality of human-dominated systems. Inherent to such approaches are system-wide perspectives and a focus on ecological processes and services, multiple spatial and temporal scales, as well as the need to incorporate diverse stakeholder interests in decision making. Thus, ecosystem management is the science and practice of managing natural resources, biodiversity and ecological processes, to meet multiple demands of society. It can be local, regional or global in scope, and addresses critical issues in developed and developing countries relating to economic and environmental security and sustainability.

This course provides an introduction to ecosystem management, and in particular the importance of integrating ecology into management systems to meet multiple societal demands. The course explores the extent to which human-managed terrestrial systems depend on underlying ecological processes, and the consequences of degradation of these processes for human welfare and environmental well-being. Building upon a theoretical foundation, the course will tackle issues in resource ecology and management, notably forests, agriculture and wild resources within the broader context of sustainability, biodiversity conservation and poverty alleviation or economic development. Case studies from tropical and temperate regions will be used to explore these issues. Dealing with ecological and economic uncertainty, and how this affects decision making, will be discussed. Strategies for conservation and management of terrestrial ecosystems will give consideration to landscape ecology, protected area systems, and community management, paying particular attention to alternative livelihood options and marketing strategies of common pool resources.

Recommended and required reading will be specified at the first class session (with possible modifications as the semester proceeds).

Ecosystem Management

No Script


Multifunctional Forest Management

Multifunctional forest management needs to control natural processes such that they efficiently provide the diverse services and goods for society in a sustainable and close to nature way. This course provides the the basic knowledge, the principles and the management tools for successful multifunctional forest management.
Objective

Forests in heavily populated areas need to provide diverse ecosystem services and goods for the benefits of society. Multifunctional forest management thus needs to control natural processes such that they efficiently provide these services and goods in a sustainable and close to nature way. This course provides the knowledge, the principles and the management tools for multifunctional forest management. Different strategies and management options are presented and discussed.

Content

Identification of social needs for the multi-dimensional ecosystem goods and services and their transformation into detailed objectives (profiles) regarding ecosystem functions, structures and processes.

Understanding of the important natural processes and their spatial and temporal dynamics in the most important forest ecosystems of Europe.

Identification of critical, relevant processes and ecosystem conditions for the different objectives (profiles).

Development of management options and strategies and assessment of their effects on ecosystem goods and services.

Requirements for modern, multifunctional forest management from a Swiss and European perspective - strategies and possible solutions.

Lecture notes

No class notes or text books

Lecture presentations are available for download

Literature

Reading assignments are given in class

A bibliography of cited literature will be available

Prerequisites / notice

Course language is German. Prerequisites: Sufficient German language skills

In addition to the lectures students need to attend 4 all day field excursions. Topic: Near natural and efficient tending concepts.

Participating on all 4 field trips is a prerequisite for credits

Additional field excursions focusing on the Swiss femelschlag system, the Plenter- and other irregular systems will be offered during spring term in an optional course named "AK des multifunktionalen Waldmanagements". 9 days of field trips will provide the possibility to consolidate theoretical knowledge, to apply it to real examples in the field, to discuss and further consolidate what has been taught in this class. The additional course is an important part of the overall formation on forest management and is highly recommended.

Decision Making, Policy and Planning

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>701-0743-01L</td>
<td>Law and Natural Resources</td>
<td>W</td>
<td>2</td>
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<tr>
<td></td>
<td>Does not take place this semester,</td>
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<td></td>
<td>The course will be offered again in the spring semester 2017.</td>
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Abstract

This course teaches the possibilities and limits of the law in order to protect natural resources and landscapes against harm and nuisance.

The learning concept is based on the co-ordinated implementation of the relevant legislations. The complexity of the legal situation will be discussed by analysing virtual and real law cases focused on spatial projects and planning.

Objective

The students know the opportunities and restrictions which are given by the law when using natural resources. They have insights into the complex environmental legal system and their application in concrete cases. The students are able to formulate typical legal questions, to understand the argumentation of courts and to solve simple legal problems with respect to environmental problems.

Content


- Waldrecht - Natur- und Landschaftsschutzrecht - Wasserrecht - Raumplanungsrecht - Umweltschutzrecht - Verfahrensrecht

Unterrichtssprache: Deutsch

Lecture notes

Den Studierenden werden Unterlagen wie eine Übersicht über den behandelten Stoff auf PP-Folien, typische Gerichtsentscheide, Zeitungsartikel etc. über neue Vorhaben mit Auswirkungen auf die Umwelt und entsprechenden Rechtsfragen abgegeben.

Literature

Griffel, A.; Raumplanungs- und Baurecht in a nutshell, Dike Verlag, Zürich/St. Gallen 2012


Keel/Zimmermann: Bundesgerichtliche Rechtsprechung zur Waldgesetzgebung. In URP 2009/3


Umweltrecht in der Praxis URP (Juristische Fachzeitschrift für Umweltrechtsfragen, herausgegeben von der Vereinigung für Umweltrecht (VUR))

Weitere Literaturangaben erfolgen in der ersten Veranstaltung.

Prerequisites / notice


Environmental Governance

Number of participants limited to 30.

Abstract

The course addresses environmental policies, focusing on new steering approaches, which are generally summarized as environmental governance. The course also provides students with tools to analyze environmental policy processes and assesses the key features of environmental governance by examining various practical environmental policy examples.

Objective

To understand how an environmental problem may (not) become a policy and explain political processes, using basic concepts and techniques from political science.

To be able to identify the main challenges and opportunities for environmental governance and to critically discuss them with reference to various practical policy examples.
### Methods and Tools

<table>
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<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
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<tbody>
<tr>
<td>701-1673-00L</td>
<td>Environmental Measurement Laboratory</td>
<td>W</td>
<td>5 credits</td>
<td>4G</td>
<td>P. U. Lehmann Grunder, D. Or</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>Measurements are the sole judge of scientific truth and provide access to unpredictable information, enabling the characterization and monitoring of complex terrestrial systems. Based on lectures and field- and laboratory training the students learn to apply modern methods to determine forest inventory parameters and to measure subsurface properties and processes.</td>
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| **Objective** | - explain functioning of sensors that are used for characterization of landscapes and terrestrial systems  
- select appropriate measurement methods and sampling design to quantify key variables and processes in the subsurface  
- deploy sensors in the field and maintain sensor network  
- interpret collected laboratory and field data and report main conclusions deduced from measurements |
| **Content** | 1) Measurement Science: Measurement precision and accuracy; sensing footprint, sampling design and sampling errors, uncertainty reduction, spatial and temporal variability, sampling network design and information costs  
2) Electronics: Basic introduction to electronic components, voltage and current measurements, A/D converters, power requirements, power consumption calculations, batteries, storage capacity, solar panels  
3) Datalogging (Lecture): Data Logging, data transfer, storage, and sensing technologies; basic data logger programming; overview of soil sensor types and sensor calibration; including programming in the laboratory  
4) Geophysical methods on Subsurface Characterization: Basic principles of ERT, GPR, and EM;  
5) Soil and Groundwater Direct Sampling (Lab): Soil physical sampling; profile characterization, disturbed and undisturbed soil sampling, direct-push geoprobe sampling; soil water content profiles and transects;  
6) Electronics Laboratory: Setup and measurement of simple circuits, selection and use of voltage dividers, batteries and solar panels; pressure and temperature measurements;  
7) Deployment of monitoring network: Field installation of TDR, temperature probes, tensiometers, data loggers and power supply  
8) Geophysics lab: Demonstration and application of geophysical methods in the field;  
9 & 10) Forest characterization/ inventory: Principles of LIDAR; structures and features of the tree crowns, size/volume of the leaf area tree positions and diameters at breast height  
11 & 12) Ecosystem- and Soil Monitoring Networks- Data management for long term monitoring networks Tereno, and other critical zone observatories  
13) Remote Sensing- Basic principles and forest-related examples including data extraction and analysis |
| **Lecture notes** | Lecture material on page |
| **Language** | Lecture material will be online for registered students: http://www.step.ethz.ch/education/environmental-measurement-lab.html |
| **Prerequisites / notice** | The details of the schedule will be optimized based on the number of students; some blocks of the course will be offered as well to students of Environmental Engineering |

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<tbody>
<tr>
<td>701-1679-00L</td>
<td>Spatial Modelling: From Climate &amp; Land Use Change to Biodiversity Conservation</td>
<td>W</td>
<td>5 credits</td>
<td>3U</td>
<td>L. Pellissier, N. Zimmermann</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>The course provides the student with the spatial tools to address societal challenges toward ensuring the sustainable use of terrestrial ecosystems and the conservation of biodiversity. Students learn theory, tools and models during a few introductory sessions and apply this knowledge to solve a practical problem in groups related to climate change, land use change and biodiversity conservation.</td>
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| **Objective** | Students learn:  
- Theoretical foundations of the species ecological niche  
- Biodiversity concepts and global change impacts  
- Basic concepts of spatial (and macro-) ecology  
- Environmental impact assessment and planning  
- Advanced statistical methods (GLM, GAM, CART) and basic programming (loops, functions, advanced scripting) in the statistical environment R.  
- The use of GIS functionality in R |
Day 1: Ecology of the forest habitats

1. The basics:
   - Introduction to the concept of the ecological niche, and biodiversity theories. Overview of the knowledge on expected biodiversity response to global changes and conservation planning methods.
   - Introduction to the statistical methods of Generalized Linear (GLM) and Generalized Additive models (GAM), and Classification and Regression Trees (CART). Introduction to basic GIS and programming elements in the statistical environment R.

2. The class project:
   - Students form groups of two, and each group solves a series of applied questions independently in R using the techniques taught in the introductory classes. The students then present and report of the obtained results that will be discussed during a mini-symposium. Each team chooses one of the following topics for the class project:
     a) Linking climate change velocities to species' migration capacities
     b) Explaining and modelling land use change in Switzerland
     c) Explaining and modelling biodiversity changes in Switzerland
     d) Designing biodiversity conservation strategies under global changes.

Prerequisites / notice: Basic knowledge in statistics (OLS regression, test statistics), and basic knowledge in geographic information science.

Electives

ECTS: 3G

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<tr>
<td>701-1453-00L</td>
<td>Ecological Assessment and Evaluation</td>
<td>W</td>
<td>3</td>
<td>3G</td>
<td>F. Knaus, U. Bollens Hunziker</td>
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<tr>
<td>701-1661-00L</td>
<td>Conservation and Development in Complex</td>
<td>W</td>
<td>3</td>
<td>6G</td>
<td>J. Ghazoul</td>
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<td>Landscapes</td>
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<td>Does not take place this semester.</td>
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<tr>
<td>701-1663-00L</td>
<td>Exploring Resilience of Tropical Forest</td>
<td>W</td>
<td>4</td>
<td>9G</td>
<td>C. Kettle, C. D. Philipson</td>
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Prerequisites / notice: Basic knowledge in statistics (OLS regression, test statistics), and basic knowledge in geographic information science.

ECTS: 701-1453-00L: 3 credits, 701-1661-00L: 3 credits, 701-1663-00L: 4 credits
Objective
The course will have four core learning objectives: 1) provide students with an understanding and experience of a range of tropical rainforest systems, and an appreciation of the challenges of managing these landscapes to provide multiple ecosystem services. 2) To develop their creative and critical scientific thinking and experimental design in the context of tropical field ecology. Specifically through design and implementation an Adaptive Management approach to tropical forest landscapes. 3) Students will develop their understanding of multiple stakeholders perspectives in the context of landscape management in SE Asian develop the knowledge to discuss these issues with experts in the field. Students will present their Adaptive Management Plans to senior Forest Researchers in the forest department at the FRC Sabah and engage in dialogue regarding diverse perspectives in forest and landscape management. 4) To develop their team building skills to work in culturally diverse groups and under sometimes challenging conditions to work toward a common research goal.

Content
Proposed topics to be covered within the scope of the projects and based upon the expertise of the course lecturers: Tropical Ecology, Forest Ecology and Forest Botany. Tropical Forest management and restoration. Conservation biology, Animal behaviour, tropical entomology, Biodiversity and ecosystem function, Resilience and Adaptive Management.

Literature
Literature presented in Tropical Rainforest Ecology

Prerequisites / notice
701-0324-00 G Rain Forest Ecology

>>> Decision Making, Policy and Planning

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<tr>
<td>851-0735-11L</td>
<td>Environmental Regulation: Law and Policy</td>
<td>W</td>
<td>3</td>
<td>1S</td>
<td>J. W. Kirchner</td>
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Does not take place this semester.

The course will be offered again in the spring semester 2017.

Number of participants limited to 15.

Abstract
The aim of this course is to make students with a technical scientific background aware of the legal and political context of environmental policy in order to place technical solutions in their regulatory context.

Objective
The aim of this course is to equip students with a legal and regulatory skill-set that allows them to translate their technical knowledge into a policy brief directed at legally trained regulators. More generally, it aims to inform students with a technical scientific background of the legal and political context of environmental policy. The focus of the course will be on international and European issues and regulatory frameworks - where relevant, the position of Switzerland within these international networks will also be discussed.

Content
Topics covered in lectures:

(1) Environmental Regulation
a. Perspectives
b. Regulatory Challenges of Environment Problems
c. Regulatory Tools

(2) Law: International, European and national laws
a. International law
b. European law
c. National law

(3) Policy: Case studies

Assessment:
(i) Class participation (25%): Students will be expected to contribute to class discussions and prepare short memos on class readings.
(ii) Exam (75%) consisting of three parts:
   a. Policy brief - a maximum of 2 pages (including graphs and tables);
   b. Background document to the policy brief - this document sets out a more detailed and academic overview of the topic (maximum 8 pages including graphs and tables);
   c. Presentation of the policy brief: presentations can use a maximum of 5 slides and can last 7 minutes.

Lecture notes
The course is taught as a small interactive seminar and significant participation is expected from the students. Participation will be capped at 15 in order to maintain the interactive nature of the classes. All classes, readings, and assignments, are in English.

Teaching will take place over two weeks in September and October. The exam date will be in December.

Literature
During the second week of the teaching period, students will have individual 30-minute meetings with the lecturer to discuss their project.

An electronic copy of relevant readings will be provided to the students at no cost before the start of the lectures.

Prerequisites / notice
No specific pre-existing legal knowledge is required, however all students must have successfully completed Grundzüge des Rechts (851-0708-00 V) or an equivalent course.

The course is (inter)related to materials discussed in Politikwissenschaft: Grundlagen (851-0577-00 V), Ressourcen- und Umweltökonomie (751-1551-00 V), Umweltrecht: Konzepte und Rechtsgebiete (851-0705-01 V), Rechtlicher Umgang mit natürlichen Ressourcen (701-0743-01 V), Environmental Governance (701-1651-00 G), Policy and Economics of Ecosystem Services (701-1653-00 G), International Environmental Politics: Part I (851-0594-00 V).

>>> Methods and Tools

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<tr>
<td>701-1316-00L</td>
<td>Physical Transport Processes in the Natural Environment</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>J. W. Kirchner</td>
</tr>
</tbody>
</table>

Abstract
Fluid flows transport all manner of biologically important gases, nutrients, toxins, contaminants, spores and seeds, as well as a wide range of organisms themselves. This course explores the physics of fluids in the natural environment, with emphasis on the transport, dispersion, and mixing of solutes and entrained particles, and their implications for biological and biogeochemical processes.

Objective
Students will learn key concepts of fluid mechanics and how to apply them to environmental problems. Weekly exercises based on real-world data will develop core skills in analysis, interpretation, and problem-solving.

Content
dimensional analysis, similarity, and scaling solute transport in laminar and turbulent flows transport and dispersion in porous media transport of sediment (and adsorbed contaminants) by air and water anomalous dispersion

Lecture notes
The course is under development. Lecture materials will be distributed as they become available.

701-1671-00L Sampling Techniques for Forest Inventories W 3 credits 2V D. Mandalia
### 701-1677-00L Quantitative Vegetation Dynamics: Models from Tree to Globe

**Abstract**
This course provides hands-on experience with models of vegetation dynamics across temporal and spatial scales. The underlying principles, assets and trade-offs of the different approaches are introduced, and students work in a number of small projects with these models to gain first-hand experience.

**Objective**
- Students will be able to understand, assess and evaluate the fundamental properties of dynamic systems using vegetation models as case studies.
- They will learn the theoretical and practical aspects of the dating of tree rings.
- They will understand, how wood is configured and how tree-ring structures are formed.
- They will understand the methodological basis for impact assessments of future climate change and other environmental changes on ecosystems.
- They will be able to work with such model types on their own.

**Content**
Models at the stand scale
- Simple approaches: matrix models
- Competition for light and other resources as central mechanisms
- Individual-based stand models: distance-dependent and distance-independent

Models at the landscape scale
- Simple approaches: cellular automata
- Dispersal and disturbances (windthrow, fire, bark beetles) as key mechanisms
- Landscape models

Global models
- Sacrificing local detail to attain global coverage: processes and entities
- Dynamic Global Vegetation Models (DGVMs)
- DGVMs as components of Earth System Models

**Lecture notes**
Handouts will be available in the course and for download.

**Literature**
- Good knowledge of general ecology, vegetation dynamics, and forest systems
- Basic training in modelling and systems analysis
- Good knowledge of general ecology, vegetation dynamics, and forest systems

**Prerequisites / notice**
- Basic training in modelling and systems analysis
- Good knowledge of general ecology, vegetation dynamics, and forest systems

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### 701-1682-00L Dendroecology

**Abstract**
The course dendroecology offers theoretical and practical aspects of dendrochronology. The impact of different environmental influences on tree-ring characteristics will be shown. The students learn various methods to date tree rings and they understand how ecological and environmental processes and patterns can be reconstructed using tree rings.

**Objective**
The students...
- understand, how wood is configured and how tree-ring structures are formed.
- are able to identify and describe different tree-ring structures.
- understand the theoretical and practical aspects of the dating of tree rings.
- know the effects of different abiotic and biotic environmental influences (climate, site, competition, insects, fire, physical-mechanical influences) on trees and tree rings.
- discover a tool for understanding and reconstructing global change processes.
- learn software to date, standardize and analyze tree rings.
- get hands-on experience based on the demonstration of wood (increment cores, stem discs, wedges), sampling in the field, and measuring and dating of tree rings in the tree-ring lab.
- solve R-based exercises (R tutorial will be provided) and answer questions in Moodle.
- work out an independent research question related to a dendroecological topic and write a short literature review based on scientific papers.

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**Autumn Semester 2016**

**Page:** 1534 of 1571
Content
- Overview and history of dendrochronology
- Principles of dendrochronology
- Evolution of tree rings
- Formation and structure of wood and tree rings
- Intra-seasonal tree-ring growth
- Continuous and discontinuous tree-ring characteristics
- Sampling and measuring
- Crossdating methods (visual, skeleton plots, quantitative)
- Standardization of tree-ring series
- Development of tree-ring chronologies
- Dendrogeomorphology, dendrohydrology, dendroclimatology
- Stable isotopes
- Climate, climate-growth relationships, climate reconstructions
- Age and size structures, forest dynamics (regeneration, growth, competition, mortality)
- Disturbance ecology (fire, insects, blowdown)
- Application of tree-ring research in practice and in interdisciplinary research projects
- Field and lab day (date for one entire day or two half days will be searched together with the students in the beginning of the semester): discussion of different dendroecological questions in the forest; sampling of trees; insight into different tree-ring projects in the lab (Swiss Federal Institute for Forest, Snow and Landscape Research WSL)

Lecture notes
Lecture notes (in English) will be handed out in the class.

Literature
Lecture notes and further documents (papers, software) can also be downloaded from Moodle (https://moodle-app2.let.ethz.ch) following registration for the course.

Prerequisites / notice
Time schedule (total of 90 hours): There will be 12 lectures with each two hours (total of 24 hours presence) as well as a field and lab day (8 hours presence). In addition, the students are expected to put 18 hours into the preparation of the lectures as well as 18 hours for the exercises. 4 hours are reserved for the lab work and 18 hours for the project.

The class language is German and English, on request English only.

Requirements:
Basics of biology, ecology and forest ecology

701-1776-00L Geographic Data Processing with Python and ArcGIS

Abstract
The course communicates the basics of the programming language Python and gives a general introduction into the geoprocessing framework of ArcGIS. In addition various Python libraries (numpy, Scipy, GDAL, statsmodels, pandas) will be introduced which increase the functional range of the geoprocessing framework substantially.

Objective
The students learn the basics of geographic data processing based on the programming language Python and ArcGIS (arcpy). They get the ability to implement their own processing sequences and models for geoprocessing. The students are able to integrate open source libraries in their python scripts and know how the libraries are applied to spatial datasets.

Content
The course communicates a deepened understanding of the geoprocessing frameworks arcpy and covers basic language concepts of Python such as datatypes, control structures and functions. In addition the application of popular Python libraries in combination with spatial datasets will be shown.

Lecture notes
Lecture notes, exercises and worked out solutions to them will be provided.

Literature

Prerequisites / notice
The course will be taught in German. All material will be provided in English. Knowledge of ArcGIS is assumed.

401-0627-00L Smoothing and Nonparametric Regression with Examples

Abstract
Starting with an overview of selected results from parametric inference, kernel smoothing (including local polynomials) will be introduced along with some asymptotic theory, optimal bandwidth selection, data driven algorithms and some special topics. Examples from environmental research will be used for motivation, but the methods will also be applicable elsewhere.

Objective
The students will learn about methods of kernel smoothing and application of concepts to data. The aim will be to build sufficient interest in the topic and intuition as well as the ability to implement the methods to various different datasets.

Content
Rough Outline:
- Parametric estimation methods: selection of important results
  - Maximum likelihood
- Least squares: regression & diagnostics
- Nonparametric curve estimation
  - Density estimation, Kernel regression, Local polynomials, Bandwidth selection
- Selection of special topics (as time permits, we will cover as many topics as possible) such as rapid change points, mode estimation, robust smoothing, partial linear models, etc.
- Applications: potential areas of applications will be discussed such as, change assessment, trend and surface estimation, probability and quantile curve estimation, and others.

Lecture notes
Brief summaries or outlines of some of the lecture material will be posted at http://www.wsl.ch/info/mitarbeitende/ghosh/index_EN (click on "ETH Course" in the left panel).

NOTE: The posted notes will tend to be just sketches whereas only the in-class lessons will contain complete information.

LOG IN: In order to have access to the posted notes, you will need the course user id & the password. These will be given out on the first day of the lectures.
Epidemiology and Prevention

The module Epidemiology and prevention describes the process of scientific discovery from the detection of a disease and its causes, to the development and evaluation of preventive and treatment interventions and to improved population health. Students will also become aware on how epidemiological facts are used in prevention, practice and politics. We will discuss study designs in the context of existing knowledge and the type of evidence needed to advance knowledge. Examples from nutrition, chronic and infectious diseases will be used in order to show the underlying concepts and methods.

Prerequisites / notice
If you are unfamiliar with R, I highly recommend the online R course etutoR.

References:
- Statistical Inference, by S.D. Silvey, Chapman & Hall.
- Density Estimation, by B.W. Silverman, Chapman and Hall.
- Kernel Smoothing, by M.P. Wand and M.C. Jones, Chapman and Hall.
- Nonparametric Simple Regression, by J. Fox, Sage Publications.

Additional references will be given out in the lectures.

Prerequisites: A background in Linear Algebra, Calculus, Probability & Statistical Inference including Estimation and Testing.

Colloquium

Number Title Type ECTS Hours Lecturers
701-1691-00L Colloquium Forest and Landscape Management Z 0 credits 1.5K H. Bugmann

Objective
This course is geared towards outreach and dissemination of research results to Swiss forest practitioners. As a rule, it is run in German, in some cases in French, and as an exception in English.

Public Health

Epidemiology and Prevention

Information for UZH students: Enrolment to this course unit only possible at ETH. No enrolment to module CS16_101 at UZH.

Please mind the ETH enrolment deadlines for UZH students: https://www.ethz.ch/en/studies/non-degree-courses/special-students-university-of-zurich.html

Objective
The module Epidemiology and prevention describes the process of scientific discovery from the detection of a disease and its causes, to the development and evaluation of preventive and treatment interventions and to improved population health.

Content
The module Epidemiology and prevention follows an overall framework that describes the course of scientific discovery from the detection of a disease to the development of prevention and treatment interventions and their evaluation in clinical trials and real world settings. We will discuss study designs in the context of existing knowledge and the type of evidence needed to advance knowledge. Examples from nutrition, chronic and infectious diseases will be used in order to show the underlying concepts and methods.

Public Health Concepts

Objective
At the end of this module students are able:
- to interpret the results of epidemiological studies
- to critically assess scientific literature
- to know the definition, dimensions and determinants of health
- to plan public health interventions and health promotion projects

Content
Concepts of descriptive and analytical epidemiology, study designs, measures of effect, confounding and bias, screening, surveillance, definition of health and health promotion, health dimensions and health determinants, prevention strategies, public health interventions, public health action cycle, epidemiology and prevention of infectious and chronic diseases (HIV, Tuberculosis, Obesity, Public health nutrition).

Infectious Diseases

Seminars

Handouts are provided to students in the classroom.

Language of the course is English.
Molecular Biology of Foodborne Pathogens

Students of this course will discuss current topics from the field of infectious disease biology. From a list of publications, each student chooses some themes that he/she is going to explain and discuss with all other participants and under supervision. The actual topics will change from year to year corresponding to the progress and new results occurring in the field.

This is an advanced course that will require significant student participation. Students will learn how to evaluate and present scientific literature and trace the development of ideas related to understanding the ecology and evolutionary biology of infectious diseases.

A core set of ~10 classic publications encompassing unifying themes in infectious disease ecology and evolution, such as virulence, resistance, metapopulations, networks, and competition will be presented and discussed. Pathogens will include bacteria, viruses and fungi. Hosts will include animals, plants and humans.

Papers will be assigned and downloaded from a web page announced during the lecture.

Lecture notes and class notes can be downloaded from a web page announced during the lecture.

The course offers detailed information on selected foodborne pathogens and toxin producing organisms; the focus lies on relevant molecular biological aspects of pathogenicity and virulence, as well as on the emergence and survival of these organisms in foods.

Detailed and current status of research and insights into the molecular basis of foodborne diseases, with focus on interactions of the microorganism or the toxins they produce with the human system. Understanding the relationship between specific types of food and the associated pathogens and microbial risks. Another focus lies on the currently available methods and techniques useful for the various purposes, i.e., detection, differentiation (typing), and antimicrobial agents.

Evolutionary Medicine for Infectious Diseases

This course explores infectious disease from both the host and pathogen perspective. Through short lectures, reading and active discussion, students will identify areas where evolutionary thinking can improve our understanding of infectious diseases and, ultimately, our ability to treat them effectively.

We will cover several topics where evolutionary thinking is relevant to understanding or treating infectious diseases. This includes: (i) determinants of pathogen host range and virulence, (ii) dynamics of host-parasite coevolution, (iii) pathogen adaptation to evade or suppress immune responses, (iv) antimicrobial resistance, (v) evolution-proof medicine. For each topic there will be a short (~30 minutes) introductory lecture, before students independently research the primary literature and develop half a page of discussion points and questions, followed by interactive discussion in class.

A basic understanding of evolutionary biology, microbiology or parasitology will be advantageous but is not essential.

Immunology III

This course provides a detailed understanding of - development of T and B cells - the dynamics of a immune response during acute and chronic infection - mechanisms of immunopathology - modern vaccination strategies

Key experimental results will be shown to help understanding how immunological text book knowledge has evolved.

- the development, activation, and differentiation of different types of T cells and their effector mechanisms during immune responses, - Recognition of pathogenic microorganisms by the host cells and molecular events thereafter, - events and signals for maturation of naive B cells to antibody producing plasma cells and memory B cells. - Optimization of B cell responses by intelligent design of new vaccines

Students will read the primary literature on each topic, and in places we will use the following books:

- Schmid Hempel 2011 Evolutionary Parasitology
- Stearns & Medzhitov 2016 Evolutionary Medicine

Immunology: from Milestones to Current Topics

Milestones in Immunology: an old concepts and modern experiments

The course will cover six grand topics in immunology (B cells, innate immunity, antigen presentation, tumor immunity, thymus and T cells, cytotoxic T cells and NK cells) and for each grand topic four hours will be allocated. During the first double hour, historical milestone papers will be presented by the supervisor providing an overview on the development of the conceptual framework and critical technological advances. The students will also prepare themselves for this double lecture by reading the historical milestone papers and contributing to the discussion. In the following lecture up to four students will present each a recent high impact research paper which emerged from the landmark achievements of the previously discussed milestone concepts.

Milestones and current topics of innate immunity, antigen presentation, B cells, thymus and T cells, cytotoxic T cells and NK cells, and tumor immunology.

Original and review articles will be distributed by the lecturer.

Immunology: from Milestones to Current Topics

Milestones in Immunology: an old concepts and modern experiments

The course will cover six grand topics in immunology (B cells, innate immunity, antigen presentation, tumor immunity, thymus and T cells, cytotoxic T cells and NK cells) and for each grand topic four hours will be allocated. During the first double hour, historical milestone papers will be presented by the supervisor providing an overview on the development of the conceptual framework and critical technological advances. The students will also prepare themselves for this double lecture by reading the historical milestone papers and contributing to the discussion. In the following lecture up to four students will present each a recent high impact research paper which emerged from the landmark achievements of the previously discussed milestone concepts.

Milestones and current topics of innate immunity, antigen presentation, B cells, thymus and T cells, cytotoxic T cells and NK cells, and tumor immunology.

Original and review articles will be distributed by the lecturer.

Molecular Biology of Foodborne Pathogens

The course offers detailed information on selected foodborne pathogens and toxin producing organisms; the focus lies on relevant molecular biological aspects of pathogenicity and virulence, as well as on the emergence and survival of these organisms in foods.

Detailed and current status of research and insights into the molecular basis of foodborne diseases, with focus on interactions of the microorganism or the toxins they produce with the human system. Understanding the relationship between specific types of food and the associated pathogens and microbial risks. Another focus lies on the currently available methods and techniques useful for the various purposes, i.e., detection, differentiation (typing), and antimicrobial agents.

Evolutionary Medicine for Infectious Diseases

This course explores infectious disease from both the host and pathogen perspective. Through short lectures, reading and active discussion, students will identify areas where evolutionary thinking can improve our understanding of infectious diseases and, ultimately, our ability to treat them effectively.

We will cover several topics where evolutionary thinking is relevant to understanding or treating infectious diseases. This includes: (i) determinants of pathogen host range and virulence, (ii) dynamics of host-parasite coevolution, (iii) pathogen adaptation to evade or suppress immune responses, (iv) antimicrobial resistance, (v) evolution-proof medicine. For each topic there will be a short (~30 minutes) introductory lecture, before students independently research the primary literature and develop half a page of discussion points and questions, followed by interactive discussion in class.

A basic understanding of evolutionary biology, microbiology or parasitology will be advantageous but is not essential.

Immunology III

This course provides a detailed understanding of - development of T and B cells - the dynamics of a immune response during acute and chronic infection - mechanisms of immunopathology - modern vaccination strategies

Key experimental results will be shown to help understanding how immunological text book knowledge has evolved.

- the development, activation, and differentiation of different types of T cells and their effector mechanisms during immune responses, - Recognition of pathogenic microorganisms by the host cells and molecular events thereafter, - events and signals for maturation of naive B cells to antibody producing plasma cells and memory B cells. - Optimization of B cell responses by intelligent design of new vaccines

Students will read the primary literature on each topic, and in places we will use the following books:

- Schmid Hempel 2011 Evolutionary Parasitology
- Stearns & Medzhitov 2016 Evolutionary Medicine

Immunology: from Milestones to Current Topics

Milestones in Immunology: an old concepts and modern experiments

The course will cover six grand topics in immunology (B cells, innate immunity, antigen presentation, tumor immunity, thymus and T cells, cytotoxic T cells and NK cells) and for each grand topic four hours will be allocated. During the first double hour, historical milestone papers will be presented by the supervisor providing an overview on the development of the conceptual framework and critical technological advances. The students will also prepare themselves for this double lecture by reading the historical milestone papers and contributing to the discussion. In the following lecture up to four students will present each a recent high impact research paper which emerged from the landmark achievements of the previously discussed milestone concepts.

Milestones and current topics of innate immunity, antigen presentation, B cells, thymus and T cells, cytotoxic T cells and NK cells, and tumor immunology.

Original and review articles will be distributed by the lecturer.

Molecular Biology of Foodborne Pathogens

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Detailed and current status of research and insights into the molecular basis of foodborne diseases, with focus on interactions of the microorganism or the toxins they produce with the human system. Understanding the relationship between specific types of food and the associated pathogens and microbial risks. Another focus lies on the currently available methods and techniques useful for the various purposes, i.e., detection, differentiation (typing), and antimicrobial agents.
Molecular biology of infectious foodborne pathogens (Listeria, Vibrio, E. coli, Campylobacter, etc) and toxin-producing organisms (Bacillus, Clostridium, Staphylococcus). How and under which conditions will toxins and virulence factors be produced, and how do they work? How is the interaction between the human host and the microbial pathogen? What are the roles of food and the environment? What can be done to interfere with the potential risks? Which methods are best suited for what approach? Last, but not least, the role of bacteriophages in microbial pathogenicity will be highlighted, in addition to various applications of bacteriophage for both diagnostics and antimicrobial intervention.

**Lecture notes**
Electronic copies of the presentation slides (PDF) and additional material will be made available for download to registered students.

**Literature**
Recommended readings will be given in the first lecture

**Prerequisites / notice**
Lectures (2 hours) will be held as a single session of approximately 60+ minutes (10:15 until approx. 11:15 h), with no break!

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<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>701-1471-00L</td>
<td>Ecological Parasitology</td>
<td>W</td>
<td>3 credits</td>
<td>1V+1P</td>
<td>O. E. Seppälä, H. Hartikainen, J. Jokela</td>
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</tbody>
</table>

**Enrollment**
Number of participants limited to 20.

**Abstract**
Course focuses on the ecology and evolution of macroparasites and their hosts. Through lectures and practical work, students learn about diversity and natural history of parasites, adaptations of parasites, ecology of host-parasite interactions, applied parasitology, and human macroparasites in the modern world.

**Objective**
1. Identify common macroparasites in aquatic organisms.
2. Understand ecological and evolutionary processes in host-parasite interactions.
3. Conduct parasitological research.

**Content**
Lectures:
1. Diversity and natural history of parasites (i.e. systematic groups and life-cycles).
2. Adaptations of parasites (e.g. evolution of life-cycles, host manipulation).
3. Ecology of host-parasite interactions (e.g. parasite communities, effects of environmental changes).
4. Applied parasitology (e.g. aquaculture and fisheries).
5. Human macroparasites (schistosomiasis, malaria).

Practical exercises:
1. Examination of parasites in fish (identification of species and description of parasite communities).
2. Examination of parasites in molluscs (identification and examination of host exploitation strategies).
3. Examination of parasites in amphipods (identification and examination of effects on hosts).

**Nutrition and Health**

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<tr>
<th>Course Code</th>
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<th>Type</th>
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<th>Hours</th>
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<tbody>
<tr>
<td>752-2122-00L</td>
<td>Food and Consumer Behaviour</td>
<td>W</td>
<td>2 credits</td>
<td>2V</td>
<td>M. Siegrist, C. Hartmann</td>
</tr>
</tbody>
</table>

**Abstract**
This course focuses on food consumer behavior, consumer’s decision-making processes and consumer’s attitudes towards food products.

**Objective**
To understand the principles, roles and mechanisms of microorganisms with metabolic activities of high potential for application in traditional and functional foods utilization with high quality, safety and potential health benefits for consumers. This course will integrate basic knowledge in food microbiology, microbial physiology, biochemistry, and technology.

**Content**
This course will address selected and current topics on new applications of microorganisms with functional properties in food and functional food products and characterization of functionality and safety of food bacteria. Specialists from the Laboratory of Food Biotechnology, as well as invited speakers from the industry will contribute to the selected topics as follows:

- Probiotics and Prebiotics: Probiotics, functional foods and health, towards understanding molecular modes of probiotic action; Challenges for the production and addition of probiotics to foods; Prebiotics and other microbial substrates for gut functionality.
- Bioprotective Cultures and Antimicrobial Metabolites: Antifungal cultures and applications in foods; Antimicrobial peptide-producing cultures (bacteriocins) for enhancing food quality and safety; Development of new protective cultures, the long path from research to industry.
- Legal and Protection Issues Related Functional Foods
- Industrial Biotechnology of Flavor and Taste Development
- Safety of Food Starter Cultures and Prebiotics

Students will be required to complete a group project on food products and ingredients with of from functional bacteria. The project will involve information research and analysis followed by an oral presentation and short written report.

**Lecture notes**
Copy of the power point slides from lectures will be provided.

**Literature**
A list of references will be given at the beginning of the course for the different topics presented during this course.

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<tr>
<th>Course Code</th>
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<tbody>
<tr>
<td>752-6101-00L</td>
<td>Dietary Etiologies of Chronic Disease</td>
<td>W</td>
<td>3 credits</td>
<td>2V</td>
<td>M. B. Zimmermann</td>
</tr>
</tbody>
</table>

**Abstract**
To have the student gain understanding of the links between the diet and the etiology and progression of chronic diseases, including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

**Objective**
To examine and understand the protective effect of foods and food ingredients in the maintenance of health and the prevention of chronic disease, as well as the progression of complications of the chronic diseases.

**Content**
The course evaluates food and food ingredients in relation to primary and secondary prevention of chronic diseases including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

**Lecture notes**
There is no script. Powerpoint presentations will be made available on-line to students.
Nutrigenomics  

W  3 credits  2V  G. Vergères

Abstract

Nutrigenomics - toward personalized nutrition?

Breakthroughs in biology recently led nutrition scientists to apply modern tools (genomics, transcriptomics, proteomics, metabolomics, genetics, epigenetics) to the analysis of the interactions of food with humans. The lecture presents these tools and illustrates their application in selected topics relevant to human nutrition and food sciences.

Objective

- Overall understanding of the transdisciplinary research being conducted under the term nutrigenomics.
- Overall understating of the omics technologies used in nutrigenomics and their applications to human nutrition and food science.
- Ability to critically evaluate the potential and risks associated with the field of nutrigenomics

Content

- For the content of the script see section "Skript" below
- The lecture is completed by an optional project entitled 'Personalized Nutrition' in which the students have the opportunity to receive a personalized nutritional guidance that is based on their own genetic makeup. The scientific literature on which the genetic tests are based is presented by the students during the lecture.

Lecture notes

The script is composed of circa 450 slides (ca 18 slides/lecture) organized in 9 modules

- Module A  
  From biochemical nutrition research to nutrigenomics

- Module B  
  Nutritional genomics

- Module C  
  Nutrigenetics

- Module D  
  Nutri-epigenomics

- Module E  
  Transcriptomics in nutrition research

- Module F  
  Proteomics in nutrition research

- Module G  
  Metabolomics in nutrition research

- Module H  
  Nutritional systems biology

- Module I  
  Individualized nutrition - opportunities and challenges

Literature

To be provided by the individual lecturers, at their discretion.

Prerequisites / notice

No compulsory prerequisites, but prior completion of Human Nutrition I + II (Humanernährung I+II) is strongly advised.

Environment and Health

Number  Title  Type  ECTS  Hours  Lecturers

701-1341-00L  Water Resources and Drinking Water  W  3 credits  2G  S. Hug, M. Berg, F. Hammes, U. von Gunten

Abstract

The course covers qualitative (chemistry and microbiology) and quantitative aspects of drinking water from the resource to the tap. Natural processes, anthropogenic pollution, legislation of groundwater and surface water and of drinking water as well as water treatment will be discussed for industrialized and developing countries.

Objective

The goal of this lecture is to give an overview over the whole path of drinking water from the source to the tap and understand the involved physical, chemical and biological processes which determine the drinking water quality.

Content

The course covers qualitative (chemistry and microbiology) and quantitative aspects of drinking water from the resource to the tap. The various water resources, particularly groundwater and surface water, are discussed as part of the natural water cycle influenced by anthropogenic activities such as agriculture, industry, urban water systems. Furthermore legislation related to water resources and drinking water will be discussed. The lecture is focused on industrialized countries, but also addresses global water issues and problems in the developing world. Finally unit processes for drinking water treatment (filtration, adsorption, oxidation, disinfection etc.) will be presented and discussed.

Lecture notes

Handouts will be distributed

Term Paper and Seminar

Number  Title  Type  ECTS  Hours  Lecturers


Abstract

- Writing of a review paper of scientific quality on a topic in the domain of Human Health, Nutrition and Environment based on critical evaluation of scientific literature.
- Acquisition of knowledge in the field of the review paper
- Assessment of original literature as well as synthesis and analysis of the findings
- Practising of academic writing in English
- Giving an oral presentation with discussion on the topic of the review paper

Objective

Topics are offered in the domains of the major ‘Human Health, Nutrition and Environment’ covering ‘Public Health’, ‘Infectious Diseases’, ‘Nutrition and Health’ and ‘Environment and Health’.

Lecture notes

Guidelines will be handed out in the beginning.

Literature

Literature will be identified based on the topic chosen.
The goal of this course is to investigate, as a group, a particular set of carbon mitigation/sequestration options and to evaluate their potential, their cost, and their consequences. From the large number of carbon sequestration/mitigation options, a few options will be selected and then investigated in detail by the group. The results of this research will then be presented to the other students, the involved faculty, and discussed in detail by the whole class. Presentations from guest speakers from industry and the public sector, and final presentations by the students.

For group exercise and presentation reasons the number of participants is limited at 35 students. For exercises students build learning and presentational groups.

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### Literature

- **Longlist:** http://www.rechsteiner-basel.ch/uploads/media/edoc_literaturliste_1404.pdf
- **REN21 Renewables GLOBAL STATUS REPORT** https://www.ren21.net
- **Mit einer grünen Anlage schwarze Zahlen schreiben** http://www.rechsteiner-basel.ch/uploads/media/Mit_einer_gruenen_Anlage_schwarze_Zahlen_schreiben.pdf
- **IEA PVPS: TRENDS 2014 IN PHOTOVOLTAIC APPLICATIONS** http://www.iea-pvps.org/index.php?id=92&elId=dam_frontend_push&docId=2795
- **Windenergie-Report Deutschland** http://windmonitor.iwes.fraunhofer.de/windmonitor_de/5_Veroeffentlichungen/1_windenergiereport/
- **IEA PVPS: TRENDS 2014 IN PHOTOVOLTAIC APPLICATIONS** http://www.iea-pvps.org/index.php?id=92&elId=dam_frontend_push&docId=2795
- **Windenergie-Report Deutschland** http://windmonitor.iwes.fraunhofer.de/windmonitor_de/5_Veroeffentlichungen/1_windenergiereport/
- **RWE Power Monitoring** http://www.rechsteiner-basel.ch/index.php?id=27
- **PVPS.org** http://www.pvps.org/index.php?id=92&action=dam_frontend_push&docId=2795
- **UNEP:** Global Trends in Renewable Energy Investments http://fs-unep-centre.org
- **REN21 Renewables GLOBAL STATUS REPORT** http://www.rechsteiner-basel.ch/Lehrmittel.27.0.html

### Notice

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### Prerequisites

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### Literature

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- **Windenergie-Report Deutschland** http://windmonitor.iwes.fraunhofer.de/windmonitor_de/5_Veroeffentlichungen/1_windenergiereport/
- **RWE Power Monitoring** http://www.rechsteiner-basel.ch/index.php?id=27
- **PVPS.org** http://www.pvps.org/index.php?id=92&action=dam_frontend_push&docId=2795
- **UNEP:** Global Trends in Renewable Energy Investments http://fs-unep-centre.org
- **REN21 Renewables GLOBAL STATUS REPORT** http://www.rechsteiner-basel.ch/Lehrmittel.27.0.html

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### Notice

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### Prerequisites

- **For group exercise and presentation reasons the number of participants is limited at 35 students. For exercises students build learning and presentational groups.**
Content

1. Pan-European power market and trading
   1.1. Power trading
   1.2. Development of the European power markets
   1.3. Energy economics
   1.4. Spot and OTC trading
   1.5. European energy exchange EEX

2. Market model
   2.1. Market place and organisation
   2.2. Balance groups / balancing energy
   2.3. Ancillary services
   2.4. Market for ancillary services
   2.5. Cross-border trading
   2.6. Capacity auctions

3. Portfolio and Risk management
   3.1. Portfolio management 1 (introduction)
   3.2. Forward and futures contracts
   3.3. Risk management 1 (m2m, VaR, hpfc, volatility, cVaR)
   3.4. Risk management 2 (PaR)
   3.5. Contract valuation (HPFC)
   3.6. Portfolio management 2
   2.8. Risk Management 3 (enterprise wide)

4. Energy & Finance I
   4.1. Options 1 basics
   4.2. Options 2 hedging with options
   4.3. Introduction to derivatives (swaps, cap, floor, collar)
   4.4. Financial modelling of physical assets
   4.5. Trading and hydro power
   4.6. Incentive regulation

Lecture notes Handouts of the lecture

Prerequisites / notice 1 excursion per semester, 2 case studies, guest speakers for specific topics.
Course Moodle: https://moodle-app2.let.ethz.ch/course/view.php?id=2196

| 227-1631-00L | Energy System Analysis | W | 4 credits | 3G | G. Hug, S. Hellweg, F. Noembrini, A. Schlüter

Abstract
The course provides an introduction to the methods and tools for analysis of energy consumption, energy production and energy flows. Environmental aspects are included as well as economical considerations. Different sectors of the society are discussed, such as electric power, buildings, and transportation. Models for energy system analysis planning are introduced.

Objective
The purpose of the course is to give the participants an overview of the methods and tools used for energy systems analysis and how to use these in simple practical examples.

Content
The course gives an introduction to methods and tools for analysis of energy consumption, energy production and energy flows. Both larger systems, e.g. countries, and smaller systems, e.g. industries, homes, vehicles, are studied. The tools and methods are applied to various problems during the exercises. Different conventions of energy statistics used are introduced.

The course provides also an introduction to energy systems models for developing scenarios of future energy consumption and production. Bottom-up and Top-Down approaches are addressed and their features and applications discussed.

The course contains the following parts:
Part I: Energy flows and energy statistics
Part II: Environmental impacts
Part III: Electric power systems
Part IV: Energy in buildings
Part V: Energy in transportation
Part VI: Energy systems models

Lecture notes Handouts

Literature

| 529-0193-00L | Renewable Energy Technologies I | W | 4 credits | 3G | A. Wokaun, A. Steinfeld

Abstract
The lectures Renewable Energy Technologies I (529-0193-00L) and Renewable Energy Technologies II (529-0191-01L) can be taken independently from one another.

Scenarios for world energy demand and CO2 emissions, implications for climate. Methods for the assessment of energy chains. Potential and technology of renewable energies: Biomass (heat, electricity, biofuels), solar energy (low temp. heat, solar thermal and photovoltaic electricity, solar chemistry), Wind and ocean energy, heat pumps, geothermal energy, energy from waste. CO2 sequestration.

Objective
Scenarios for the development of world primary energy consumption are introduced. Students know the potential and limitations of renewable energies for reducing CO2 emissions, and their contribution towards a future sustainable energy system that respects climate protection goals.

Content

Lecture notes Lecture notes will be distributed electronically during the course.

Literature
Minor in Global Change and Sustainability

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>701-0015-00L</td>
<td>Seminar on Transdisciplinary Research for Sustainable Development</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>C. E. Pohl, M. Stauffacher</td>
</tr>
</tbody>
</table>

Abstract
The seminar is designed for students and researchers (MA, PhD, PostDoc) who use inter- and transdisciplinary elements in their projects. It addresses the challenges of this research: How to integrate disciplines? How (and in what role) to include societal actors? How to bring results to fruition? We discuss these questions based on case studies and theories and on the participant's projects.

Objective
The participants understand the specific challenges of inter- and transdisciplinary research in general and in the context of sustainable development in particular. They know methods and concepts to address these challenges and apply them to their research projects.

Content
The seminar covers the following topics:
1. Theories and concepts of inter- and transdisciplinary research
2. The specific challenges of inter- and transdisciplinary research
3. Involved stakeholders
4. Collaborating disciplines
5. Exploration of tools and methods
6. Analysing participants' projects to improve inter- and transdisciplinary elements

Literature
Handouts.

Prerequisites
The seminar is specifically suitable for PhD or PostDoc researchers. It is open to master students (minor "global change and sustainability") and further interested people, who preferably are preparing, or working on, a project/thesis.

Minor in Transdisciplinarity for Sustainable Development

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<tr>
<td>701-1551-00L</td>
<td>Sustainability Assessment</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>P. Krüttli, C. E. Pohl</td>
</tr>
</tbody>
</table>

Abstract
The course deals with the concepts and methodologies for the analysis and assessment of sustainable development. A special focus is given to the social dimension and to social justice as a guiding principle of sustainability as well as to trade-offs between the three dimensions of sustainability.

Objective
At the end of the course students should
Know:
- core concepts of sustainable development, and;
- the concept of social justice - normatively and empirically - as a core element of social sustainability;
- important empirical methods for the analysis and assessment of local / regional sustainability issues.

Understand and reflect on:
- the challenges of trade-offs between the different goals of sustainable development;
- and the respective impacts on individual and societal decision-making.

Content
The course is structured as follows:
- Overview of rationale, objectives, concepts and origins of sustainable development;
- Importance and application of sustainability in science, politics, society, and economy;
- Sustainable (local / regional) development in different national / international contexts;
- Analysis and evaluation methods of sustainable development with a focus on social justice;
- Trade-offs in selected examples.

Lecture notes
Handouts.

Literature
Selected scientific articles & book chapters

851-0594-00L | International Environmental Politics | W    | 3    | 2V    | T. Bernauer

Abstract
This course focuses on the conditions under which cooperation in international environmental politics emerges and the conditions under which such cooperation and the respective public policies are effective and/or efficient.

Objective
The objectives of this course are to (1) gain an overview of relevant questions in the area of international environmental politics from a social sciences viewpoint; (2) learn how to identify interesting/innovative questions concerning this policy area and how to answer them in a methodologically sophisticated way; (3) gain an overview of important global and regional environmental problems.

Content
This course deals with how and why international cooperation in environmental politics emerges, and under what circumstances such cooperation is effective and efficient. Based on theories of international political economy and theories of government regulation various examples of international environmental politics are discussed: the management of international water resources, the problem of unsafe nuclear power plants in eastern Europe, political responses to global warming, the protection of the stratospheric ozone layer, the reduction of long-range transboundary air pollution in Europe, the prevention of pollution of the oceans, etc.

The course is open to all ETH students. Participation does not require previous coursework in the social sciences.

After passing an end-of-semester test (requirement: grade 4.0 or higher) students will receive 3 ECTS credit points. The workload is around 90 hours (meetings, readings, assignments, preparation of test).

Visiting students (e.g., from the University of Zurich) are subject to the same conditions. Registration of visiting students in the web-based system of ETH is compulsory.

Lecture notes
Assigned reading materials and slides will be available at http://www.ib.ethz.ch/teaching.html (select link 'Registered students, please click here for course materials' at top of that page). Log in with your nethz name and password. Questions concerning access to course materials can be addressed to Mike Hudecheck (Mike.Hudecheck@student.ethz.ch). All assigned papers must be read ahead of the respective meeting. Following the course on the basis of on-line slides and papers alone is not sufficient. Physical presence in the classroom is essential. Many books and journals covering international environmental policy issues can be found at the D-GEES library at the IFW building, Haldeneggsteig 4, B-floor, or in the library of D-USYS.

Literature
Assigned reading materials and slides will be available at http://www.ib.ethz.ch/teaching.html (select link 'Registered students, please click here for course materials' at top of that page). Log in with your nethz name and password. Questions concerning access to course materials can be addressed to Mike Hudecheck (Mike.Hudecheck@student.ethz.ch).

Prerequisites
None
The course deals with transdisciplinary (td) methods, concepts and their applications in the context of case studies and other problem oriented research projects. Td methods are used in research at the science-society interface and when collaborating across scientific disciplines.

Students learn to apply methods within a functional framework. The format of the course is seminar-like, interactive.

At the end of the course students should:

Know:
- Function, purpose and algorithm of a selected number of transdisciplinary methods

Understand:
- Functional application in case studies and other problem oriented projects

Be able to reflect on:
- Potential, limits, and necessity of transdisciplinary methods

Be prepared for:
- Transdisciplinary Case Study 2017

The course is seminar-like, interactive.

The lecture is structured as follows:

- Overview of concepts and methods of inter-/transdisciplinary integration of knowledge, values and interests (approx. 20%)
- Analysis of a selected number of transdisciplinary methods focusing problem framing, problem analysis, and impact (approx. 50%)
- Practical application of the methods in a broader project setting (approx. 30%)

Handouts are provided by the lecturers

Selected scientific articles and book-chapters

This course is recommended and helpful for students participating in the Transdisciplinary Case Study 2017.

The course deals with the concepts and methodologies for the analysis and assessment of sustainable development. A special focus is given to the social dimension and to social justice as a guiding principle of sustainability as well as to trade-offs between the three dimensions of sustainability.

The course is seminar-like, interactive.

At the end of the course students should:

Know:
- core concepts of sustainable development, and;
- the concept of social justice - normatively and empirically - as a core element of social sustainability;
- important empirical methods for the analysis and assessment of local / regional sustainability issues.

Understand and reflect on:
- the challenges of trade-offs between the different goals of sustainable development;
- and the respective impacts on individual and societal decision-making.

The course is structured as follows:

- Overview of concepts and methods of inter-/transdisciplinary integration of knowledge, values and interests (approx. 20%)
- Analysis of a selected number of transdisciplinary methods focusing problem framing, problem analysis, and impact (approx. 50%)
- Practical application of the methods in a broader project setting (approx. 30%)

Handouts.

Selected scientific articles & book chapters

This course is recommended and helpful for students participating in the Transdisciplinary Case Study 2017.

An Introduction to Sustainable Development in the Built Environment

This year the UN Conference in Paris will shape future world objectives to tackle climate change.

This course provides an introduction to the notion of sustainable development when applied to our built environment

At the end of the semester, the students have an understanding of the term of sustainable development, its history, the current political and scientific discourses and its relevance for our built environment.

In order to address current challenges of climate change mitigation and resource depletion, students will learn a holistic approach of sustainable development. Ecological, economical and social constraints will be presented and students will learn about methods for argumentation and tools for assessment (i.e. life cycle assessment).

For this purpose an overview of sustainable development is presented with an introduction to the history of sustainability and its today definition as well as the role of cities, urbanisation and material resources (i.e. energy, construction material) in social economic and environmetal aspects.

The course aims to promote an integral view and understanding of sustainability and describing different spheres (social/cultural, ecological, economical, and institutional) that influence our built environment.

Students will acquire critical knowledge and understand the role of involved stakeholders, their motivations and constraints, learn how to evaluate challenges, identify deficits and define strategies to promote a more sustainable construction.

After the course students should be able to define the relevance of specific local, regional or territorial aspects to achieve coherent and applicable solutions toward sustainable development.

The course offers an environmental, socio-economic and socio-technical perspective focussing on buildings, cities and their transition to resilience with sustainable development. Students will learn on theory and application of current scientific pathways towards sustainable development.
The following topics give an overview of the themes that are to be worked on during the lecture.

- Overview on the history and emergence of sustainable development
- Overview on the current understanding and definition of sustainable development
- Case Study 1: Sustainable construction, the role of construction industry (national/international)
- Case Study 2: Cities, forms of settlements
- Case Study 3: Material resources, scenarios, energy, construction materials, urban metabolism
- Case Study 4: Buildings, heating/cooling, consumers, prosumers and other stakeholder, cooperations
- Method 1: Life cycle assessment (planning, construction, operation/use, deconstruction)
- Method 2: Economics for sustainable construction
- Method 3: Construction, flexibility, modularity
- Method 4: Transition to sustainable development
- Method 5: Climate Change mitigation and adaptation in cities
- Method 6: Synthesis 2: Transition to sustainable development

Lecture notes
The study materials for each lecture are made available on the lecture homepage.

Literature
A list of the basic literature will be offered on a specific online platform, that could be used by all students attending the lectures.

102-0317-00L Advanced Environmental Assessments

<table>
<thead>
<tr>
<th>Number</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>529-0041-00L</td>
<td>W</td>
<td>6</td>
<td>3G</td>
<td>R. Zenobi, B. Hattendorf, P. Martinez-Lozano Sinues</td>
</tr>
</tbody>
</table>

Abstract
Modern mass spectrometry, hyphenational methods, speciation, methods of surface analysis, chemometrics.
Biogeochemistry of Trace Elements

Carbon Mitigation

Future climate change can only be kept within reasonable bounds when CO₂ emissions are drastically reduced. In this course, we will discuss problem-oriented development of analytical strategies and solutions.

Isotopic and Organic Tracers in Biogeochemistry

The course aims at understanding the fractionation of stable isotopes in biogeochemical processes. Students learn to know the origin and decay modes of relevant radionuclides. They discover the spectrum of possible geochronological tracers and biomarkers, their potential and limitations and get familiar with important applications.

The goal of this course is to investigate, as a group, a particular set of carbon mitigation/sequestration options and to evaluate their effectiveness. Isotopic and Organic Tracers in Biogeochemistry

Exercises are an integral part of the lecture. 

Lecturers: 
S. Hug, M. Berg, F. Hammes, M. Etique, L. Winkel

Future climate change can only be kept within reasonable bounds when CO₂ emissions are drastically reduced. In this course, we will discuss problem-oriented development of analytical strategies and solutions.

No final exam. Pass/No-Pass is assigned based on the quality of the presentation and ensuing discussion.

Prerequisites:
529-0051-00 "Analytische Chemie I (3. Semester)"
529-0058-00 "Analytische Chemie II (4. Semester)"
(or equivalent)

529-0043-00L Analytical Strategy

W 7 credits 3G R. Zenobi, M. Badertscher, P. S. Dittrich, D. Günther

Prerequisites:
Copies of problem sets and solutions will be distributed for charge.

Problem-oriented development of analytical strategies and solutions.

Principles of sampling. Design and application of microanalytical systems. 

Lecture notes
Copies of problem sets and solutions will be distributed free of charge.

Minor in Biogeochemistry

Number Title Type ECTS Hours Lecturers

701-1313-00L Isotopic and Organic Tracers in Biogeochemistry W 3 credits 2G R. Kipfer, S. Ladd

Abstract
The course introduces the scientific concepts and typical applications of tracers in biogeochemistry. The course covers stable and radioactive isotopes, geochemical tracers and biomarkers and their application in biogeochemical processes as well as regional and global cycles. The course provides essential theoretical background for the lab course "Isotopic and Organic Tracers Laboratory".

Objective
The course aims at understanding the fractionation of stable isotopes in biogeochemical processes. Students learn to know the origin and decay modes of relevant radionuclides. They discover the spectrum of possible geochronological tracers and biomarkers, their potential and limitations and get familiar with important applications

Content
Geogenic and cosmogenic radionuclides (sources, decay chains); stable isotopes in biogeochemistry (natural abundance, fractionation); geochemical tracers for processes such as erosion, productivity, redox fronts; biomarkers for specific microbial processes.

Lecture notes
Handouts will be provided for every chapter

Literature
A list of relevant books and papers will be provided

701-1315-00L Biogeochemistry of Trace Elements

W 3 credits 2G A. Voegelin, M. Etique, L. Winkel

Abstract
The course addresses the biogeochemical classification and behavior of trace elements, including key processes driving the cycling of important trace elements in aquatic and terrestrial environments and the coupling of abiotic and biotic transformation processes of trace elements. Examples of the role of trace elements in natural or engineered systems will be presented and discussed in the course.

Objective
The students are familiar with the chemical characteristics, the environmental behavior and fate, and the biogeochemical reactivity of different groups of trace elements. They are able to apply their knowledge on the interaction of trace elements with geosphere components and on abiotic and biotic transformation processes of trace elements to discuss and evaluate the behavior and impact of trace elements in aquatic and terrestrial systems.

Content
(i) Definition, importance and biogeochemical classification of trace elements. (ii) Key biogeochemical processes controlling the cycling of different trace elements (base metals, redox-sensitive and chalcophile elements, volatile trace elements) in natural and engineered environments. (iii) Abiotic and biotic processes that determine the environmental fate and impact of selected trace elements.

Lecture notes
Selected handouts (lecture notes, literature, exercises) will be distributed during the course.

Prerequisites:
Students should have a basic knowledge of biogeochemical processes (BSc course on Biogeochemical processes in aquatic systems or equivalent)

701-1341-00L Water Resources and Drinking Water


Abstract
The course covers qualitative (chemistry and microbiology) and quantitative aspects of drinking water from the resource to the tap. Natural processes, anthropogenic pollution, legislation of groundwater and surface water and of drinking water as well as water treatment will be discussed for industrialized and developing countries.

Objective
The goal of this lecture is to give an overview over the whole path of drinking water from the source to the tap and understand the involved physical, chemical and biological processes which determine the drinking water quality.

Content
The course covers qualitative (chemistry and microbiology) and quantitative aspects of drinking water from the resource to the tap. The various water resources, particularly groundwater and surface water, are discussed as part of the natural water cycle influenced by anthropogenic activities such as agriculture, industry, urban water systems. Furthermore legislation related to water resources and drinking water will be discussed. The lecture is focused on industrialized countries, but also addresses global water issues and problems in the developing world. Finally unit processes for drinking water treatment (filtration, adsorption, oxidation, disinfection etc.) will be presented and discussed.

Lecture notes
Handouts will be distributed

Literature
Will be mentioned in handouts

701-1346-00L Carbon Mitigation

W 3 credits 2G N. Gruber

Abstract
Future climate change can only be kept within reasonable bounds when CO₂ emissions are drastically reduced. In this course, we will discuss a portfolio of options involving the alteration of natural carbon sinks and carbon sequestration. The course includes introductory lectures, presentations from guest speakers from industry and the public sector, and final presentations by the students.

Objective
The goal of this course is to investigate, as a group, a particular set of carbon mitigation/sequestration options and to evaluate their potential, their cost, and their consequences.

Content
From the large number of carbon sequestration/mitigation options, a few options will be selected and then investigated in detail by the students. The results of this research will then be presented to the other students, the involved faculty, and discussed in detail by the whole group.

Lecture notes
None

Literature
Will be identified based on the chosen topic.

Prerequisites:
Exam: No final exam. Pass/No-Pass is assigned based on the quality of the presentation and ensuing discussion.
102-0337-00L Landfilling, Contaminated Sites and Radioactive Waste Repositories  W  3 credits  2G  W. Hummel, L. M. Plötze

Abstract
Practices of landfilling and remediation of contaminated sites and disposal of radioactive waste are based on the same concepts that aim to protect the environment. The assessment of contaminants may then lead into the environment as a function of time and how to reduce the rate of their release is key to the design of chemical, technical and geological barriers.

Objective
Upon successful completion of this course students are able to:
- assess the risk posed to the environment of landfills, contaminated sites and radioactive waste repositories in terms of fate and transport of contaminants
- describe technologies available to minimize environmental contamination
- describe the principles in handling of contaminated sites and to propose hand and evaluate suitable remediation techniques
- explain the concepts that underlie radioactive waste disposal practices

Content
This lecture course comprises of lectures with exercises and guided case studies.
- A short overview of the principles of environmental protection in waste management and how this is applied in legislation.
- A overview of the chemistry underlying the release and transport of contaminants from the landfilled/contaminated material/radioactive waste repository focusing on processes that control redox state and pH buffer capacity; mobility of heavy metals and organic compounds
- Technical barrier design and function. Clay as a barrier.
- Contaminated site remediation: Site evaluation, remediation technologies
- Concepts and safety in radioactive waste management
- Role of the geological and engineered barriers and radionuclide transport in geological media.

Lecture notes
Short script plus copies of overheads

Literature
Literature will be made available.

Prerequisites / notice
This is an interdisciplinary course aimed at environmental scientists and environmental engineers.

Minor in Physical Glaciology

Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
101-0289-00L | Applied Glaciology | W | 3 credits | 2G | M. Funk, A. Bauder, D. Farinotti

Abstract
We will explain the fundamentals of physics of glaciers which are necessary for treating applied problems. We will go into climate-glacier interactions, flow of glaciers, lake ice and hydrology of glaciers.

Objective
To understand the fundamental physical processes in glaciology.
To learn some basic numerical techniques for glacier flow.
To identify glaciological hazards and to learn some assessment and mitigation possibilities.

Content
Basics in physical glaciology
Dynamics of glaciers: deformation of glacier ice, role of water in glacier motion, reaction of glaciers to climate changes, glacier calving, surges
Ice falls, ice avalanches
Glacier floods
Lake ice and bearing capacity

Lecture notes
Handouts are available

Literature
Relevante Literatur wird während der Vorlesung angegeben.

Prerequisites / notice
Für aktuelle Fallbeispiele werden risikobasierte Massnahmen bei glaziologischen Naturgefahren diskutiert.

Voraussetzungen: Es werden Grundkenntnisse in Mechanik und Physik vorausgesetzt.

651-1581-00L Seminar in Glaciology  W  3 credits  2S  A. Bauder

Abstract
Studium aktueller und klassischer Arbeiten der glaziologischen Forschung

Objective
Vertiefte Kenntnisse in ausgewählten Bereichen der glaziologischen Forschung erarbeiten. Kennenlernen von Formen der wissenschaftlicher Präsentation und Verbessem der eigenen Fähigkeit in der Diskussion von wissenschaftlichen Themen

Content
Studium aktueller und klassischer Arbeiten der glaziologischen Forschung

Lecture notes
benötigte Unterlagen werden im Verlaufe der Veranstaltung abgegeben


Abstract
Understanding glaciers and ice sheets with simple physical concepts. Topics include the reaction of glaciers to the climate, ice rheology, temperature in glaciers and ice sheets, glacier hydrology, glacier seismology, basal motion and calving glaciers. A special focus is the current development of Greenland and Antarctica.

Objective
After the course the students are able understand and interpret measurements of ice flow, subglacial water pressure and ice temperature. They will have an understanding of glaciology-related physical concepts sufficient to understand most of the contemporary literature on the topic. The students will be well equipped to work on glacier-related problems by numerical modeling, remote sensing, and field work.

Content
The dynamics of glaciers and polar ice sheets is the key requisite to understand their history and their future evolution. We will take a closer look at ice deformation, basal motion, heat flow and glacier hydraulics. The specific dynamics of tide water and calving glaciers is investigated, as is the reaction of glaciers to changes in mass balance (and therefore climate).

Lecture notes
http://people.ee.ethz.ch/~luethim/teaching.html

Literature
A list of relevant literature is available on the class web site.

Prerequisites / notice
Good high school mathematics and physics knowledge required.

651-4077-00L Quantification and Modeling of the Cryosphere: Dynamic Processes (University of Zurich)  W  3 credits  1V  University lecturers

Abstract
Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

Objective
Overview of the most important earth surface processes and landforms in cold regions (regions with glaciers and intense frost) with emphasis on high-mountain aspects. Discussion of present research challenges.

Content
Knowledge of the most prominent climate-related geomorphological processes and phenomena in high-mountain regions, understanding of primary research challenges.

Lecture notes
Erosion and sedimentation by glaciers as a function of topography, englacial temperature, sediment balance, sliding and melt water runoff. Processes and landforms in regions of seasonal and perennial frost (frost weathering, rock falls, debris cones/talus, solifluction, permafrost creep/rock glaciers, debris flows).

Glacial and periglacial geomorphodynamics in high-mountain regions. Ca. 100 pages.
Minor in Catchment Management and Natural Hazards

Additionally, the module GEC231 Physiurgische Geographie III für die Erdwissenschaften can be taken at the UZH for this Minor.

No enrolment to this course at ETH Zurich. Book the module directly at UZH.

Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

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<tr>
<td>701-0565-00L</td>
<td>Fundamentals of Natural Hazards Management</td>
<td>W</td>
<td>3</td>
<td>3G</td>
<td>H. R. Heinimann, B. Krummenacher, S. Löw</td>
</tr>
<tr>
<td>102-0293-00L</td>
<td>Hydrology</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>P. Burlando</td>
</tr>
</tbody>
</table>

### Number 701-0565-00L Fundamentals of Natural Hazards Management

**Abstract**
Risks to life and human assets result when settlement areas and infrastructure overlap regions where natural hazard processes occur. This course utilizes case studies to teach how a future natural hazards-specialist should analyze, assess and manage risks.

**Objective**
- Explain the principles of risk-governance.
- Apply principles to determine acceptable risks to human life and assets in order to identify locations which should receive added protection.
- Explain causes for conflicts between risk perception and risk analysis.
- Risk management - What steps should be taken to manage risks?
- Explain how various hazard mitigation approaches reduce risk.
- Describe hazard scenarios as a base for adequate dimensioning of control measures.
- Identify the best alternative from a set of thinkable measures based on an evaluation scheme.
- Identify the main features of engineering hydrology. Apply methods to estimate hydrological variables for dimensioning hydraulic structures.

**Content**
- Exposition- und Folgenanalyse
- Gefahrenbeurteilung
- Systemabgrenzung

**Number 102-0293-00L Hydrology**

**Abstract**
The course introduces the students to engineering hydrology. It covers first physical hydrology, that is the description and the measurement of hydrological processes (precipitation, interception, evapotranspiration, runoff, erosion, snow), and it introduces then the basic mathematical models of the single processes and of the rainfall-runoff transformation, thereby including flood analysis.

**Objective**
- Explain the principles of risk-governance.
- Apply principles to determine acceptable risks to human life and assets in order to identify locations which should receive added protection.
- Explain causes for conflicts between risk perception and risk analysis.
- Risk management - What steps should be taken to manage risks?
- Explain how various hazard mitigation approaches reduce risk.
- Describe hazard scenarios as a base for adequate dimensioning of control measures.
- Identify the best alternative from a set of thinkable measures based on an evaluation scheme.

**Content**
- Einführung ins Vorgehenskonzept (1W)
- Risikobewertung (2W)
- Risikomanagement (2W + Exkursion)
- Abschlussbesprechung (1W)

**Literature**
I. Burgert
ECTS
H. R. Heinimann
I. Burgert
Systems Engineering Lab, O. F. Kläusler

[1] Methodische Grundlagen
In an introduction to wood anatomy, the general structural features of softwoods and hardwoods will be explained and factors of diversity

Fundamentals of Wood Elaboration and
2G

Rock, soil and rock mass: scale effects and fundamental geotechnical properties. Soil mechanical properties and their determination. Rock

Type
Introduction to Engineering Geology

2G

2P

Introduction to Engineering Geology

Written course documentation available under "Kursunterlagen".

The lecture Wood structure and function conveys basic knowledge on the microstructure of softwoods and hardwoods as well as general

Learning target is a fundamental understanding of the dominating wood machining processes, which are applied to fabricate common wood

processes for the fabrication of a vast variety of wood products.

Thus, Students having already assigned to 701-1801-00L are not allowed to assign to 701-0637-10L. Remark: Replaces 701-1801-00L

would be given by wood identification exercises for softwood species. Further the students will gain insight into the relationships between tree

growth and wood properties with a specific focus on the wood function in the living tree.

Thus, Students having already assigned to 701-0637-20L are not allowed to assign to 101-0637-20L. Remark: Replaces 701-1803-00. Thus, students having already assigned to 701-1803-00 are not allowed to assign to 101-0637-20L.

Abstract
The lecture Wood structure and function conveys basic knowledge on the microstructure of softwoods and hardwoods as well as general

Objective
Learning target is a basic understanding of the anatomy of wood and the related impact of endogenous and exogenous factors. The

Content
1.01-0637-10L Structures of Wood and Function
Number of participants limited to 15.

Remark: Replaces 701-1801-00L

Thus, Students having already assigned to 701-1801-00 are not allowed to assign to 101-0637-10.

Abstract
The lecture Wood structure and function conveys basic knowledge on the microstructure of softwoods and hardwoods as well as general

Objective
Learning target is a basic understanding of the anatomy of wood and the related impact of endogenous and exogenous factors. The

Content
In an introduction to wood anatomy, the general structural features of softwoods and hardwoods will be explained and factors of diversity

and variability will be discussed. A specific focus is laid on common central European tree species with relevance in the wood sector, which

will be in the focus of the lecture. Topics covered are mechanical stability and water transport, branches, reaction wood formation (compression wood, tension wood), spiral growth, growth stresses as well as adaptive growth of trees.

Remark: Replaces 701-1803-00. Thus, students having already assigned to 701-1803-00 are not allowed to assign to 101-0637-20L.

Abstract
The lecture Wood processing conveys knowledge on technological properties of wood and wood-based materials as well as on industrial

processes for the fabrication of a vast variety of wood products.

Objective
Learning target is a fundamental understanding of the dominating wood machining processes, which are applied to fabricate common wood

products. Students will be introduced to the economic relevance of the renewable resource wood and are trained in its technological

properties. The students will learn to identify the relationships between wood species and their properties as well as the suitable wood

machining processes to fabricate targeted wood products.


H. R. Heinimann

Number / notice
Vorbereitende zu Hydrologie I sind die Vorlesungen in Statistik. Der Inhalt, der um ein Teil der Übungen zu behandeln und um ein Teil der

Vorlesungen zu verstehen notwendig ist, kann zusammengefasst werden, wie hintereinander es beschrieben wird:

Elementare Datenverarbeitung: Hydrologische Messungen und Daten, Datenreduzierung (grafische Darstellungen und numerische

Kenngrössen).

Frequenzanalyse: Hydrologische Daten als Zufallsvariablen, Wiederkehrperiode, Frequenzfaktor, Wahrscheinlichkeitspapier, Anpassen

von Wahrscheinlichkeitsverteilungen, parametrische und nicht-parametrische Tests, Parametrierschätzung.

651-3525-00L Introduction to Engineering Geology

Number
701-1805-00L Systems Engineering Lab

ECTS
3 credits
3G
S. Löw

Type
W

W

3 credits

2P

H. R. Heinimann

Lecturers
I. Burgert, E. R. Zürcher

I. Burgert, O. F. Kläusler

Autumn Semester 2016

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Data: 06.03.2019 12:57
The general introduction shows the economic relevance of the resource wood in a global, European and Swiss context and reflects aspects of sustainability in wood production and certification. In terms of bulk wood products a specific focus is laid on sawn timber production and drying processes. With regard to wood veneer production, steaming, veneer cutting and assembly to veneer lumber products are presented. Further the common technologies for the production of particle boards and fibre boards as well as paper will be discussed. In the following, the topics are related to wood gluing and wood protection as well as potentials and limitations in the application of wood and wood-based products. At the end of the lecture an excursion to a Swiss wood manufacturer is planned, in order to facilitate practical experience.

### Production Management

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>363-0445-00L</td>
<td>Production and Operations Management</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>T. Netland, P. Schönsleben</td>
</tr>
</tbody>
</table>

**Abstract**

This core course on Production and Operations Management provides the students' insights into the basic theories, principles, concepts, and techniques used to design, analyze, and improve the operational capabilities of an organization.

**Objective**

- Students learn why and how operations can be a competitive weapon; how to design, plan, control, and manage production and service processes; how to improve efficiency and effectiveness in operations; how to take advantage of new technological advancements; and how environmental and social concerns affect decisions in global production networks.

**Content**

The course covers the most fundamental strategic and tactical concepts in production and operations management. The lectures cover: Introduction to POM; Operations Strategy: Capacity management; Production planning and control; Production philosophies; Lean management; Performance measurement; Problem solving; Service operations; New technologies in POM; Servitization; Global production; and Triple-bottom line.

**Literature**


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### Environmental Management

<table>
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<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
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<tbody>
<tr>
<td>102-0317-00L</td>
<td>Advanced Environmental Assessments</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>S. Helweg, R. Frischknecht</td>
</tr>
</tbody>
</table>

**Abstract**

This course deepens students' knowledge of the environmental assessment methodologies and their various applications.

**Objective**

- Ability to judge the scientific quality and reliability of environmental assessment studies, the appropriateness of inventory data and modelling, and the adequacy of life cycle impact assessment models and factors
- Knowledge about the current state of the scientific discussion and new research developments
- Ability to properly plan, conduct and interpret environmental assessment studies
- Knowledge of how to use LCA as a decision support tool for companies, public authorities, and consumers
- Inventory developments, transparency, data quality, data completeness, and data exchange formats
- Allocation (multioptput processes and recycling)
- Hybrid LCA methods.
- Consequential and marginal analysis
- Recent development in impact assessment
- Spatial differentiation in Life Cycle Assessment
- Workplace and indoor exposure in Risk and Life Cycle Assessment
- Uncertainty analysis
- Subjectivity in environmental assessments
- Multicriteria analysis
- Case Studies

**Literature**

- No script. Lecture slides and literature will be made available at the lecture homepage.
- Literature will be made available at the lecture homepage.

**Prerequisites / notice**

Basic knowledge of environmental assessment tools is a prerequisite for this class. Students that have not done classwork in this topic before are required to read an appropriate textbook before or at the beginning of this course (e.g. Jolliet, O et al. 2016: Environmental Life Cycle Assessment, CRC Press, Boca Raton - London - New York. ISBN 978-1-4398-8766-0 (Chapters 2-5.2)).

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### Minor in Soil-Plant Relations and Land Use

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Data: 06.03.2019 12:57

Autumn Semester 2016

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Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
701-1681-00L | Element Balancing and Soil Functions in Managed Ecosystems | W | 3 credits | 2G | A. Keller

Abstract
Applying element balances of agricultural soils and the assessment of soil functions for real applications in computer exercises to design preventive strategies against soil pollution and to support sustainable management of regional agroecosystems also in the context of spatial planning procedures.

Objective
The students learn to critically assess changes in land use management on element cycles in agro-ecosystems and to assess soil services (soil functions). You design solutions for chemical problems in soil protection at the regional scale and learn to assess soil functions using different methods.

Content
The students apply a regional balance model for Swiss regions in computer exercises and assess major soil functions of agricultural soils. You assess the sustainability of current land use and analyse management options improving nutrient and metal cycling in agro-ecosystems. The students will have the opportunity to calculate specific scenarios regarding land use management and environmental changes. Special focus will be paid on the soil services such as regulation-, production function and soil as habitat, and the assessment of these functions based on soil mapping data.

Lecture notes
Literature
Documents will be distributed during the lecture Literature will be provided.

Prerequisites / notice
The course consists of lectures and computer exercises. The course takes place every 2 weeks à 4 hours. recommended prerequisites for attending this course:
- Bodenschutz und Landnutzung
- Biochemistry of Trace Elements
- Angewandte Bodenökologie

751-3405-00L | Radio-Isotopes in Plant Nutrition | W | 3 credits | 2G | E. Frossard

Abstract
The course will present the principles underlying the use of radioisotopes in soil/plant systems. It will present how the introduction of an isotope into a system can be done to get some information on the structure of the system. Case studies will be presented to determine element availability. Finally, published studies from other groups will be analyzed and presented by the students.

Objective
At the end of the course the students are familiar with the principles on which radioisotope works are based and they have learned from case studies how radioisotopes can be used to obtain meaningful data. They are aware of the advantages of using radioisotopes in element cycling studies, but also of the risks and open questions related to isotopic work.

Content
Radio-isotopes are extensively used at the soil/plant or ecosystem level to quantify the fluxes of elements (phosphorus (P), heavy metals, radionuclides) within a given system and to assess the importance of processes controlling these fluxes (e.g. exchange reactions between the soil solution and the soil solid phase, element turnover through the microbial biomass, organic matter mineralization etc.). The course will first present the principles, the basic assumptions and the theoretical framework that underlay the work with radioisotopes. It will present how the introduction of an isotope into a system can be done so as to get information on the structure of the system (e.g. number and size of compartments). Secondly, case studies on isotopic dilution and tracer work will be presented for instance on the isotopic exchange kinetics method to determine nutrients or pollutants availability. These case studies will be adapted to the ongoing research of the group of plant nutrition and will thus give an insight into our current research. In addition, published studies will be analyzed and presented by the students. Finally, the advantages and disadvantages of work with radioisotopes will be analyzed and discussed critically.

Lecture notes
Literature
Documents will be distributed during the lecture Will be given during the lecture

Prerequisites / notice
The lecture will take place at the ETH experimental station in Eschikon Lindau. See the location of the station at: http://www.pe.ipw.agr.ethz.ch/about/reach

751-5101-00L | Biogeochemistry and Sustainable Management | W | 2 credits | 2G | N. Buchmann, L. Höltnerg

Abstract
This course focuses on the interactions between ecology, biogeochemistry and management of agro- and forest ecosystems, thus, coupled human-environmental systems. Students learn how human impacts on ecosystems via management or global change are mainly driven by effects on biogeochemical cycles and thus ecosystem functioning, but also about feedback mechanisms of terrestrial ecosystems.

Objective
Students will know and understand the complex and interacting processes of ecology, biogeochemistry and management of agro- and forest ecosystems. Students can analyze and evaluate the various impacts of different management practices under different environmental conditions, search literature, write and evaluate scientific reports, and be able to coordinate and work successfully in small (interdisciplinary) teams.

Content
Agroecosystems and forest ecosystems play a major role in all landscapes, either for production purposes, ecological areas or for recreation. The human impact of any management on the environment is mainly driven by effects on biogeochemical cycles. Effects of global change impacts will also act via biogeochemistry at the soil-biosphere-atmosphere-interface. Thus, ecosystem functioning, i.e., the interactions between ecology, biogeochemistry and management of terrestrial systems, is the science topic for this course.

Students will gain profound knowledge about nutrient cycles and population dynamics in managed and unmanaged grassland, cropland and forest ecosystems in the field and in the lab. Responses of agro- and forest ecosystems to the environment, e.g., climate, anthropogenic deposition, major disturbances, soil nutrients or competition of plants (including invasives) and microorganisms, but also feedback mechanisms of ecosystems on (micro)climate, soils or vegetation patterns will be studied. Different management practices will be investigated and assessed in terms of production and quality of yield (ecosystem goods and services), but also in regard to environmental regulations (including subsidies) and their effect on the environment, e.g., greenhouse gas budgets. Thus, students will learn about the complex interactions of a coupled human-environmental system.

Lecture notes
Literature
Handouts will be available on the webpage of the course. Will be discussed in class.

Prerequisites / notice
Prerequisites: Attendance of introductory courses in plant ecophysiology, ecology, and grassland or forest sciences. Course will be taught in English.

751-5123-00L | Rhizosphere Ecology | W | 4 credits | 4G | H. A. Gamper, T. I. McLaren

Abstract
This course is about the physical, chemical, and biological processes in the rhizosphere and their effect on plant growth. Effects of fertilisers, companion plants, and microbial symbionts, and other microbes on nutrient cycling and plant uptake are discussed. An “intercropping” experiment in the glasshouse is used as a model to check for rhizosphere effects on plant growth and mineral nutrition.

Number of participants limited to 18.

Prerequisites: Only students who have passed the courses 751-3401-00L Pflanzennährung I and 751-3402-00L Pflanzennährung II - Integriertes Nährstoffmanagement can be admitted to this course.
Objective
To gain a holistic understanding of resource-driven and regulatory processes in agricultural and natural ecosystems.
Develop skills on the critical analysis of scientific papers.
Define explanatory hypotheses, identify knowledge gaps for further investigations.
Carry out a multi-disciplinary experiment that involves aspects of soil, (micro-)biology, plant physiology, pathology, and ecology.
Develop manual skills in the set up of a glasshouse experiment, in soil and plant analyses, and in isolation and DNA-based characterisation of rhizobia.
Gain insights on basic methods to analyse (bio-)chemical, molecular genetic, and graphical data.
Discuss and interpret data in the context of the literature.
Prepare a research report in the format of a scientific paper and a poster in the format of a conference paper, partially alone and partially in small groups, using data obtained from the glasshouse experiment.

Content
This course is designed to stimulate thinking and promote critical analysis of important processes that occur in the rhizosphere. As part of this course, the knowledge acquired will be used for analysing and interpreting experimental data, as well as, preparing a scientific report and conference-type poster.

The course will cover the relative importance of spatial scales and various physicochemical and microbiological dynamics as influenced by roots. We will discuss root traits and activities that influence the immediately root-surrounding soil and thereby contribute to mineral nutrient mobilization and immobilization. An overview of the most relevant root-microbe symbioses for agroecosystems will be provided and root and microbial traits discussed, which could be of use in efforts towards utilization of intercropping and bioinoculants as a possible means of reducing energetically expensive inputs to farming systems. A special emphasis will be given to the importance of physicochemical features of soils and the chemical forms (= species) of elements important for plant uptake.

Practical experience will be gained with setting up a glasshouse experiment, soil and root sampling, basic soil and plant analyses, isolation of rhizobia, determination of the number of colony forming units (CFU), assays to screen for phosphorus and zinc solubilizing bacteria, DNA extraction, PCR amplification, and restriction fragment length polymorphism analysis (RFLP) of host range determining symbiosis-specific genes.

In short, the processes dealt with in this course occur on a small-scale and are generally (bio)chemical and microbiological in nature. Furthermore, they are generally not taken into account using current methods of agronomic management for plant production. However, they are increasingly being recognized as a potentially useful means of obtaining a resource-efficient and hence, economically and environmentally sustainable agricultural system, including for ecosystem restoration. Therefore, the course will invite for critical reflections and exemplify challenges in translating knowledge from scientific studies and ecology into application for plant production.

Lecture notes
For documentation, lecture slides and laboratory protocols will continuously be uploaded to the directory ‘751-5123-00L Rhizosphere Ecology’ on the electronic document exchange platform ILIAS, LDA-ELBA:
https://ilias-app2.let.ethz.ch/ilias.php?ref_id=109651&cmd=view&cmdClass=ilobjcoursegui&cmdNode=et:fv;baseClass=ilRepositoryGUI
This course guides students in analyzing and comprehending tropical agroecosystems. Students gain practical knowledge of field methods.

**Tropical Soils and Land Use**

**Prerequisites / notice**

We ask all course attendees of the agricultural sciences to have passed the exams at the end of the lectures Plant Nutrition I and II (Nutrient cycling in agroecosystems) by Prof. E. Frossard. All others, have to have successfully worked through the e-learning module Plant Nutrition I by Prof. E. Frossard.

**Abstract**

This course guides students in analyzing and comprehending tropical agroecosystems. Students gain practical knowledge of field methods, diagnostic tools and survey methods for tropical soils and agroecosystems. An integral part of the course is the two-week field project in Western Kenya, which is co-organized with University of Eldoret (Kenya) and KU Leuven (Belgium).
Spatial development deals with the development and the design of our living space. To meet the expectations, the interests and the plans of the different actors, it is needed a planning approach considering the overview of both the actual and future situation. The concept of sustainable development in spatial planning leads necessarily to an efficient management of the resources, especially regarding the resource land. The basics of this important discipline will be the subject of this lecture, which is therefore organised in three parts:

- **Inner development**
- **Integrated spatial and infrastructure development**
- **Cross-border issues in spatial development**

**Contents**

- Tasks of Spatial Planning and development
- Issues of local and supra-local interest
- Recurring spatial changes, impacts and key figures
- Formal and informal instruments and procedures in spatial planning
- Spatial Design - Ideas about the future
- Reasoning and assessing the situation in spatial planning
- Spatial planning as a sequence of decisions and interventions
- Process and procedures management
- Focus issues - Inner development before external development
- Focus issues - Cross-border tasks
- Focus Issues - Integrated spatial and infrastructure development

Lecture notes

Further information and the documents for the lecture can be found on the homepage of the Chair of Spatial Development.

### 103-0317-00L Sustainable Spatial Development I

**Objective**

Lectures and exercises:

1. Introduction to international soil classification with focus on tropical soils
2. Soil suitability (chemical, physical and biological fertility) for tropical crops
3. Soil conservation practices and stakeholder involvement
4. Approaches to analyzing tropical agroecosystems

**Field project:**

5. Overview of the major land use systems in Western Kenya
6. Analysis of agricultural production systems
7. Hands-on training on the use of field methods, diagnostic tools and survey methods
8. Collaboration in international student teams (MSc students from Switzerland, Belgium and Kenya)

**Literature**


**Prerequisites / notice**

The number of participants is limited to 12 students due to capacity limitations for the field project in Kenya. Selection of participants will be based on (1) the student’s motivation statement, (2) successful participation in the BSc lectures “Sustainable Agroecosystems I + II” and (3) related topic for BSc thesis/ tentative topic for MSc thesis. The motivation statement is due in the first week of the semester.

**Lecture notes**

Further information and the documents for the lecture can be found on the homepage of the Chair of Spatial Development.

### 103-0435-01L Land Management

**Objective**

First part: Spatial planning on the Commune level with focus on the special land use management

Second part: land re-allocation as an instrument of spatial planning; specific explanations for land re-allocations in rural regions and in construction zones.

Third part: land marketing: the view of investors.

**Content**

- Getting knowledge in spatial planning and land re-allocation as an interactive process.
- PART 1: Spatial Planning and Special Land Use Management
  - Overview about Spatial Planning on the commune level
  - workflows and planning methods on the commune level
  - comprehension of the public
  - getting knowledge of the special land use management

- PART 2: Methods of Land Re-Allocation
  - Intensions and principles of land re-allocation
  - implementation of the land re-allocation
  - land re-allocation in construction zones
  - amelioration

- PART 3: Agricultural Planning

**Lecture notes**

Lecture notes and slides (in German) can be downloaded from the PLUS homepage.

Download: [http://www.irl.ethz.ch/plus/education](http://www.irl.ethz.ch/plus/education)

**Literature**

References in the lecture notes

### 701-1695-00L Soil Science Seminar

**Objective**

Invited external speakers present their research on current issues in the field of soil science and discuss their results with the participants. The program will be announced through various channels and also be made available through the teaching materials.

Master and PhD students are introduced to current areas of research in soil sciences and get first-hand experience in scientific discussion.

#### Minor in Agricultural Plant Production and Environment
<table>
<thead>
<tr>
<th>Number</th>
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<tr>
<td>751-4001-00L</td>
<td>Forage Cropping</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>N. Buchmann, A. Lüscher</td>
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<td>751-4104-00L</td>
<td>Alternative Crops</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>A. Walter, B. Büter, E. A. Pérez Torres</td>
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<td>751-4003-01L</td>
<td>Current Topics in Grassland Sciences (HS)</td>
<td>W</td>
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<td>2S</td>
<td>N. Buchmann</td>
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<td>751-5001-00L</td>
<td>Agroecologists without Borders</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>C. Decock, A. Hofmann, J. Six</td>
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<td>751-5003-00L</td>
<td>Sustainable Agroecosystems II</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>J. Six, A. Hofmann</td>
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<tr>
<td>363-0537-00L</td>
<td>Resource and Environmental Economics</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>L. Bretschger, A. Brausmann</td>
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</tbody>
</table>

### Forage Cropping
- **Abstract**: This course is an introduction into forage cropping and grassland sciences. Topics include: extensive/intensive use, grassland evaluation, grassland maintenance, management using fertilization, cutting, etc. Relationships between site, vegetation composition and management will be explored.
- **Objective**: Studierenden werden wichtige Mischungen und Pflanzengemeinschaften mitteleuropäischer Grasslandökosysteme kennen, klassische und aktuelle Arbeiten der Bestandesökophysiologie kennenlernen, in der Lage sein, den Einfluss von Umweltfaktoren und Bewirtschaftung nicht nur auf Einzelpflanzen, sondern auf Pflanzenbestände und ihre Erträge abzuschätzen, und üben, ein wissenschaftliches Thema schriftlich prägnant zusammenzufassen.
- **Content**: In diesem Kurs werden die verschiedenen Typen des Futterbaus und die wichtigsten Mischungen, aber auch natürliche Pflanzengemeinschaften in Mitteleuropa vorgestellt (Bestandesbeurteilung). Basierend auf der Ökophysiologie von Einzelpflanzen wird die Ökophysiologie von Pflanzenbeständen erarbeitet. Es werden verschiedene Arten der Bewirtschaftung vorgestellt (z. B. Bestandeslenkung durch Düngung, Beweidung, Schnittterrine, etc.) und ihre Auswirkungen auf die Bestandeszusammensetzung und auf die Erträge diskutiert. Feedback-Mechanismen zwischen Umwelt und Futterbausystemen werden angesprochen.
- **Lecture notes**: Handouts werden auf dem Netz zur Verfügung gestellt.
- **Literature**: Wird in der Veranstaltung angesprochen.
- **Prerequisites / notice**: Course will be given in German. Course builds on the Ertrags- und Ökophysiologie lecture and provides the basics for the Grasslandsysteme.

### Alternative Crops
- **Abstract**: Few crops dominate the crop rotations worldwide. Following the goal of an increased agricultural biodiversity, species such as buckwheat but also medicinal plants might become more important in future. The biology, physiology, stress tolerance and central aspects of the value-added chain of the above-mentioned and of other alternative crops will be depicted.
- **Objective**: During this course, students learn to assess the potential of different minor or alternative crops compared to the dominant major crops based on their biological and agronomical features. Each student will assess and present a specific alternative crop of his or her choice based on information from scientific articles and Wikipedia. A Wikipedia-entry will be generated.
- **Prerequisites / notice**: Prerequisites: Basic knowledge of plant ecophysiology, terrestrial ecology and management of agro- and forest ecosystems. Course will be taught in English.

### Sustainable Agroecosystems II
- **Abstract**: This class is intended to convey methods of agroecological research through selected case studies from current research projects and hands-on exercises. Students will gain an overview on actors in the field of sustainable agricultural development.
- **Objective**: (1) Get to know methods for field and laboratory investigations in agroecology, (2) Analyze case studies from current agroecological research, (3) Place institutions and related projects into the context of sustainable agricultural development
- **Prerequisites / notice**: Prior participation in the lecture Nachhaltige Agrarökosysteme I (Sustainable Agroecosystems I) 751-5000-00G (in spring semester) recommended; classes taught mostly in English

### Minor in Environmental, Resource and Food Economics
<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>363-0537-00L</td>
<td>Resource and Environmental Economics</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>L. Bretschger, A. Brausmann</td>
</tr>
</tbody>
</table>
Abstract
Relationship between economy and environment, market failure, external effects and public goods, contingent valuation, internalisation of externalities; economics of non-renewable resources, economics of renewable resources, cost-benefit analysis, sustainability, and international aspects of resource and environmental economics.

Objective
Understanding of the basic issues and methods in resource and environmental economics; ability to solve typical problems in the field using the appropriate tools, which are concise verbal explanations, diagrams or mathematical expressions.

Topics are:
- Introduction to resource and environmental economics
- Importance of resource and environmental economics
- Main issues of resource and environmental economics
- Normative basis
- Utilitarianism
- Fairness according to Rawls
- Economic growth and environment
- Externality in the environmental sphere
- Governmental internalisation of externalities
- Private internalisation of externalities: the Coase theorem
- Free rider problem and public goods
- Types of public policy
- Efficient level of pollution
- Tax vs. permits
- Command and Control Instruments
- Empirical data on non-renewable natural resources
- Optimal price development: the Hotelling-rule
- Effects of exploration and Backstop-technology
- Effects of different types of markets
- Biological growth function
- Optimal depletion of renewable resources
- Social inefficiency as result of over-use of open-access resources
- Cost-benefit analysis and the environment
- Measuring environmental benefit
- Measuring costs
- Concept of sustainability
- Technological feasibility
- Conflicts sustainability / optimality
- Indicators of sustainability
- Problem of climate change
- Cost and benefit of climate change
- Climate change as international ecological externality
- International climate policy: Kyoto protocol
- Implementation of the Kyoto protocol in Switzerland
- Economy and natural environment, welfare concepts and market failure, external effects and public goods, measuring externalities and contingent valuation, internalising external effects and environmental policy, economics of non-renewable resources, renewable resources, cost-benefit-analysis, sustainability issues, international aspects of resource and environmental problems, selected examples and case studies.

Lecture notes
Learning material and script can be found here: https://moodle-app2.let.ethz.ch/course/view.php?id=328

Literature

751-1555-00L Applied Food Industrial Organisation

Abstract
Concepts of microeconomics and Industrial Organization and their application to the European food sector. Aspects include industry structure as well as strategic actions and performance of food sector firms.

Objective
Understanding and application of theoretical concepts along the Structure-Conduct-Performance paradigm. Ability to apply theory to empirical settings; understand and critically evaluate empirical industrial organization research and to replicate the results of such research using econometric methods.

Content
- Introduction IO
  - Relevant topics for the food sector
  - high competition and market saturation
  - low R&D intensity
  - bargaining power of retailers
  - Private label introduction
- Theoretical Approaches
  - Structure Conduct Performance
  - Market Based View
  - Porters Five Forces
  - Resource Based View
  - Knowledge Based View
  - Empirical Issues (Based on published research papers)
    - Competition / Concentration
    - Profitability
    - Impact of Innovation / R&D
    - Efficiency
    - Market power
    - Econometric Approaches

Literature
Several theoretical and empirical IO related research papers.

751-2103-00L Socioeconomics of Agriculture

Abstract
The main part of this lecture will examine constellations where hierarchies, markets or cooperation have been observed and described in the agricultural sector. On a more aggregated level, different agricultural systems will be evaluated in terms of main socioeconomic parameters like social capital or perceptions.

Objective
Students should be able to describe the dynamics of hierarchies, markets and cooperation in an agricultural context.
Groups, identities and utility maximization - some conceptual foundations
Micro-Socioeconomics: Hierarchy, cooperation and markets
Macro-Socioeconomics: Varieties of Capitalism
Agricultural Administration: Path dependencies and efficiency issues
Causes and Impacts of farm succession
Occupational Choice in the farming sector
System Choice and segregation (organic, GMO etc.)
The economics of rural areas
Common Resource Management in Alpine Farming
Agricultural Cooperatives
Societal perceptions of agriculture
Perceptions of farming from within
Varieties of agricultural systems and policies


Content: 701-0019-00L

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<td>701-0019-00L</td>
<td>Readings in Environmental Thinking</td>
<td>W</td>
<td>3 credits</td>
<td>2S</td>
<td>J. Ghazoul, G. Hirsch Hadorn, A. Patt</td>
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</table>

Abstract: This course introduces students to foundational texts that led to the emergence of the environment as a subject of scientific importance, and shaped its relevance to society. Above all, the course seeks to give confidence and raise enthusiasm among students to read more widely around the broad subject of environmental sciences and management both during the course and beyond.

Objective: The course will provide students with opportunities to read, discuss, evaluate and interpret key texts that have shaped the environmental movement and, more specifically, the environmental sciences. Students will gain familiarity with the foundational texts, but also understand the historical context within which their academic and future professional work is based. More directly, the course will encourage debate and discussion of each text that is studied, from both the original context as well as the modern context. In so doing students will be forced to consider and justify the current societal relevance of their work.

Content: The course will be run as a book reading club. The first session will provide a short introduction as to how to explore a particular text (that is not a scientific paper) to identify the key points for discussion. Thereafter, in each week a text (typically a chapter from a book or a paper) considered to be seminal or foundational will be assigned by a course lecturer. The lecturer will introduce the selected text with a brief background of the historical and cultural context in which it was written, with some additional biographical information about the author. He/she will also briefly explain the justification for selecting the particular text.

The students will read the text, with two to four students (depending on class size) being assigned to present it at the next session. Presentation of the text requires the students to prepare by, for example:
- identifying the key points made within the text
- identifying issues of particular personal interest and resonance
- considering the impact of the text at the time of publication, and its importance now
- evaluating the text from the perspective of our current societal and environmental position

Such preparation would be supported by a mid-week tutorial discussion (about 1 hour) with the assigning lecturer.

These students will then present the text (for about 15 minutes) to the rest of the class during the scheduled class session, with the lecturer facilitating the subsequent class discussion (about 45 minutes). Towards the end of the session the presenting students will summarise the emerging points (5 minutes) and the lecturer will finish with a brief discussion of how valuable and interesting the text was (10 minutes). In the remaining 15 minutes the next text will be presented by the assigning lecturer for the following week.
The specific texts selected for discussion will vary, but examples include:

- Leopold (1949) *A Sand County Almanach*
- Carson (1962) *Silent Spring*
- Lovelock (1979) *Gaia: A new look at life on Earth*
- Jared Diamond (2005) *Collapse*

Discussions might also encompass films or other forms of media and communication about nature.

### 701-0337-00L Environmental Mineralogy

**Z** 1 credit 1V A. U. Gehring

**Abstract**
The lecture Environmental Mineralogy provides an outline of chemical and physical properties of iron oxides, clays, and carbonates. Analytical methods (XRD, spectroscopy and magnetics) are presented in order to identify and characterize minerals in natural samples as a tool for the reconstruction of weathering in soils, of diagenesis in sediment, and of phase transitions in hydrothermal systems.

**Objective**
Knowledge of the most important minerals (Fe-oxides, carbonates, and sheet silicates) in environmental systems
Knowing about the technical and analytical tools for the identification and characterization of mineral phases.
Development of strategies for the analytical handling of multiminerall systems.

The application of mineralogical informations to solve specific environmental problems.

**Content**
- Domain specific knowledge: Students have immersed knowledge about a certain complex, societal topic which will be selected every Autumn Semester.

**Literature**
- Environmental Mineralogy, A. Cabello Llamas
- The week is mainly about problem solving and design thinking applied to the complex world of water. During ETH Week students will have...

**Prerequisites / notice**

### 701-0901-00L ETH Week 2016: Challenging Water

**W** 1 credit

**Abstract**
The ETH Week is an innovative one-week course designed to foster critical thinking and creative learning. Students from all departments as well as professors and external experts will work together in interdisciplinary teams. They will develop interventions that could play a role in solving some of our most pressing global challenges. In 2016, ETH Week will focus on the topic of water.

**Objective**
- Domain specific knowledge: Students have immersed knowledge about a certain complex, societal topic which will be selected every year. They understand the complex system context of the current topic, by comprehending its scientific, technical, political, social, ecological and economic perspectives. The focus in 2016 is on challenging water systems.

- Analytical skills: The ETH Week participants are able to structure complex problems systematically using selected methods. They are able to acquire further knowledge and to critically analyze the knowledge in interdisciplinary groups and with experts and the help of team tutors.

- Design skills: The students are able to use their knowledge and skills to develop concrete approaches for problem solving and decision making to a selected problem statement, critically reflect these approaches, assess their feasibility, to transfer them into a concrete form (physical model, prototypes, strategy paper,...) and to present this work in a creative way (role-plays, videos, exhibitions, etc.).

- Self-competence: The students are able to plan their work effectively, efficiently and autonomously. By considering approaches from different disciplines they are able to make a judgment and form a personal opinion. In exchange with non-academic partners from business, politics, administration, nongovernmental organizations and media they are able to communicate appropriately, present their results professionally and creatively and convince a critical audience.

- Social competence: The students are able to work in multidisciplinary teams, i.e. they can reflect critically their own discipline, debate with students from other disciplines and experts in a critical-constructive and respectful way and can relate their own positions to different intellectual approaches. They can assess how far they are able to actively make a contribution to society by using their personal and professional talents and skills and as "Change Agents".

**Content**
The week is mainly about problem solving and design thinking applied to the complex world of water. During ETH Week students will have the opportunity to work in small interdisciplinary groups, allowing them to critically analyze both their own approaches and those of other disciplines, and to integrate these into their work.

While deepening their knowledge about how the food system works, students will be introduced to various methods and tools for generating creative ideas and understand how different people are affected by each part of the system. In addition to lectures and literature, students will acquire knowledge via excursions into the real world, empirical observations, and conversations with researchers and experts

A key attribute of the ETH Week is that students are expected to find their own problem, rather than just solve the problem that has been handed to them. Therefore, the first three days of the week will concentrate on identifying a problem the individual teams will work on, while the last two days are focused on generating solutions and communicating the team’s ideas.

A panel of experts will judge your presentations at the end of the week. The winning teams will receive attractive prizes.

**Prerequisites / notice**

No prerequisites. Program is open to Bachelor and Masters from all ETH Departments. All students must apply through a competitive application process that will open in March 2016 at www.ethz.ch/ETHWeek. Participation is subject to successful selection through this competitive process.
Lecturers

ECTS

In the mandatory internship outside of ETH, the students in Environmental Sciences learn about how environmental issues are handled. The students experience political/legal, economic, social and psychological aspects in a professional working environment and acquire key skills such as communication and planning skills, cooperation with non-specialists or recognition of relevant aspects. Further they make useful contacts for starting their careers.

The internship is a mandatory part of the two-year Master programme and lasts for at least 18 weeks (30 credit points). The internship agreement is a condition for the performance assessment of the internship.

Course Catalogue of ETH Zurich

Work Experience

<table>
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<td>701-1001-00L</td>
<td>Internship ■ Only for Environmental Sciences MSc:</td>
<td>O</td>
<td>30 credits</td>
<td></td>
<td>A. Funk</td>
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</table>

Abstract

In the mandatory internship outside of ETH, the students in Environmental Sciences learn about how environmental issues are handled professionally through their own practical work and by applying the knowledge they acquired. They will analyze complex environmental problems on scientific, technical and social levels and develop solutions in conjunction with social actors.

Objective

The students experience political/legal, economic, social and psychological aspects in a professional working environment and acquire key skills such as communication and planning skills, cooperation with non-specialists or recognition of relevant aspects. Further they make useful contacts for starting their careers.

Content

This internship takes place outside of ETH. The main locations of an internship are the following: environmental consulting firms, planning and engineering offices, industrial and service companies, public administration, environmental organisations (nature conservation and protection, development cooperation).

The internship is a mandatory part of the two-year Master programme and lasts for at least 18 weeks (30 credit points). The internship agreement is a condition for the performance assessment of the internship.

Prerequisites / notice

Class attendance and active participation is crucial as much of the learning occurs through the work in teams during class. Therefore, attendance is obligatory for every session. Please also note that the group work outside class is an essential element of this course, so that students must expect an above-average workload.

Course Catalogue of ETH Zurich

Master’s Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-1002-00L</td>
<td>Master’s Thesis ■ Only students who fulfill the following criteria are allowed to begin with their Master thesis:</td>
<td>O</td>
<td>30 credits</td>
<td>64D</td>
<td>Lecturers</td>
</tr>
</tbody>
</table>

Abstract

The course is completed by a Master thesis. This component is designed to enable the students to explore how the course content can be applied to an actual scientific problem. The thesis also provides an opportunity for the students to exercise initiative and to demonstrate that they are capable of working independently and in a scientifically structured manner.
This course covers mathematical concepts and techniques necessary to model, solve and discuss scientific problems - notably through physics.

**Introduction to the scientific methodology.** The student should develop his/her capability to turn physical observations into mathematical models, and to solve the latter.

The student should acquire an overview over the basic concepts in mechanics.

### Course Units for Additional Admission Requirements

The courses below are only available for Master students with additional admission requirements.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>406-0062-AAL</td>
<td>Physics I: Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.</td>
<td>E-</td>
<td>5 credits</td>
<td>11R</td>
<td>A. Vaterlaus</td>
</tr>
<tr>
<td></td>
<td>Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.</td>
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<tr>
<td></td>
<td>Introduction to the concepts and tools in physics: mechanics of point-like and rigid bodies, elasticity theory, elements of hydrostatics and hydrodynamics, periodic motion and mechanical waves.</td>
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<tr>
<td></td>
<td>Objective Introduction to the scientific methodology. The student should develop his/her capability to turn physical observations into mathematical models, and to solve the latter.</td>
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<tr>
<td></td>
<td>Literature Chapters: 1, 2, 3, 4, 5, 6 (without: 6-5, 6-6, 6-8), 7, 8 (without 8-9), 9, 10 (without 10-10), 11 (without 11-7), 13 (without 13-13, 13-14), 14 (without 14-6), 15 (without 15-3, 15-5)</td>
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<tr>
<td></td>
<td>see &quot;Content&quot; Friedhelm Kuppers Physik für Ingenieure und Naturwissenschaftler Band 1: Mechanik und Thermodynamik Wiley-VCH Verlag, 2002, 544 S, ca.: Fr. 68.-</td>
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<tr>
<td>406-0063-AAL</td>
<td>Physics II: Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.</td>
<td>E-</td>
<td>5 credits</td>
<td>11R</td>
<td>A. Vaterlaus</td>
</tr>
<tr>
<td></td>
<td>Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.</td>
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<td></td>
<td>Introduction to the &quot;way of thinking&quot; and the methodology in Physics. The Chapters treated are Magnetism, Refraction and Diffraction of Waves, Elements of Quantum Mechanics with applications to Spectroscopy, Thermodynamics, Phase Transitions, Transport Phenomena.</td>
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<tr>
<td></td>
<td>Objective Introduction to the scientific methodology. The student should develop his/her capability to turn physical observations into mathematical models, and to solve the latter.</td>
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<tr>
<td></td>
<td>see &quot;Content&quot; Friedhelm Kuppers Physik für Ingenieure und Naturwissenschaftler Band 2 Elektrizität, Optik, Wellen Verlag Wiley-VCH, 2003, Fr. 77.-</td>
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<tr>
<td>406-0251-AAL</td>
<td>Mathematics I: Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.</td>
<td>E-</td>
<td>6 credits</td>
<td>13R</td>
<td>A. Cannas da Silva</td>
</tr>
<tr>
<td></td>
<td>Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.</td>
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<tr>
<td></td>
<td>This course covers mathematical concepts and techniques necessary to model, solve and discuss scientific problems - notably through differential equations.</td>
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<tr>
<td></td>
<td>Objective Mathematics is of ever increasing importance to the Natural Sciences and Engineering. The key is the so-called mathematical modelling cycle, i.e. the translation of problems from outside of mathematics into mathematics, the study of the mathematical problems (often with the help of high level mathematical software packages) and the interpretation of the results in the original environment. The goal of Mathematics I and II is to provide the mathematical foundations relevant for this paradigm. Differential equations are by far the most important tool for modelling and are therefore a main focus of both of these courses.</td>
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<tr>
<td></td>
<td>Content 1. Linear Algebra and Complex Numbers: systems of linear equations, Gauss-Jordan elimination, matrices, determinants, eigenvalues and eigenvectors, cartesian and polar forms for complex numbers, complex powers, complex roots, fundamental theorem of algebra. 2. Single-Variable Calculus: review of differentiation, linearisation, Taylor polynomials, maxima and minima, antiderivative, fundamental theorem of calculus, integration methods, improper integrals. 3. Ordinary Differential Equations: separable ordinary differential equations (ODEs), integration by substitution, 1st and 2nd order linear ODEs, homogeneous systems of linear ODEs with constant coefficients, introduction to 2-dimensional dynamical systems.</td>
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</tbody>
</table>
Mathematics I covers mathematical concepts and techniques necessary to model, solve and discuss scientific problems - notably through the study of the mathematical problems (often with the help of high level mathematical software packages) and the interpretation of the results in the original environment.

- Thomas, G. B.: Thomas' Calculus, Parts 2 (Pearson Addison-Wesley).

Mathematics II

- Bretscher, O.: Linear Algebra with Applications (Pearson Prentice Hall).
- Thomas, G. B.: Thomas' Calculus, Parts 1 - Early Transcendentals (Pearson Addison-Wesley).

Stochastics (Probability and Statistics)

- Thomas, G. B.: Thomas' Calculus, Parts 2 (Pearson Addison-Wesley).

Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Prerequisites: familiarity with the basic notions from Calculus, in particular those of function and derivative.

Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

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The goal of Mathematics I and II is to provide the mathematical foundations relevant for this paradigm. Differential equations are by far the most important tool for modelling and are therefore a main focus of both of these courses.

- Single-Variable Calculus:
  review of differentiation, linearisation, Taylor polynomials, maxima and minima, antiderivative, fundamental theorem of calculus, integration methods, improper integrals.
- Ordinary Differential Equations:
  separable ordinary differential equations (ODEs), integration by substitution, 1st and 2nd order linear ODEs, homogeneous systems of linear ODEs with constant coefficients, introduction to 2-dimensional dynamical systems.
- Multivariable Differential Calculus:
  functions of several variables, partial differentiation, curves and surfaces in space, scalar and vector fields, gradient, curl and divergence.
- Partial Differential Equations:
  separation of variables, Fourier series, heat equation, wave equation, Laplace equation, Fourier transform.
- Multivariable Integral Calculus:
  multiple integrals, line and surface integrals, work and flow, Green, Gauss and Stokes theorems, applications.

Objective

Mathematics I covers mathematical concepts and techniques necessary to model, solve and discuss scientific problems - notably through the study of the mathematical problems (often with the help of high level mathematical software packages) and the interpretation of the results in the original environment.

Main focus: multivariable calculus and partial differential equations.

Main focus of Mathematics II: multivariable calculus and partial differential equations.

The goal of Mathematics I and II is to provide the mathematical foundations relevant for this paradigm. Differential equations are by far the most important tool for modelling and are therefore a main focus of both of these courses.

- Linear Algebra and Complex Numbers:
  systems of linear equations, Gauss-Jordan elimination, matrices, determinants, eigenvectors, eigenvectors, cartesian and polar forms for complex numbers, complex powers, complex roots, fundamental theorem of algebra.
- Ordinary Differential Equations:
  separable ordinary differential equations (ODEs), integration by substitution, 1st and 2nd order linear ODEs, homogeneous systems of linear ODEs with constant coefficients, introduction to 2-dimensional dynamical systems.
- Multivariable Differential Calculus:
  functions of several variables, partial differentiation, curves and surfaces in space, scalar and vector fields, gradient, curl and divergence.
- Multivariable Integral Calculus:
  multiple integrals, line and surface integrals, work and flow, Green, Gauss and Stokes theorems, applications.
- Partial Differential Equations:
  separation of variables, Fourier series, heat equation, wave equation, Laplace equation, Fourier transform.

Objective

Mathematics is of ever increasing importance to the Natural Sciences and Engineering. The key is the so-called mathematical modelling cycle, i.e. the translation of problems from outside of mathematics into mathematics, the study of the mathematical problems (often with the help of high level mathematical software packages) and the interpretation of the results in the original environment.

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- Multivariable Integral Calculus:
  multiple integrals, line and surface integrals, work and flow, Green, Gauss and Stokes theorems, applications.
- Partial Differential Equations:
  separation of variables, Fourier series, heat equation, wave equation, Laplace equation, Fourier transform.

Objective
529-2001-AAL Chemistry I and II E- 9 credits 19R H. Grützmacher, W. Uhlig

Abstract
Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Objective
Introduction to general and inorganic chemistry. Basics of the composition and the change of the material world. Introduction to the thermodynamically controlled physico-chemical processes. Macroscopic phenomena and their explanation through atomic and molecular properties. Using the theories to solve qualitatively and quantitatively chemical and ecologically relevant problems.

Content
1. Stoichiometry
2. Atoms and Elements (Quantenmechanical Model of the Atom)
3. Chemical Bonding
4. Thermodynamics
5. Chemical Kinetics
6. Chemical Equilibrium (Acids and Bases, Solubility Equilibria)
7. Electrochemistry

Lecture notes
Nivaldo J. Tro
Chemistry - A molecular Approach (Pearson), Chapter 1-18

551-0001-AAL General Biology I E- 3 credits 6R U. Sauer, O. Y. Martin, A. Widmer

Abstract
Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Objective
Organismic biology to teach the basic principles of classical and molecular genetics, evolutionary biology and phylogeny.

This is a virtual self-study lecture for non-German speakers of the "Allgemeine Biology I (551-0001-00L) lecture. The exam will be written jointly with the participants of this lecture.

The understanding of basic principles of biology (inheritance, evolution and phylogeny) and an overview of the diversity of life.
Content: The first semester focuses on the organismal biology aspects of genetics, evolution and diversity of life in the Campbell chapters 12-34.

Week 1-7 by Alex Widmer, Chapters 12-25
12 Cell biology Mitosis
13 Genetics Sexual life cycles and meiosis
14 Genetics Mendelian genetics
15 Genetics Linkage and chromosomes
20 Genetics Evolution of genomes
21 Evolution How evolution works
22 Evolution Phylogenetic reconstructions
23 Evolution Microevolution
24 Evolution Species and specialization
25 Evolution Macroevolution

Week 8-14 by Oliver Martin, Chapters 26-34
26 Diversity of Life Introduction to viruses
27 Diversity of Life Prokaryotes
28 Diversity of Life Origin & evolution of eukaryotes
29 Diversity of Life Nonvascular&seedless vascular plants
30 Diversity of Life Seed plants
31 Diversity of Life Introduction to fungi
32 Diversity of Life Overview of animal diversity
33 Diversity of Life Introduction to invertebrates
34 Diversity of Life Origin & evolution of vertebrates

Lecture notes: No script


Prerequisites / notice: This is a virtual self-study lecture for non-german speakers of the "Allgemeine Biology I (551-0001-00L)" lecture. The exam will be written jointly with the participants of this lecture.

Example exam questions will be discussed during the lectures, and old exam questions are kept by the various student organisations. If necessary, please contact Prof. Uwe Sauer (sauer@ethz.ch) for details regarding the exam.

551-0002-AAL General Biology II E- 4 credits 6R U. Sauer, R. Aebersold, H.M. Fischer, W. Gruissem

Abstract: Molecular biology approach to teach the basic principles of biochemistry, cell biology, cogenetics, evolutionary biology and form and function of vascular plants.

Objective: The understanding basic concepts of biology: the hierarchy of the structural levels of biological organisation, with particular emphasis on the cell and its molecular functions, the fundamentals of metabolism and molecular genetics, as well as form and function of vascular plants.

Content: The structure and function of biomacromolecules; basics of metabolism; tour of the cell; membrane structure and function; basic energetics of cellular processes; respiration, photosynthesis; cell cycle, from gene to protein; structure and growth of vascular plants, resource acquisition and transport, soil and plant nutrition.

Specifically the following Campbell chapters will be covered:
3 Biochemistry Chemistry of water
4 Biochemistry Carbon: the basis of molecular diversity
5 Biochemistry Biological macromolecules and lipids
7 Cell biology Cell structure and function
8 Cell biology Cell membranes
10 Cell biology Respiration: introduction to metabolism
10 Cell biology Cell respiration
11 Cell biology Photosynthetic processes
16 Genetics Nucleic acids and inheritance
17 Genetics Expression of genes
18 Genetics Control of gene expression
19 Genetics DNA Technology
35 Plant structure&function Plant Structure and Growth
36 Plant structure&function Transport in vascular plants
37 Plant structure&function Plant nutrition
38 Plant structure&function Reproduction of flowering plants
39 Plant structure&function Plants signal and behavior

Lecture notes: No script


Prerequisites / notice: Basic general and organic chemistry

PLEASE NOTE This lecture is newly conceived and will be held for the first time in the spring semester 2017.

701-0023-AAL Atmosphere E- 3 credits 6R H. Wernli, T. Peter

Abstract: Basic principles of the atmosphere, physical structure and chemical composition, trace gases, atmospheric cycles, circulation, stability, radiation, condensation, clouds, oxidation capacity and ozone layer.

Objective: Understanding of basic physical and chemical processes in the atmosphere. Understanding of mechanisms of and interactions between: weather - climate, atmosphere - ocean - continents, troposphere - stratosphere. Understanding of environmentally relevant structures and processes on vastly differing scales. Basis for the modelling of complex interrelations in the atmosphere.

Content: Basic principles of the atmosphere, physical structure and chemical composition, trace gases, atmospheric cycles, circulation, stability, radiation, condensation, clouds, oxidation capacity and ozone layer.

Data: 06.03.2019 12:57 Autumn Semester 2016 Page 1562 of 1571
701-0243-AAL  
**Biology III: Essentials of Ecology**  
**E-** 3 credits 6R  J. Levine  
Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.  

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.  

**Abstract**  
This course assigns reading for students needing further background for understanding ecological processes. Central problems in ecology, including population growth and regulation, the dynamics of species interactions, the influence of spatial structure, the controls over species invasions, and community responses to environmental change will be explored from basic and applied perspectives.  

**Objective**  
Original language Students will understand how ecological processes operate in natural communities. They will appreciate how mathematical theory, field experimentation, and observational studies combine to generate a predictive science of ecological processes.  

Upon completing the course, students will be able to:  
- Understand the factors determining the outcome of species interactions in communities, and how this information informs management.  
- Apply theoretical knowledge on species interactions to predict the potential outcomes of novel species introductions.  
- Understanding the role of spatial structure in mediating population dynamics and persistence, species interactions, and patterns of species diversity.  
- Use population and community models to predict the stability of interactions between predators and prey and between different competitors.  
- Understand the conceptual basis of predictions concerning how ecological communities will respond to climate change.  

**Content**  
Readings from a text book will focus on understanding central processes in community ecology. Topics will include demographic and spatial structure, consumer resource interactions, food webs, competition, invasion, and the maintenance of species diversity. Each of these more conceptual topics will be discussed in concert with their applications to the conservation and management of species and communities in a changing world.  

701-0401-AAL  
**Hydrosphere**  
**E-** 3 credits 6R  R. Kipfer, C. Roques  
Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.  

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.  

**Abstract**  
Qualitative and quantitative understanding of the physical processes that control the terrestrial water cycle. Energy and mass exchange, mixing and transport processes are described and the coupling of the hydrosphere with the atmosphere and the solid Earth are discussed.  

**Objective**  
Qualitative and quantitative understanding of the physical processes that control the terrestrial water cycle. Energy and mass exchange, mixing and transport processes are described and the coupling of the hydrosphere with the atmosphere and the solid Earth are discussed.  

**Content**  
Topics of the course.  
Physical properties of water (i.e. density and equation of state)  
- global water resources  
- Exchange at boundaries  
- energy (thermal & kinetic), gas exchange  
Mixing and transport processes in open waters  
- vertical stratification, large scale transport  
- turbulence and mixing  
- mixing and exchange processes in rivers  
Groundwater and its dynamics  
- ground water as part of the terrestrial water cycle  
- ground water hydraulics, Darcy’s law  
- aquifers and their properties  
- hydrochemistry and tracer  
- ground water use  
Case studies  
- 1. Water as resource, 2. Water and climate  

**Lecture notes**  
In addition to the self-learning literature handouts are distributed.  

**Literature**  
Textbooks for self-studying.  
Surface water:  
Chapter 4: Imboden, D.M., and Wüest, A. 'Mixing Mechanisms in Lakes'  
Chapter 6.4: Air-Water Partitioning  
Chapter 19.2: Bottleneck Boundaries  
Groundwater:  
Chapters 1 - 6, 8, 10, 11.  

Optional additional readers.  

Abstract
Introduction to the formation and properties of soils as a function of parent rock, landscape position, climate, and soil organisms. Complex relationships between soil forming processes, physical and chemical soil properties, soil biota, and ecological soil properties.

Objective
Introduction to the formation and properties of soils as a function of parent rock, landscape position, climate, and soil organisms. Complex relationships between soil forming processes, physical and chemical soil properties, soil biota, and ecological soil properties.

Content
Definition of the pedosphere, soil functions, rocks as parent materials, minerals and weathering, soil organisms, soil organic matter, physical soil properties and functions, chemical soil properties and functions, soil formation, principles of soil classification, global soil regions, soil fertility, land use and soil degradation.

Abstract
This is an introductory course in psychology. This course will emphasize cognitive psychology and the psychological experiment.

Objective
Knowledge of key concepts and exemplary theories of psychology and their relation to “daily” psychology. Comprehension of relation between theory and experiment in psychology.

Goals: Learning how psychologists are thinking, a side change from the ETH natural science perspective to psychological thinking.

Domains of psychology:
- Psychology fields
- Concept definitions of psychology
- Theories of psychology
- Methods of psychology
- Results of psychology

Capability:
Be able to define a psychological research question
Basics understanding of role of psychology

Comprehension:
Psychology as a science of experience and behavior of the human

Content
Einführung in die psychologische Forschung und Modellbildung unter besonderer Berücksichtigung der kognitiven Psychologie und des psychologischen Experiments. Themen sind u.a.: Wahrnehmung; Lernen und Entwicklung; Denken und Problemlösen; Kognitive Sozialpsychologie; Risiko und Entscheidung.

Literature

Prerequisites / notice
Prerequisites: Basic knowledge in chemistry, biology and geology.

701-0721-AAL Psychology E- 3 credits 6R M. Siegrist
Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract
This is an introductory course in psychology. This course will emphasize cognitive psychology and the psychological experiment.

Objective
Knowledge of key concepts and exemplary theories of psychology and their relation to “daily” psychology. Comprehension of relation between theory and experiment in psychology.

Goals: Learning how psychologists are thinking, a side change from the ETH natural science perspective to psychological thinking.

Domains of psychology:
- Psychology fields
- Concept definitions of psychology
- Theories of psychology
- Methods of psychology
- Results of psychology

Capability:
Be able to define a psychological research question
Basics understanding of role of psychology

Comprehension:
Psychology as a science of experience and behavior of the human

Content
Einführung in die psychologische Forschung und Modellbildung unter besonderer Berücksichtigung der kognitiven Psychologie und des psychologischen Experiments. Themen sind u.a.: Wahrnehmung; Lernen und Entwicklung; Denken und Problemlösen; Kognitive Sozialpsychologie; Risiko und Entscheidung.

Literature

Prerequisites / notice
Prerequisites: Basic knowledge in chemistry, biology and geology.

701-0757-AAL Systems Analysis E- 4 credits 6R N. Gruber
Enrolment ONLY for MSc students with a decree declaring this course unit as an additional admission requirement.

Any other students (e.g. incoming exchange students, doctoral students) CANNOT enrol for this course unit.

Abstract
Self study course in Systems Analysis to fulfill requirements for enrollment into the master program. Topics covered include linear box models with one and several variables; non-linear box models with one or several variables; discrete-time models; and continuous models in space and time.

Objective
The aim of this course is to develop an understanding of the dynamical behavior of environmental systems and how this behavior can be captured and understood using mathematical concepts.
Lecture notes
For English Speaking students:
Chapters 12.3, 12.4, 18.2, 21, 22.1 and 22.2

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<th>Key for Type</th>
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<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
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<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
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<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
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<tr>
<td>O</td>
<td>Compulsory</td>
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<td>V</td>
<td>lecture</td>
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<tr>
<td>G</td>
<td>lecture with exercise</td>
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<td>U</td>
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<td>S</td>
<td>seminar</td>
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<td>K</td>
<td>colloquium</td>
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<td>P</td>
<td>practical/laboratory course</td>
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<td>A</td>
<td>independent project</td>
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<td>D</td>
<td>diploma thesis</td>
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<td>R</td>
<td>revision course / private study</td>
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</table>

ECTS European Credit Transfer and Accumulation System
Special students and auditors need special permission from the lecturers.
## Core Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<tbody>
<tr>
<td>151-0107-20L</td>
<td>High Performance Computing for Science and</td>
<td>W</td>
<td>4</td>
<td>4G</td>
<td>M. Troyer, P. Chatzidoukas</td>
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<tr>
<td></td>
<td>Engineering (HPCSE) I</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<tr>
<td></td>
<td>This course gives an introduction into algorithms and numerical methods for parallel computing for multi and many-core architectures and for applications from problems in science and engineering.</td>
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<td><strong>Objective</strong></td>
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<td>Introduction to HPC for scientists and engineers</td>
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<td></td>
<td>Fundamental of:</td>
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<td></td>
<td>1. Parallel Computing Architectures</td>
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<td>2. MultiCores</td>
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<td>3. ManyCores</td>
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<td></td>
<td><strong>Content</strong></td>
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<tr>
<td></td>
<td>Programming models and languages:</td>
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<td></td>
<td>1. C++ threading (2 weeks)</td>
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<td>2. OpenMP (4 weeks)</td>
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<td>3. MPI (5 weeks)</td>
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<td>Computers and methods:</td>
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<td>1. Hardware and architectures</td>
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<td>2. Libraries</td>
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<td>3. Particles: N-body solvers</td>
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<td>4. Fields: PDEs</td>
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<td>5. Stochastics: Monte Carlo</td>
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<td><strong>Lecture notes</strong></td>
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<td><a href="http://www.cse-lab.ethz.ch/index.php/teaching/42-teaching/classes/615-hpcse1">http://www.cse-lab.ethz.ch/index.php/teaching/42-teaching/classes/615-hpcse1</a></td>
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<tr>
<td></td>
<td>Class notes, handouts</td>
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<table>
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<tr>
<th>151-0213-00L</th>
<th>Fluid Dynamics with the Lattice Boltzmann Method</th>
<th>W</th>
<th>4</th>
<th>3G</th>
<th>I. Karlin</th>
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<tbody>
<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td></td>
<td>The course provides an introduction to theoretical foundations and practical usage of the Lattice Boltzmann Method for fluid dynamics simulations.</td>
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<td><strong>Objective</strong></td>
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<td>Methods like molecular dynamics, DSMC, lattice Boltzmann etc are being increasingly used by engineers all over and these methods require knowledge of kinetic theory and statistical mechanics which are traditionally not taught at engineering departments. The goal of this course is to give an introduction to ideas of kinetic theory and non-equilibrium thermodynamics with a focus on developing simulation algorithms and their realizations.</td>
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<td>During the course, students will be able to develop a lattice Boltzmann code on their own. Practical issues about implementation and performance on parallel machines will be demonstrated hands on.</td>
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<td>Central element of the course is the completion of a lattice Boltzmann code (using the framework specifically designed for this course).</td>
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<td>The course will also include a review of topics of current interest in various fields of fluid dynamics, such as multiphase flows, reactive flows, microflows among others.</td>
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<td>Optionally, we offer an opportunity to complete a project of student's choice as an alternative to the oral exam. Samples of projects completed by previous students will be made available.</td>
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<td></td>
<td><strong>Content</strong></td>
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<td></td>
<td>The course builds upon three parts:</td>
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<td></td>
<td>I Elementary kinetic theory and lattice Boltzmann simulations introduced on simple examples.</td>
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<td>II Theoretical basis of statistical mechanics and kinetic equations.</td>
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<td>III Lattice Boltzmann method for real-world applications.</td>
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<td>The content of the course includes:</td>
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<td></td>
<td>1. Background: Elements of statistical mechanics and kinetic theory:</td>
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<td></td>
<td>Particle's distribution function, Liouville equation, entropy, ensembles; Kinetic theory: Boltzmann equation for rarefied gas, H-theorem, hydrodynamic limit and derivation of Navier-Stokes equations, Chapman-Enskog method, Grad method, boundary conditions; mean-field interactions, Vlasov equation; Kinetic models: BGK model, generalized BGK model for mixtures, chemical reactions and other fluids.</td>
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<td>2. Basics of the Lattice Boltzmann Method and Simulations:</td>
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<td>Minimal kinetic models: lattice Boltzmann method for single-component fluid, discretization of velocity space, time-space discretization, boundary conditions, forcing, thermal models, mixtures.</td>
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<td>3. Hands on: Development of the basic lattice Boltzmann code and its validation on standard benchmarks (Taylor-Green vortex, lid-driven cavity flow etc);</td>
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<td>4. Practical issues of LBM for fluid dynamics simulations:</td>
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<td>Lattice Boltzmann simulations of turbulent flows; numerical stability and accuracy.</td>
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<td>5. Microflow: Rarefaction effects in moderately dilute gases; Boundary conditions, exact solutions to Couette and Poiseuille flows; micro-channel simulations.</td>
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<td>6. Advanced lattice Boltzmann methods:</td>
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<td>Entropic lattice Boltzmann scheme, subgrid simulations at high Reynolds numbers; Boundary conditions for complex geometries.</td>
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<td>7. Introduction to LB models beyond hydrodynamics:</td>
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<td>Relativistic fluid dynamics; flows with phase transitions.</td>
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<td><strong>Lecture notes</strong></td>
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<td>Lecture notes on the theoretical parts of the course will be made available. Selected original and review papers are provided for some of the lectures on advanced topics.</td>
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<td>Handouts and basic code framework for implementation of the lattice Boltzmann models will be provided.</td>
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<thead>
<tr>
<th>151-0293-00L</th>
<th>Combustion and Reactive Processes in Energy and</th>
<th>W</th>
<th>4</th>
<th>2V+1U+2A</th>
<th>K. Boulouchos, F. Ernst.</th>
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<tbody>
<tr>
<td></td>
<td><strong>Prerequisites / notice</strong></td>
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<td>The course addresses mainly graduate students (MSc/Ph D) but BSc students can also attend.</td>
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</tbody>
</table>
The students should become familiar with the fundamentals and with application examples of chemically reactive processes in energy conversion (combustion engines in particular) as well as the synthesis of new materials.

This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore the application of these principles to important engineering problems is demonstrated.

The class covers separation techniques that are central in the purification and downstream processing of chemicals and bio-pharmaceuticals. Examples from both areas illustrate the utility of the methods: 1) Liquid-liquid extraction; 2) Adsorption and chromatography; 3) Membrane processes; 4) Crystallization and precipitation.

The students should become familiar with the fundamentals of chemically reactive processes in energy conversion (combustion engines in particular) as well as the synthesis of new materials. The course is part of the focus "Energy, Flows & Processes" on the Bachelor level and is recommended as a basis for a future Master in the area of energy. It is also a facultative lecture on Master level in Energy Science and Technology and Process Engineering.

The students are supposed to obtain detailed insight into the fundamentals of separation processes that are frequently applied in modern life science processes in particular, fine chemistry and biotechnology.

The goal of the lecture is to expound design characteristics of systems for process engineering applications.
Content
Fundamentals of plant and apparatus design; materials in the process industries, mechanical design and design rules of main components; pumps and fans; piping and armatures, safety in process industry

Lecture notes
Script is available, English slides will be distributed

Literature

151-0957-00L
Practica in Process Engineering I

Prerequisites: "Einführung in Verfahrenstechnik" (151-0973-00L) and further process engineering courses.

Abstract
Practical training at pilot facilities for fundamental processing steps, typical laboratory and pilot facility experiments.

Objective
Getting acquainted with unit operations, measuring tools and data processing

Content
5 practica in total (3 from Prof. Norris, 2 from Prof. Rudolf von Rohr), details on dates are available at the beginning of the semester in ML H 14 and on our website

Heat transfer
Rudolf von Rohr

Residence time distribution
Rudolf von Rohr

Thin-film deposition
Norris

Elemental analysis
Norris

Photovoltaics
Norris

529-0613-00L
Process Simulation and Flowsheeting

Abstract
This course encompasses the theoretical principles of chemical process simulation, as well as its practical application in process analysis and optimization. The techniques for simulating stationary and dynamic processes are presented, and illustrated with case studies. Commercial software packages are presented as a key engineering tool for solving process flowsheeting and simulation problems.

Objective
This course aims to develop the competency of chemical engineers in process flowsheeting and simulation. Specifically, students will develop the following skills:
- Deep understanding of chemical engineering fundamentals: the acquisition of new concepts and the application of previous knowledge in the area of chemical process systems and their mechanisms are crucial to intelligently simulate and evaluate processes.
- Modelling of general chemical processes and systems: students have to be able to identify the boundaries of the system to be studied and develop the set of relevant mathematical relations, which describe the process behavior.
- Mathematical reasoning and computational skills: the familiarization with mathematical algorithms and computational tools is essential to be capable of achieving rapid and reliable solutions to simulation and optimization problems. Hence, students will learn the mathematical principles necessary for process simulation and optimization, as well as the structure and application of process simulation software. Thus, they will be able develop criteria to correctly use commercial software packages and critically evaluate their results.

Content
Overview of process simulation and flowsheeting
- Definition and fundamentals
- Classification: stationary (steady-state) versus dynamic (transient state) systems
- Fields of application
- Case studies

Process modeling
- Modeling strategies of process systems
- Mass conservation
- Species balance
- Energy conservation
- Momentum balance
- Multiphase-systems: equilibrium & non-equilibrium models
- Process system model

Process simulation
- Process specification
- Introduction to process specification
- Classification of mathematical models: AMS, DOE, DAE, PDE
- Model validation
- Software tools
- Solution methods for process flowsheeting
- Simultaneous methods
- Sequential methods
- Dynamic simulation
- Numerical solution: explicit and implicit methods
- Continuous-discrete simulation: handling of discontinuities

Process optimization and analysis
- Classification of optimization problems
- Linear programming
- Non-linear programming
- Dynamic programming
- Optimization methods in process flowsheeting
- Sequential methods
- Simultaneous methods

Commercial software for simulation: Aspen Plus
- Thermodynamic property methods
- Reaction and reactors
- Separation / columns
- Convergence & debugging
**Prerequisites / notice**

A basic understanding of material and energy balances, thermodynamic property methods and typical unit operations (e.g., reactors, flash separations, distillation/absorption columns etc.) is required.

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**636-0001-00L Separations in Biotechnology and Bioprocess**

**Economy** W 6 credits 3G S. Panke

**Abstract** Separations play an integral part of any biotechnological process. This course aims at enabling students specifically with a chemistry/biology background to select & roughly design suitable separation processes for typical biotechnological products such as monoclonal antibodies, antibiotics, and fine chemicals and at providing a basic set of purification operations & judge on process economy.

**Objective** Students should be able to select for a given biotechnological product a suitable set of purification operations and judge on process economy.

**Content** Lecture notes

**Literature** Microscale Acoustofluidics, T. Laurell and A. Lenshof, Ed., Royal Society of Chemistry, 2015

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**151-0185-00L Radiation Heat Transfer**

**Abstract** Advanced course in radiation heat transfer

**Objective** Fundamentals of radiative heat transfer and its applications. Examples are combustion and solar thermal/thermochemical processes, and other applications in the field of energy conversion and material processing.

**Content**


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**151-0104-00L Uncertainty Quantification for Engineering & Life Sciences**

**Abstract** Does not take place this semester. Number of participants limited to 60.

**Objective** Quantification of uncertainties in computational models pertaining to applications in engineering and life sciences. Exploitation of massively available data to develop computational models with quantifiable predictive capabilities. Applications of Uncertainty Quantification and Propagation to problems in mechanics, control, systems and cell biology.

**Content** The course will teach fundamental concept of Uncertainty Quantification and Propagation (UQ+P) for computational models of systems in Engineering and Life Sciences. Emphasis will be placed on practical and computational aspects of UQ+P including the implementation of relevant algorithms in multicore architectures.

**Literature** 1. Data Analysis: A Bayesian Tutorial by Devinderjit Sivia
2. Probability Theory: The Logic of Science by E. J. Jaynes
3. Class Notes

**Prerequisites / notice**

Fundamentals of Probability, Fundamentals of Computational Modeling

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**151-0509-00L Microscale Acoustofluidics**

**Abstract** In this lecture the basics as well as practical aspects (from modelling to design and fabrication ) are described from a solid and fluid mechanics perspective with applications to microsystems and lab on a chip devices.

**Objective** Understanding acoustophoresis, the design of devices and potential applications

**Content** Linear and nonlinear acoustics, foundations of fluid and solid mechanics and piezoelectricity, Gorkov potential, numerical modelling, acoustic streaming, applications from ultrasonic micro robots to surface acoustic wave devices.

**Literature** Yes, incl. Chapters from the Tutorial: Microscale Acoustofluidics, T. Laurell and A. Lenshof, Ed., Royal Society of Chemistry, 2015

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**Semester Project**

**Number** 151-1008-00L **Title** Semester Project Process Engineering **Type** O **ECTS** 8 credits **Hours** 17A **Lecturers** Professors

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**Multidisciplinary Courses**

The students are free to choose individually from the entire course offer of ETH Zurich, ETH Lausanne and the Universities of Zurich and St. Gallen.

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**Course Catalogue of ETH Zurich**
The subject of the Master Thesis and the choice of the supervisor (ETH-professor) are to be approved in advance by the tutor.

Abstract

The semester project is designed to train the students in the solution of specific engineering problems. This makes use of the technical and social skills acquired during the master's program. Tutors propose the subject of the project, elaborate the project plan, and define the roadmap together with their students, as well as monitor the overall execution.

Objective

The semester project is designed to train the students in the solution of specific engineering problems. This makes use of the technical and social skills acquired during the master's program.

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**Industrial Internship**

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<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>151-1012-00L</td>
<td>Industrial Internship Process Engineering</td>
<td>O</td>
<td>8 credits</td>
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<td>external organisers</td>
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</table>

Abstract

The main objective of the 12-week internship is to expose master's students to the industrial work environment. During this period, students have the opportunity to be involved in on-going projects at the host institution.

Objective

The main objective of the 12-week internship is to expose master's students to the industrial work environment.

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**GESS Science in Perspective**

Recommended GESS Science in Perspective (Type B) for D-MAVT.

see GESS Science in Perspective: Type A: Enhancement of Reflection Capability

see GESS Science in Perspective: Language Courses ETH/UZH

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**Master's Thesis**

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<th>Number</th>
<th>Title</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>151-1005-00L</td>
<td>Master's Thesis Process Engineering</td>
<td>O</td>
<td>30 credits</td>
<td>64D</td>
<td>Professors</td>
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</table>

Abstract

Master's programs are concluded by the master's thesis. The thesis is aimed at enhancing the student's capability to work independently toward the solution of a theoretical or applied problem. The subject of the master's thesis, as well as the project plan and roadmap, are proposed by the tutor and further elaborated with the student.

Objective

The thesis is aimed at enhancing the student's capability to work independently toward the solution of a theoretical or applied problem.

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**Seminars, Colloquia, and Additional Courses**

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<th>Number</th>
<th>Title</th>
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<tr>
<td>151-0931-00L</td>
<td>Seminar on Particle Technology</td>
<td>E-</td>
<td>0 credits</td>
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<td>S. E. Pratsinis</td>
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Abstract

The goal of the lecture is to convey a basic knowledge in the area of FV materials as well as their construction and production processes and to empower the students to apply the knowledge gained to address current problems in research and practice.

Objective

Students attend and give research presentations for the research they plan to do and at the end of the semester they defend their results and answer questions from research scientists. Familiarize the students with the latest in this field.

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<tr>
<td>151-0933-00L</td>
<td>Seminar on Advanced Separation Processes</td>
<td>E-</td>
<td>0 credits</td>
<td>1S</td>
<td>M. Mazzotti</td>
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</table>

Abstract

Research seminar for master's students and doctoral students

Objective

Research seminar for master's students and doctoral students

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<th>Number</th>
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<tbody>
<tr>
<td>227-0920-00L</td>
<td>Seminar in Systems and Control</td>
<td>E-</td>
<td>0 credits</td>
<td>1S</td>
<td>F. Dörfler, R. D'Andrea, J. Lygeros, R. Smith</td>
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Abstract

Current topics in Systems and Control presented mostly by external speakers from academia and industry see above

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<tr>
<th>Number</th>
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<tr>
<td>227-0950-00L</td>
<td>Acoustics</td>
<td>E-</td>
<td>0 credits</td>
<td>0.5K</td>
<td>K. Heutschi</td>
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Abstract

Current topics in Acoustics presented mostly by external speakers from academia and industry. see above

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<th>Lecturers</th>
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<tbody>
<tr>
<td>227-0970-00L</td>
<td>Research Topics in Biomedical Engineering</td>
<td>E-</td>
<td>0 credits</td>
<td>2K</td>
<td>M. Rudin, S. Kozerke, K. P. Prüssmann, M. Stampanoni, K. Stephan, J. Vörös</td>
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Abstract

Getting insight into actual areas and problems of Biomedical Engineering an Health Care.

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**Process Engineering Master - Key for Type**

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<th>Dr</th>
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<tr>
<td>Compulsory</td>
<td>Eligible for credits and recommended</td>
<td>Eligible for credits</td>
<td>Recommended, not eligible for credits</td>
<td>Courses outside the curriculum</td>
<td>Suitable for doctorate</td>
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<td>Key for Hours</td>
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<td>lecture with exercise</td>
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<td>practical/laboratory course</td>
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<td>A</td>
<td>independent project</td>
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<td>diploma thesis</td>
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<td>R</td>
<td>revision course / private study</td>
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ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.